A Radiological Study Concerning the Anterior Loop of the Mandibular Canal and the Location of the Mental Foramen in a Greek Population

SUMMARY

The mental foramen can be found in various locations, ranging from the root of the first lower premolar to the roots of the first molar. The anterior loop is described as the mental canal, which rises from the mandibular canal and runs outward, upward, and backward to open at the mental foramen. The knowledge of the location of the mental foramen and the existence of an anterior loop is important for successful administration of local anaesthesia, for surgical (including implantology), operative or diagnostic purposes. The aim of the study was to evaluate the radiographic appearance of the position of the mental foramen and the presence of an anterior loop of the mandibular canal in a Greek population. 1000 panoramic radiographs of Greek adult patients were interpreted. The course of the mandibular canal and the position of the mental foramen were evaluated.

The most frequent position of the mental foramen was under the second lower premolar (52.9%), followed by the one between premolars (32.3%). An anterior loop of the mandibular canal was present in 29.8% of the radiographs observed. The anterior loop demands attention during pre-surgical evaluation for implant placement. Our results are in agreement with the results of similar studies of other ethnic groups.

Keywords: Mental Foramen; Panoramic Radiographs

Introduction

Panoramic radiographs are a useful tool for the dentist. Their correct interpretation requires good knowledge of the anatomical structures of the facial region and the mandible, including the mandibular canal and the mental foramen. The inferior alveolar neurovascular bundle enters the mandibular foramen and travels forward with the mandibular canal. It is divided into 2 terminal branches, the mental and incisive neurovascular bundle. The incisive bundle continues within the incisive canal, while the mental bundle exits at the mental foramen. There is 1 mental foramen on each side of the mandible through which the mental artery and vein and the mental nerve pass. The mental nerve is the largest of the 2 terminal branches of the inferior alveolar nerve. There may be more than 1 mental nerves and the inferior alveolar nerve may extend beyond the mental foramen as an intraosseous anterior loop. The anterior loop is described as the mental canal, which rises from the mandibular canal and runs outward, upward, and backward to open at the mental foramen. In radiographs, the mental foramen appears as a radiolucent area in the lower premolar region. The mental foramen can be found in various locations, ranging from the root of the first premolar to the roots of the first molar.

The knowledge of the location of the mental foramen is important for successful administration of local anaesthesia (mental nerve block anaesthesia) for surgical, operative or diagnostic purposes and for endodontic treatment. The position of the mental foramen and the presence or absence of an anterior loop is of great importance for oral surgeons as they often have to operate in the region of the lower premolars or to insert implants in the inter-foraminal region of the mandible. Post-
surgical complications (e.g. neurosensory dysfunction or failure of osseointegration) are possible when this loop is not identified, as placement of implants in this area may impinge on the inferior alveolar nerve. Thorough evaluation of the anatomical structures of the maxilla and the mandible is basic for every pre-surgical planning. Panoramic radiographs are commonly used for this reason.

In order to avoid this kind of complications, it is important for every oral surgeon to evaluate the radiographic appearance of the course of the mandibular canal and to have in mind the individual variations of the location of the mental foramen. Increased knowledge concerning the occurrence and the radiographic appearance of the anterior loop should heighten the success of implant placement into the anterior mandible.4

Yosue and Brooks34,35, classified the radiographic appearance of the mental foramen into 4 types: (1) Continuous type which shows continuity with the mandibular canal through the mental canal, (2) Separated type, in which the foramen is distinctly separated from the mandibular canal; (3) Diffused type, in which the foramen has an indistinct border; and (4) Unidentified type, in which the mental foramen cannot be identified on the panoramic radiographs.

The above classification does not refer to the presence or absence of an anterior loop, probably because when it was first described dental implants were not yet widely used in clinical practice. The purpose of this study was to evaluate the radiographic appearance of the position of the mental foramen and the presence of an anterior loop of the mandibular canal in Greek people.

Material and Methods

1000 panoramic radiographs of Greek adult patients were interpreted in order to evaluate the course of the mandibular canal and the position of the mental foramen. All radiographs were taken at the department of Oral Surgery, Surgical Implantology and Dental Radiology of the Aristotle University of Thessaloniki Dental School.

Inclusion criteria:
- Panoramic radiographs from Greek patients with fully erupted lower premolars
- No radiopaque or radiolucent areas near the mental foramen region
- No exposure or processing artefacts/good contrast.

a) Position of the Mental Foramen

If one or more of the mandibular premolars was missing then only the side with both premolars, if there was one, was evaluated for the position of the mental foramen. The sides that had one or both lower premolars missing were evaluated only for the type of the mental foramen.

The position of the radiographic image of the mental foramen was classified into 5 positions using the mandibular first and second premolars as reference guides. Mental foramina that could not be identified were characterized as having position 0.

Position 0: unidentified mental foramen;
Position 1: situated anterior to the first premolar;
Position 2: situated in line with the first premolar;
Position 3: situated between the first and the second premolar;
Position 4: situated in line with the second premolar;
Position 5: situated posterior to the second premolar.

In cases where multiple foramina were seen then the true radiographic mental foramen was considered to be the uppermost and rearmost landmark because there is the possibility that a part of the mental canal may be observed as a second or third foramen.34,35

For avoiding problems during measurements and sample selection, we used a modification of the method that Green9 used in a similar study. A transparent plastic membrane was used, which was marked with a “T”. The horizontal portion of the “T” was aligned with the apparent occlusal plane and the vertical part was used to locate the foramen. If any part of the foramen met the vertical line passing along the longitudinal axis of a tooth, the foramen was classified to that position. If any part laid on the vertical line passing through the contact area between the teeth, it was assigned to that position. If the foramen was too small to intersect a line or too large, intersecting 2 lines, then it was assigned to the position that the foramina centre was closer to. If the centre was in the middle between 2 positions, then the foramen was assigned to the more anterior position.

The symmetry or not of the position of the mental foramina on the 2 sides was also recorded. This was done only in the cases that both sides had the 2 premolars present.

b) Type of Mental Foramen

Because Yosue and Brook’s classification34,35 did not clearly present the cases of an anterior loop radiographic image as a separate type of mental foramen, we modified it. We subdivided the “continuous type” into 2 subtypes: I) the continuous type without an anterior loop and II) the continuous type with an anterior loop (anterior loop type). The complete classification was:

1. Continuous type without an anterior loop (Fig. 1);
2. Anterior loop type (Fig. 2);
3. Separated type (Fig. 3);
4. Diffused type (Fig. 4);
5. Unidentified type (Fig. 5).

The radiographs were examined and the findings were classified to the above 5 types. The symmetry of the type of mental foramen on the 2 sides of the mandible was also recorded.
The radiographs were interpreted by 2 observers. If there were any differences in the results then a third observer with experience in oral radiology would make the final evaluation.

## Results

A total of 1000 panoramic radiographs were examined, 448 of which concerned male and 552 female Greek adults. There was no difference in the distribution of the position of the mental foramen by gender (p<0.001). 769 panoramic radiographs (in which premolars were present on both sides and the mental foramina were not unidentified) were evaluated for the symmetry of the position of the foramen on the 2 sides. In only 62.9% of the examined radiographs the position of the foramen was symmetrical. For this reason and because gender made no difference to the distribution, each side of the mandible was considered as an independent unit.

1757 sites in which both lower premolars were present were evaluated for the position of the mental foramen as mentioned above. The results are presented in table 1. The most frequent position of the mental foramen was in line with the second lower premolar (52.9%). In 32.3% of the cases, the radiographic image of the total number of mental foramina was found to be between the first and second premolar followed by the position in line with the first premolar (4.9%). In 3.6% the mental foramen was behind the second premolar and in 0.6% in front of the first premolar. In 5.6% of the examined sites the mental foramen was unidentified.

All 1000 radiographs were evaluated for the type of the mental foramen (2000 sites - table 2). Gender did not influence the distribution. The most frequent type of mental foramen was the “continuous type without an anterior loop” (59.6%). The “anterior loop type” was present in 29.8%, followed by the “separated type” (3.6%) and the “diffused type” (1.8%). In 5.2% of the sides examined the mental foramen was unidentified.
In 929 radiographs in which the type of the mental foramen was not unidentified on either side, the symmetry of the type was evaluated. In 85.6% the type was symmetrical on the 2 sides.

<table>
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<th>TOTAL</th>
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<td>TOTAL</td>
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Table 1. The position of the mental foramen in relation to the mandibular premolars

Position 0: unidentified mental foramen; position 1: situated anterior to the first premolar; position 2: situated in line with the first premolar; position 3: situated between the first and the second premolar; position 4: situated in line with the second premolar; position 5: situated posterior to the second premolar

<table>
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<td>(22.4)</td>
<td>448</td>
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Table 2. The type of the mental foramen

Type 1: Continuous type without an anterior loop; type 2: Anterior loop type; type 3: Separated type; type 4: Diffused type; type 5: Unidentified type

Discussion

In the literature, it is mentioned that the mental foramen is located at the midpoint of the inferior border of the mandible and the alveolar crest in the region of the second premolar. A clinically significant amount of individual variation exists but the most frequent position of the mental foramen in Greek people was found to be the one situated in line with the second premolar. There was no difference in the distribution of the position of the mental foramen by gender.

In clinical dentistry, the knowledge of the variations of the position of the mental foramen is necessary for both the successful administration of mental nerve block anaesthesia and the differential diagnosis of small radiolucencies in the premolar and molar regions of the mandible. It is also important for an implantologist to identify the anterior loop in the course of the mandibular canal, especially in cases of implant placement in the anterior region of the mandible.

Errors in patient positioning and variations in facial morphology can lead to mesial and distal angulations of the X-ray beam. Comparative studies on dry skulls have shown a close correlation with the radiographic location of the mental foramina. It seems that the shift in the actual antero-posterior position of the mental foramen in panoramic radiographs is insignificant.

The findings of our study are similar to the findings of other studies, concerned with other ethnic groups. Most studies, conducted in different ethnic and racial groups, showed that the most common position of the mental foramen was in line with the longitudinal axis.
of the lower second premolar tooth. The second most common place was between the longitudinal axes of the first and the second premolar. These studies included analyses of radiographs or direct measurements on human specimens. Few studies showed that the most common position of the foramen was the one between the axes of the first and the second premolar closely followed by the one below the longitudinal axis of the lower second premolar. Fishel et al found that in periapical radiographs the highest percentage of mental foramina was located between the 2 premolars (70%). In a later study, Phillips et al found that in periapical radiographs (using the paralleling technique), the radiographic position of the foramen was an average of 2.18 mm mesial to the actual position. The mesial shift of the foramen in panoramic radiographs was found to be only 0.13 mm.

In our study the radiographic appearance of an anterior loop of the mandibular canal was present in a significant percentage (29.8%). Many authors studied the existence of an anterior loop. Bavitz et al compared measurements of the radiographic length and the actual length of the anterior loop in human specimens and found that there is a clear tendency to overestimate the length of the anterior loop in radiographic examinations. He found that although the radiographic length of the loop varied from 0.0 to 7.5 mm, the actual length varied from 0.0 to 1 mm, stating that no correlation exists between the radiographic versus the clinical loop. These findings were not in agreement with the findings of others. Arzouman et al demonstrated that the skeletal length of the anterior loop was significantly greater than that measured radiographically. They found a loop length of 3.18 to 3.45 mm in panoramic radiographs of 25 dry skulls; when they measured the loop in the dried mandibles, they found an average of 6.95 mm. They also found that significantly fewer loops were detected in radiographs as compared with anatomic assessment. They recorded loop existence in 92-96% of the direct measurements (56-76% in radiographic measurements using 2 different panoramic radiographs). They used bone markers inserted into the canal. The accuracy of his method was later questioned.

Radiographs). They used bone markers inserted into the nerve prior to its exit from the mental nerve, with a length of up to 5 mm. They recommend that a safe distance of at least 6 mm anterior to the mental foramen should be maintained when performing surgery in the mandibular premolar region. Misch and Crawford state that the loop averages 5 mm and is visible radiographically 12% of the time.

Rosenquist in a study conducted in patients in whom nerve transposition were performed for implant placement, found that the anterior loop of the inferior alveolar nerve was present in only 26% of the patients (in 15 out of 58 patients), and it was not bigger than 1 mm. Bavitz says that the anterior loop may represent a well defined incisive canal. If that’s the case and there is an incisive nerve of considerable thickness, it is still important for an implantologist to avoid placing an implant in that region.

If an implant is placed in contact with the branch of the nerve, then 2 problems may erupt: firstly, the implant may fail to integrate due to the migration of soft tissues around the implant; secondly, trauma of the branch of the nerve centrally to its separation can cause neurosensory dysfunction. He gives another possible explanation of the radiographic image of the anterior loop: it may be a radiographic phenomenon caused by the mylohyoid line and/or a deep sublingual fovea.

Answers should be given to these hypotheses. Until then, surgeons should avoid placing implants to the region which is in close proximity to the mental nerve, especially when there is a radiographic image of an anterior loop. When they do they must thoroughly detect the walls of the prepared site within the bone prior to the placement of the implant.

It is important to positively identify the mental foramen radiographically before surgery in the region. The modification of the flap design accordingly, would be beneficial. The placement of an implant near the mental foramen without taking into account an anterior loop, can lead to a direct contact of the implant to the neural branch. Nevertheless, because the radiographic determination of the mental foramen is quite challenging, it is recommended that the mental neurovascular bundle be identified in vivo during implant placement and surgery in the region.

Conclusions

In panoramic radiographs of Greek adults the most frequent position of the mental foramen is in line with the second lower premolar. The anterior loop is present in a significant percentage of the population and demands attention during pre-surgical evaluation for implant placement. Our results are in agreement with the results of similar studies concerned with other ethnic groups.

References