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Research Paper: CBCT Anatomic Characteristics of Mental Foramen and Anterior Loop of Mandibular Canal in a population of South IRAN

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ABSTRACT

Introduction: Regarding the anatomic variety in the anterior mandible it is necessary to obtain adequate information about the vital structures in this area to protect them in dental surgeries and preventing injuries that might occur afterwards. The aim of this study is to describe anatomic characteristics of mental foramen and anterior loop on CBCT images.

Materials and Methods: On CBCT images of 326 hemimandibles, opening angle of mental foramen, vertical distance from mental foramen to the mandibular inferior border, location of mental foramen in relation to nearby teeth and the length of the anterior loop were measured.

Results: Anterior loop was present in 52.1% of hemimandibles. The mean exit angle of mental foramen was 42.72±10.82 degrees. The highest frequency of the location of mental foreman with respect to the adjacent teeth was between the first and second premolar and the lowest frequency was between canine and the first premolar as well as between the second premolar and the first molar. The mean distance from mental foreman to the mandibular lower border was 15±5.85 millimeters. The mean length of the anterior loop was estimated to be 3.92±1.17 millimeters.

Conclusion: Regarding variations in anatomic characteristics of mental foramen and anterior loop, precise examinations of these vital structures are necessary to protect them during surgical procedures of mandible.

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Introduction

Mandibular surgical experiments like insertion of dental implants and chin bone graft in the area between two mental foramina can potentially injure the vascular or neural content of the passing mandibular canal through this region which result in hemorrhage and neuro-sensory disorders (1-4). Surgical procedures might damage inferior alveolar nerve and lingual nerve in 64.4% and 28.8% of cases, respectively. The risk of sensory damage of the lower lip after implant placement in interforaminal area is about 7-10% (4). This vindicates the need to precise anatomic information of the vital landmarks including mental foramen, anterior loop of mandibular canal and the incisive canal (5).

As there is no particular or tangible anatomic landmark to determine the precise location of these structures, radiography is to be unavoidably used to assess the presence and location of them prior to the surgery (2).

Two-dimensional imaging techniques (periapical and panoramic imaging) help to provide a dentist with adequate information about the teeth, alveolar bone, and pathologic changes as well as how they affect the surrounding structures. However, due to magnification, distortion and inefficiency in the buccolingual dimension, they are of limited advantage in anterior mandible (4, 6-10).

Sectional imaging such as computed tomography (CT) and cone beam computed tomography (CBCT) are capable of reconstructing images in three main coronal, sagittal, axial planes. For the reason that overlapping of structures is removed, it can provide more reliable information (11, 12). Conventional CT-scan was reported to be able to display mental foramen and the anterior loop of mandibular canal in 7 and 10% of cases, respectively. This capability can be increased up to 55% via the spiral CT-scan technique (13).

As an advanced imaging technique, CBCT has the ability to reconstruct three-dimensional images through a one-cycle rotation of a cone shaped X-ray source utilizing certain algorithms (14). Not only patient exposure to X-ray radiation is reduced in comparison to CT-scan, but it is also of a higher spatial resolution resulting in displaying anatomic structures with a higher precision.

Regarding the anatomic variety in the anterior mandible and the fact that this segment is vulnerable during surgical procedures, it is necessary to obtain adequate information about the vital structures in this area to protect them in dental surgeries and preventing injuries and problems that might occur afterwards (15). The aim of this study is to describe anatomic characteristics of mental foramen and anterior loop on CBCT images.

Methodology

The present research explored the CBCT images of 163 patients who referred to a private oral and maxillofacial radiology center in Bandar Abbas, Iran. CBCT scans records were taken with a Pax Duo-3D, Vatech CBCT device for analysis before implant placement and other clinical indications such as impacted tooth assessment. According to the altered anatomic morphology of the mandible, exclusion criteria were the positive history of trauma and pathologic conditions, previous jaw surgery, edentulous patients as well as those with mixed dentition.

The scanning accomplished using available imaging protocols: field of view (FOV) of 8.5*8.5 and 8.5*12.5cm and a 0.2-mm voxel size. All the volumes included the anterior and middle mandibular body bilaterally at least from the right 1st molar to the left one and were of adequate diagnostic quality. Exposure parameters of KVp and mA were set automatically based on patient's anatomy. Patients were in a standing straight position with horizontal occlusal plane through scanning.

The images reconstruction, measurements and analysis were compiled by the use of default software EZ3D.

Initially, the axial plane was set with the mandibular inferior border so that the reconstructed cross-sectional images oriented perpendicular to the lower mandibular border. To assess the presence of the anterior loop of mandibular

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canal and measure its length, the reconstructed panoramic like image was considered.

On reconstructed cross-section containing the mental foramen, the crossing angle between the long axis of alveolar process and emerging direction of the mental nerve was recorded as opening angle of mental foramen.

The vertical distance from the central point of mental foramen to the mandibular inferior border measured in millimeters to determine the relation of mental foramen to the mandibular body.

The location of mental foramen in relation to nearby teeth was classified as between canine and 1st premolar, just mesial to the 1st premolar, along the apex of the 1st premolar, just distal to the 1st premolar, between the 1st and 2nd premolars, just mesial to the 2nd premolar, along the apex of 2nd premolar, just distal to the 2nd premolar and between the 2nd premolar and 1st molar.

On reconstructed panoramic like image, the horizontal distance from the anterior border of mental foreman to the most anterior limit of the present anterior loop was considered as the length of the anterior loop.

Data were analyzed with Statistical Package for Social Sciences 18, using Chi-square, Mann-Whitney U-test and Kruskal-Wallis tests.

Results

The study sample consisted of 163 CBCT scans containing 326 hemimandibles. From these, 118 (36.2%) hemimandibles belonged to 59 male while 208 (63.8%) belonged to 104 female. The age group 60-69 years had the lowest frequency (3.1%) whereas the age group 30-39 years enjoyed the highest frequency (35%) in the sample.

From the total sample, in 170 hemimandibles (52.1%) the mandibular canal ended to mental foramen with anterior loop and in 156 (47.9%) without that. The frequency of anterior loop was 51% in male and 52% in female with no statistically significant difference (p=.902).

The mean exit angle of mental foramen was 42.72±10.82 degrees. In male, this angle was 42.23±10.01 while it was 43.01±11.27 in female. This divergence was not, however, statistically significant as Mann-Whitney u-test results revealed (p=.423).

The highest frequency of the location of mental foreman with respect to the adjacent teeth was between the first and second premolar (31%) and the lowest frequency was between canine and the first premolar as well as between the second premolar and the first molar (0.3%). According to the chi-square test results, no statistically significant difference was found in different location groups (p=.713).

As Mann-Whitney test results revealed (p< .001). The mean distance from the center of mental foreman to the mandibular lower border was found to be 15±5.85 millimeters. The mean score was reported to be 17.10±9.28 in male and 14.29±1.44 in female. As revealed by Mann-Whitney u-test results (p<.001), the difference was significant.

The frequency of the anterior loop in the right and left hemimandibles was respectively 51% and 52% which was not statistically different (p=.825). The mean length of the anterior loop was estimated to be 3.92±1.17 millimeters. This mean length was reported to be 4.4±1 in male and 3.6±1.1 in female with a statistically significant difference. The mean emerging angle of mental foramen from the mandible in right and left sides was respectively 42.49±10.91 and 42.96±10.77 degrees which was not statistically significant.

Discussion

This study was conducted to assess the location of MF regarding adjacent teeth, its position related to the mandibular inferior border and its exit angle from the mandible. Surgical procedures in the anterior mandible are accompanied by potential injuries to existing neuro-vascular structures in this area causing surgical and postsurgical complications such as bleeding, pain and permanent or temporary numbness. That is why an awareness of the proximity and interlinks of the sensitive anatomic elements in this area is essential.

CT and CBCT scans are sectional imaging

Journal of Dentomaxillofacial Radiology, Pathology and Surgery

modalities free of superimpositions and distortions with improved contrast resolution and acceptable spatial resolution which further makes them appropriate to evaluate anatomic structures as precisely as possible (9, 10, 16-18).

In an attempt to measure the length of the anterior loop in corpses, U Chida et al. applied two methods, a direct measurement and an indirect one using CBCT images. The mean difference of the two measures was reported to be .05 millimeters. Due to the insignificant difference between the two methods, these researchers suggested CBCT imaging as a reliable and precise method to do such measurement (15).

The present study found a detection rate of 100% and 3.68% for mental foramen and accessory foramens, respectively. Twelve out of 326 hemimandibles, had one accessory mental foramen from which 4 were on the right and 8 were on left mandible. Similarly, Muinelo-Lorenzo et al. used CBCT images and estimated the frequency of mental foreman as 100% and that of the accessory foreman as 13% (17). The frequency of mental foreman and accessory foreman was reported by Khojastepour et al. to be respectively 100% and 5.1% (19). von Arx et al. (20) reported that from 142 cases they studied, 26 individuals had MF on both sides of mandible (bilateral), whereas in 116 cases MF occurred unilaterally. These figures are surprisingly different introducing the probable role of ethnicity. It is necessary to aware the surgeon about the presence of accessory mental foramen to prevent common surgical complications.

In a variety of investigations, the most frequent location of mental foreman was between the first and second premolar teeth (16) or below the apex of 2nd premolar (17). In the present research, the predominant location of MF was between the apex of 1st and 2nd premolar in right hemimandibles and apical to the 2nd premolar in left ones with no significant difference for gender or side. Taking clinical crowns as reference, the most frequent location of MF was in line with the 2nd premolar.

Considering the opening angle of mental foreman, a raising question is the probable effect of this factor on the success rate of anesthesia injections for mental nerve block. The mean opening angle of mental foreman in a coronal view was reported by Von Arx (20) as 46.8 degrees toward superior and in an axial view as 69.2 degrees toward posterior. Muinelo-Lorenzo (17) estimated the mean opening angle of mental foreman as 53.45±15.9 degrees and in the present research it was found to be 42.72±10.82 degrees related to the long axis of alveolar process. In all cases, mental foramen opened upward which was consistent with the findings of similar investigations. The opening angle of mental foreman was reported by Muinelo-Lorenzo to be wider in men than women (17). In Von Arx's investigation (20) as well as the present research this variable did not show to significantly differ between the male and female. Moreover, Muinelo-Lorenzo et al. observed that this opening angle was wider among the elderly while no significant divergence was observed in the present study in different age groups (17). Their results also demonstrated the MF diameter, shape and exit angle influence on their visibility on panoramic radiography as oval shaped MF with higher exit angle had the best visibility.

The mean distance of mental foramen from the lower border of mandible in this study was 15±1.78 mm. Muinelo-Lorenzo and Von Arx independently found a longer distance between mental foreman and the lower mandibular border in male (17,20) consistent with the present findings. This could be due to the fact that the height of alveolar bone is expected to be higher in men. Due to the probable resorption and diminished height of alveolar process, lower mandibular border was selected as reference point for this measurement.

The frequency of mandibular canal's anterior loop has a wide range based on various studies from 7.7% to 85.2 % (14). In present research performed in south Iran, anterior loop was visualized in 52.1% of cases. Dalili Kajan and parnia launched similar studies in north Iran and reported the frequency of anterior loop to be 36.9% and 84% (21, 22). This discrepancy can be ascribed to ethnic factor, method of

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amination (cadaveric and two or three dimensional radiographic) and the quality of alveolar bone. As being an intramedullary structure surrounded by thick cortical plates makes it difficult to differentiate in plain films. Since panoramic is a commonly used radiography in dental examination, not visualizing the anterior loop on panoramic radiography, does not mean it is absent and CBCT is to be used for investigating anterior loop of mandibular canal.

No statistically significant difference was observed between male and female patients in terms of the frequency of the anterior loop in this and other similar studies.

The right and left hemimandibles showed no statistically significant difference in terms of the frequency of the anterior loop.

The mean length of the anterior loop of mandibular canal was reported by Apostolakis, Nacimento and I Lu to be respectively .89, 1.1± .8 and 1.46±1.25 millimeters (1, 5, 21). In the present research, the mean length of this loop was found to be 3.92±1.17 millimeters. The prevalence of 52.1% and the length variation range of 1.5 to 7.20 millimeters in the present research enhances the necessity of accurate examination of interforaminal region with the help of precise radiographic techniques. As in a number of cases, even when a distance of 5 millimeters is considered from the mental foramen, there is still a probability of neuro-vascular injury.

In their investigations, Nacimento, Rosa and Sahman observed that the anterior loop of mandibular canal was longer in men than women which is consistent with the present findings (21-23).

Conclusion

Due to the probable threats that might result from disregarding mental foreman and the anterior loop of mandibular canal in surgeries to the lower jaw, these susceptible anatomic structures need to be investigated thoroughly to prevent neurovascular injuries. As panoramic radiographies have some limitations in diagnosis of these structures, advanced technologies such as CBCT scan are needed to obtain more precise exand thorough information with this respect.

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