

ASSESSMENT OF MENTAL FORAMEN AND ANTERIOR LOOP OF THE MENTAL NERVE USING CONE BEAM COMPUTERIZED TOMOGRAPHY: ITS CLINICAL CORRELATION IN SURGICAL INTERVENTIONS IN MANDIBLE IN INTER-FORAMINAL REGION

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ABSTRACT

Background- The anatomy of the mental foramen and its anterior loop is critical for surgeons performing surgical procedures in the interforaminal region of the mandible.

Material and Methods- 60 CBCT images of patients planned for anterior mandibular surgery were studied. Mental foramina were analyzed for position, dimensions, and distances from the midline, alveolar crest, and mandibular border, including mesial extension length. Postoperative neurosensory deficits were assessed on days 1, 7, and at 1 and 3 months using two-point discrimination, contact detection, sharp/blunt discrimination, and thermal tests.

Result- The most common position of mental foramen was found to be in between 1st and 2nd premolar (57%). The mean distance from midline of mandible, alveolar crest and inferior border of mandible to mental foramen was 22.49 mm, 11.56 mm and 12.8 mm respectively. The mean length of anterior loop was 3.02 mm. Statistically significant difference was found genders in case of height of mental foramen and its distance from inferior border of mandible. None of the patients showed post-operative neurosensory deficit.

Conclusion- This study concludes preoperative examination of mental foramen in CBCT images can prevent mental nerve injury while performing surgical procedure in anterior mandible.

KEYWORDS- Mental foramen, Anterior loop of mental foramen, CBCT

INTRODUCTION

Mandibular nerve is the third division of the trigeminal nerve and it enters the mandible through mandibular foramen. The terminal part of the inferior alveolar nerve sometimes passes below the mental foramen as an intraosseous anterior loop. Mental foramen in the embryonic period is at the apical area of the canine and first deciduous molar and is displaced anteriorly but after eruption of second deciduous molar it redirects posteriorly, that displacement is a possible cause for development of anterior loop of inferior alveolar nerve before it emerges as mental nerve. [1,2]

The most important anatomical landmark for any surgical procedures in the inter-foraminal region is the mental foramen due to the possibility of presence of anterior loop of mental nerve. The surgeons should be aware of this while considering regional anesthesia, incisions, flap elevation, and osteotomy in the inter-foraminal region of mandible. In the anterior region of mandible during insertion of dental implants, surgical removal of roots or teeth, cyst, tumor or orthognathic surgery, and fixation of bone fractures, the clinician must be careful to avoid damage to the neurovascular bundle emerging from the mental foramen. [3,4]

Failure to identify the IAN preoperatively might result in iatrogenic damage to the nerve. Damage to the anterior loop may present as anaesthesia, paraesthesia, dysesthesia, of the mental nerve. The mental nerve supplies sensation to labiomental area and gingival tissue up to the mandibular second premolar. Altered sensation in this region may impede the ability to perform routine activities such as eating, speaking and even tooth brushing.

The present study aims to radiographically determine the position of mental foramen and the mesial extension of the anterior loop of mental nerve by using CBCT in patients requiring surgical procedures in anterior mandible and use this data while performing surgery. Postoperatively patients were reviewed if there was any neurosensory deficit. Our study is

to assess the reliability of cone beam computed tomography (CBCT) findings of morphometric dimensions of mental foramen to predict possible post-surgical mental nerve injury.

MATERIAL AND METHOD

This is a prospective analytical study carried out for a duration of 18 months from February 2021 to September 2022. Patients seeking treatment requiring surgery in the anterior mandible such as implant placement, genioplasty, ORIF for anterior mandible fracture, impacted teeth removal, and distraction osteogenesis for alveolar bone regeneration were considered for the study. 60 subjects (120 Hemimandibles) from the age group of 16-65 years who were fulfilling the inclusion criteria were selected. A prior ethical approval was obtained from the Institutional Ethical Committee before the start of the study. All images were taken prospectively following a standardized protocol for patient positioning, exposure parameters (60-90 kVp, 4-12.5mA, 20 sec) and image acquisition at 0.3 mm voxel size by the same radiographer. These images were reconstructed from the CBCT data using proprietary ONDEMAND 3D and Scanora software.

Inclusion criteria:

1. Patients from the age group of 16 and 65 years.
2. Patient required Implant surgery, Distraction osteogenesis, ORIF for fracture, Impacted tooth removal in the anterior part of the mandible.
3. Patient required Genioplasty procedure for aesthetic correction.

Exclusion criteria:

1. Presence of systemic diseases affecting growth and developmental anomalies.
2. Pregnancy/ Lactating & psychiatric patients.
3. Patient with pre-existing sensory disturbance in the lip and mucosa at the anterior region.

The parameters that were observed in the study in each CBCT pre-operatively are:

- position of mental foramen with respect to teeth
- distance of mental foramen from midline
- dimension (height and width) of mental foramen
- position of mental foramen from alveolar crest
- position of mental foramen from inferior border of mandible
- length of anterior loop (mesial extension)

Position of mental foramen with respect to tooth: The position of mental foramen was first seen on 3D view. The position of mental foramen was classified as follows according to Ngeow et al: [5]

1. Position 1: The mental foramen is located in front of the first premolar
2. Position 2: The mental foramen is located in line with the apex of the first premolar
3. Position 3: The mental foramen is located between first and second premolars
4. Position 4: The mental foramen is located in line with the apex of the second premolar
5. Position 5: The mental foramen is located between the second premolar and the first molar
6. Position 6: The mental foramen is located under the apex of the mesial root of the first molar

Height and width of mental foramen, position of mental foramen from alveolar crest, inferior border of mandible and that from the midline is measured in millimeters in coronal section.

Length of anterior loop (mesial extension)- The inferior alveolar nerve was traced with the software along with the anterior loop and part of the incisive nerve. Vertical lines were drawn on the panoramic view from the slice that corresponded to the opening of mental foramen and the most anterior point of the AnLL as seen from the cross-sectional view. The opening of the mental foramen from the cross-sectional view and translated to the panoramic view and marked as Point-1 (P1). Point-2 (P2) was marked on the most anterior confinement of the anterior loop and a measurement was made from P1 to P2, as depicted in Figure 1. [FIGURE-1]

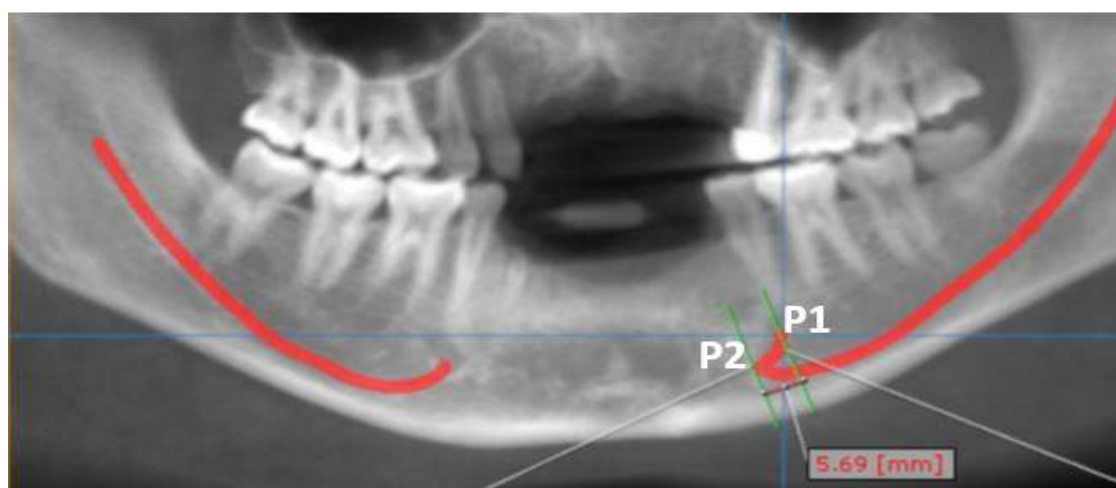


FIGURE- 1- MEASUREMENT OF MESIAL EXTENSION OF MENTAL NERVE

Postoperative nerve injury test

After measuring the above-mentioned parameters regarding mental foramen, surgical procedures were carried out in each individual patients. Post-operative neurological symptom namely paraesthesia was evaluated for all cases on postoperative 1st day, 7th day, 1st month, 3rd month by two-point discrimination, contact detection, sharp blunt discrimination, thermal test method of nerve testing. Testing was performed over a 1-cm span on the labio-mental at the anterior region of mandible. The right side of the labio-mental fold was taken as control site. Any abnormality noted in the sensation was recorded. [6]

Level A Test

Two-Point Discrimination Test - The two pointed, but not sharp, tips of the calliper touched the skin simultaneously with light pressure while the patient's eyes were closed. The separation of the two points was gradually reduced from 20 mm at the chin and 10 mm at the lip at 2 mm interval to the moment where the patient could feel one point only. This was repeated three times for each test area. The minimum separation at which two points could be detected was recorded. Distances 2 mm greater than the normal values were considered abnormal. They are considered diminished at 15-20 mm and absent above 20 mm. [6]

Level B Test

Contact Detection (Light touch)- This test was done by wisp of cotton wool. The patient's perception of touch is evaluated on contact in the region of the operated and unoperated site (control). [6]

Level C Tests

Sharp Blunt Discrimination test- This test was done by touching the test area with a sharp or a blunt head of the mechanical probe. A rubber stopper is centred at the end of the dental probe so that when the tip is pressed to the skin, a constant degree of skin indentation was caused. The patient has to decide whether the stimulus was sharp or blunt. [6]

Thermal Test- Perception of warmth is attributed to the integrity of A delta fibre and cold to C fibre. Two small glass tube containing water at 50°C (warm) and 15°C (cold) were used. The report of each stimulus i.e. cold versus hot was recorded. [6]

STATISTICAL ANALYSIS

The study data were analyzed using SPSS [Statistical Package for Social Sciences] v.26 [IBM, Corp.,] for Windows. Descriptive analysis of all the explanatory and outcome parameters was done using mean and standard deviation for quantitative variables, frequency and proportions for categorical variables. Chi-square test was used to compare the difference types of Anterior loop on mental foramen based on the side and gender of the study patients. One-way ANOVA test followed by Tukey's post hoc test was used to compare the mean length based on the type of anterior loop. The level of significance was set at $P < 0.05$. And any other relevant test, if found appropriate during the time of data analysis was dealt accordingly.

RESULT

60 CBCT images were studied, that includes 120 sites of mental foramen (60 right and 60 left side). Among them, 43.33% ($n = 26$) of sites were of male candidates and 56.67% ($n = 34$) were of female. All patients included in the study were planned for surgical procedure in the anterior region of mandible. It includes placement of dental implants ($n = 37$; 61.67%), ORIF for symphysis or parasymphysis fracture ($n = 15$; 25%), surgical removal of anterior impacted tooth ($n = 6$; 10%), distraction osteogenesis ($n = 2$; 3.33%).

Position of mental foramen with respect to teeth

In our study, the most common position of mental foramen is found to be in between 1st and 2nd premolar (57%), followed by in line with 2nd premolar (31%), in between 2nd premolar and 1st molar (7%), in line with 1st premolar (5%). In none of the cases mental foramen was found in between in front of 1st premolar and under the apex of the mesial root of the first molar. The position of mental foramen was compared among genders and sides, but no statistical difference was found.

Distance of mental foramen from midline

In the present study, mean distance from midline of mandible to mental foramen was found to be 22.49 ± 3.12 mm.

Dimension (height and width) of mental foramen

The mean height of mental foramen was found to be 2.53 ± 0.91 mm. There was statistically significant difference in height of mental foramen among genders, with males (2.92 ± 0.93 mm) having greater dimension than female (2.23 ± 0.78 mm).

The mean width of mental foramen was seen as 3.63 ± 1.22 mm.

Position of mental foramen from alveolar crest

In the present study, mean distance from mental foramen from alveolar crest was 11.56 ± 2.16 mm.

Position of mental foramen from inferior border of mandible

In the present study, mean distance of mental foramen from inferior border of mandible was 12.8 ± 1.62 mm. There was statistically significant difference among genders with males (12.37 ± 1.56) having greater distance than female (12.11 ± 1.32).

Length of anterior loop (mesial extension)

In present study, the mean length of anterior loop of mental foramen was 3.02 ± 1.6 mm.

Comparison of each of the parameters among male and female and sides are described in Table 1, Table 2.

PARAMETER	MALE	FEMALE	p- VALUE
Distance of mental foramen from midline	22.6 ± 2.75 mm	22.42 ± 3.4 mm	0.756
Height of mental foramen	2.92 ± 0.93 mm	2.23 ± 0.78 mm	<0.0001
Width of mental foramen	3.82 ± 1.06 mm	3.47 ± 1.31 mm	0.087
Distance from mental foramen from alveolar crest	11.81 ± 2.29 mm	11.36 ± 2.06 mm	0.26
Distance of mental foramen from inferior border of mandible	12.37 ± 1.56 mm	12.11 ± 1.32 mm	<0.0001
Length of anterior loop of mental foramen	2.97 ± 1.4 mm	3.08 ± 1.7 mm	0.7057

TABLE- 1- COMPARISON OF EACH PARAMETERS AMONG MALE AND FEMALE; P-VALUE <0.05 IS CONSIDERED SIGNIFICANT

PARAMETER	RIGHT	LEFT	p- VALUE
Distance of mental foramen from midline	22.56 ± 3.27 mm	22.44 ± 2.99 mm	0.83
Height of mental foramen	2.46 ± 0.89 mm	2.6 ± 0.94 mm	0.4
Width of mental foramen	3.7 ± 1.16 mm	3.55 ± 1.28 mm	0.5
Distance from mental foramen from alveolar crest	11.89 ± 2.26 mm	11.21 ± 2.02 mm	0.08
Distance of mental foramen from inferior border of mandible	12.71 ± 1.89 mm	12.89 ± 1.32 mm	0.55
Length of anterior loop of mental foramen	3.06 ± 1.74 mm	2.99 ± 1.48 mm	0.8128

TABLE- 2- COMPARISON OF EACH PARAMETERS AMONG RIGHT AND LEFT SIDE; P-VALUE <0.05 IS CONSIDERED SIGNIFICANT

Postoperative nerve injury test

Out of 60 patients none of the patients presented with post-operative mental nerve paresthesia, as checked by two-point discrimination, contact detection, sharp blunt discrimination, thermal test method on postoperative 1st day, 7th day, 1st month and 3rd month.

DISCUSSION

It is of utmost importance to have complete information about the mental foramen and anatomy of the anterior segment of the mandible before performing any surgical procedure at this site. Though it is believed that the inter-foraminal area of the mandible should be considered safe for placing implants and other surgeries, detailed anatomy of this area is still a matter of controversy, because the position, dimension of mental foramen as well as its loop varies among different population and races. There can be neuro sensory disturbances encountered if this important landmark is ignored while doing any invasive treatment in this region.

Position of mental foramen with respect to teeth

Knowledge of position of mental foramen is very important when we are performing any surgical procedure in the inter-foraminal site without raising the mucoperiosteal flap, such as mental nerve block or placing intermaxillary fixation screws. In our study, the most common position of mental foramen is found to be in between 1st and 2nd premolar (57%), and least in line with 1st premolar (5%). Its position is highly variable among different ethnic groups and races. Position of mental foramen as observed in different studies are depicted in Table 3.

Authors	Populations of study	Results
Ngeow et al (1994)	Malay population	In line with the longitudinal axis of the second premolar (69.2%) followed by position between the first and second premolar (19.6%)
Al Jasser et al (1998)	Saudi Arabia	In line with the longitudinal axis of the second premolar (45.3%) followed by in between the first and second premolars (42.7%).

Olasoji et al (2004)	Nigerian adults	The most common location was the interdental space between the first and second mandibular premolars followed by the position apical to the second premolars
Ilayperuma et al (2009)	Sri Lankan population	In line with the longitudinal axis of the lower second premolar (52.94%) followed by a position between first and second premolar (26.47%)
Haghanifar et al (2009)	Iranian population	Between the first and second premolars in 47.2% of patients and in line with the second premolar in 46%
Gada et al (2014)	Mumbai City (India)	Between the two premolars (63%), followed by position behind the second premolar (20.67%)
Babshet et al (2015)	Dharwad, Karnataka, India	43% in between first and second premolars and 39% in line with second premolar
Patel et al (2015)	Dried adult human skulls, Gujarat	The longitudinal axis of the second premolar for right side was 40.32% and left side 43.55% followed by the longitudinal axis which passed between the first and second premolars
Bharathi et al (2015)	20 Indians and 20 Iranians	Mental foramen below the apex of the second premolar in 52.5% of Indians, 47.5% of Iranians; 45% of it was between the first and second premolars among Indians and 47.5% of Iranians

TABLE 3- POSITION OF MENTAL FORAMEN AS OBSERVED IN DIFFERENT STUDIES

Distance of mental foramen from midline

Usually, position of mental foramen is determined by the position of premolars and molars. But in edentulous patients, determination of position of mental foramen becomes cumbersome. In such cases, it can be localized if the distance from the midline of mandible is known. In the present study, the mean distance is 22.49 ± 3.12 mm.

In studies with CBCT images, **Sheikhi et al. [7]** stated, the mean distance from the anterior border of mental foramen to midline was 25.86mm (SD ± 0.27) in the right side and 25.53mm (SD ± 0.31) in the left side, while **Afkhami et al. [8]** in their study stated, the mean distance from the mental foramen to the mandibular midline was 27.77 ± 3.20 mm.

Dimension (height and width) of mental foramen

In present study, mean height and width of mental foramen was found to be 2.53 ± 0.91 mm and 3.63 ± 1.22 mm respectively. **Philips et al [9]** reported that anatomically the mental foramen is generally oval shaped with an average size of 4.6 mm horizontally and 3.4 mm vertically. **Kalender et al. [10]** in their study found a mean height of 3.7 mm and a mean length of 3.4 mm, with male patients having significantly larger mental foramen than female patients. Such a gender difference was also observed in the present study.

Position of mental foramen from alveolar crest

Haktanir et al. [11] assessed 100 dentulous patients by using multidetector CT. The mean distance was 14.2 mm. In the present sample, the mean distance from mental foramen to the alveolar crest was 11.56 ± 2.1 mm, with wide variations ranging from 6.5–17 mm. This wide variation may be attributed to the crestal bone loss either due to crestal bone loss due to periodontitis or due to loss of alveolar bone due to tooth loss. Some authors have suggested the use of the cemento-enamel junction of adjacent teeth as a more reliable reference point.

Position of mental foramen from inferior border of mandible

In the present study, the mental foramen was located on average 12.68 mm above the inferior border of mandible. **Kalender et al [10]** in their study with CBCT images found a mean distance of 12.4 mm. Distances did not differ significantly by side, but they were significantly greater in male patients (13.1 mm) than in female patients (11.8 mm). This significant difference among the genders correlates with the present study.

Length of anterior loop (mesial extension)

The anterior loop is an extension of the inferior alveolar nerve, anterior to the mental foramen, which loops back to exit the mental foramen. This structure is important in determining a safe margin for surgical procedures such as harvesting graft in the symphysis, placement of endosseous implants or genioplasty, to prevent neurosensory disturbances. Several studies have been performed to detect and measure the anterior loop length using different diagnostic methods on panoramic radiographs; cone beam computed tomography (CBCT) and CT scans of patients and cadaver. Studies have shown panoramic radiographs are not reliable because of high rates of false positive or false negative interpretations, so CT scans and CBCT are recommended before the surgeries in inter-foraminal region. Among them, CBCT is preferred because of lower radiation doses.

Apostolakis et al [12] in their study with CBCT images among stated, the anterior loop length ranged from 0–5.7 mm, with a mean value of 0.89 ± 1.17 mm. **Thomas et al. [3]** in their study with CBCT images stated, the mean mesial extension of anterior loop of mental foramen was 2.3 mm (range, 0.9–5.6 mm). In present study, the length of anterior loop of mental foramen ranged from 0.34 mm to 7.98 mm, with a mean length of was 2.97 ± 1.54 mm. Though the mean length of anterior loop in the present study differed from different studies, it correlates with the fact that no statistically significant difference was observed among genders and sides.

Postoperative nerve injury

Bartling et al. [13], in their study with 94 patients reported mental nerve injury with symptoms of hyperesthesia or dysesthesia in 8.5% of patients. **Khan et al. [14]**, in their study regarding complications of genioplasty, reported temporary numbness in 6.8% patients. **Schenkel et al. [15]**, reported 27% of the study population presented with postinjury (preoperative) mental nerve hypoesthesia, 46% suffered from purely postoperative hypoesthesia. In our study none of the patients showed postoperative neurosensory deficit. This can be attributed to the fact that preoperatively, each of the CBCT images were studied carefully to get thorough anatomical characteristic of mental foramen and surgical cuts were planned accordingly.

CONCLUSION

For performing any surgical procedure in the anterior region of mandible, the most important anatomical landmark is mental foramen. It is very important to have knowledge about the variations of position, dimensions of mental foramen and the anterior loop of mental foramen to prevent its damage leading to neuro-sensory disturbances. It is also recommended to study thoroughly each of patient's CBCT images before performing any surgical interventions because the anatomy of mental foramen varies among each individual, and also among each side of same individual.

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