# ASSESSMENT OF MENTAL LOOP USING CONE BEAM COMPUTED TOMOGRAPHY (CBCT) IN A SAMPLE OF EGYPTIANS.

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## ABSTRACT

**INTRODUCTION:** Although the inferior alveolar nerve had been described as a single entity that travels through the mandibular canal and leaves it through the mental foramen directly giving rise to mental nerve, presence of mental loop was reported. Improper identification of mental loop led to increasing   the incidence of nerve injury during surgical procedures especially implant placement.

**OBJECTIVE OF THE STUDY:** The purpose of this study was to assess mental loop and its length among a sample of Egyptians, using cone beam computed tomography (CBCT).

**MATERIALS AND METHODS**: Two hundred and sixty-seven CBCTs were collected in which one hundred were males and one hundred and sixty-seven were females, then evaluated for the presence of the mental loop. The length of the loop was measured on reconstructed panoramic views of CBCT using on demand software.

**RESULTS:** Mental loop was present in one hundred and nine patients (40% of the patients), 63 females and 46 males. The minimum length observed was 2.27 mm. while the maximum length was 7.18mm and the mean length was 4.36±.96mm. There was no significant difference between males and females.

**CONCLUSIONS:** High prevalence of mental loop was detected in Egyptians. Based on this finding proper identification of mental loop by the method explained in this study prior to surgical planning is essential.

**KEYWORDS:** Anatomical variant, CBCT, inferior alveolar canal, mental nerve loop.

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## INTRODUCTION

Inferior alveolar nerve (IAN) is a branch of the mandibular division of the trigeminal nerve. It carries sensory innervation to lower molars and second premolars by entering the mandibular canal. Then it gives two terminal branches which are the mental nerve that leaves through the mental foramen and the incisive nerve which continues anteriorly (1).

The mental nerve provides sensation to the lower lip, chin, and labial gingiva. Normally, the mental nerve emerges from the mental foramen directly. However in some cases the mental nerve extends mesial to the mental foramen before it departs through it giving rise to the mental loop(2).

Sicher(3)is one of the pioneers to define the mental loop as "the mental canal which originates from the mandibular canal and goes inside out and leads to upward and backward course to end up at the mental foramen" . Later Jalbout and Tabourian (4)described the anterior loop as "an extension of the inferior alveolar nerve, anterior to the mental foramen, prior to exiting the canal."

The possible cause for the development of mental loop of IAN is the displacement of mental foramen during development. The mental foramen in embryonic period is placed apically to canine and first deciduous molar. Then after first deciduous molar eruption, it is displaced anteriorly and finally it redirects posteriorly after second deciduous molar eruption(5).

Injury of the mental nerve is a common complication following a surgical procedure in the sub mental area. Ellies and Hawker (6)  observed altered mandibular alveolar nerve sensation after two weeks in 36 %of patients and 13 %after one year. Another study has found 8.5% of the patient-reported altered sensation in the chin and the lower lip following implant placement(7). These complications are mainly related to improper identification of mental foramen and anterior mental loop. Thus, the location of the foramen, together with the possible presence of the anterior loop that may overreach mesial to the mental foramen, needs to be considered to avoid surgical complications of mental nerve injury, especially during dental implant placement in this region(8).

Different studies were conducted to determine the prevalence of the anterior mental loop and its average length. Variable results were given ranging from 0 – 88%

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(9-12). Neiva et al (13), reported the longest loop length in literature being 11mm.

A study conducted to compare panoramic x-ray and CBCT in evaluation of mental loop has found that the mental loop was visible in 36.6% of panoramic radiographs examined and in 48.8% of CBCT scans(11). It was proven that panoramic radiographs give false negative results.

It is substantial not only to detect the mental loop but also to determine its length. in order to define the safety margin for implant placement and graft harvesting from the mental area(13).

Since there is conflict in occurrence and presence of the mental loop in different populations, and due to absence of studies conducted in Egypt; thus, studying mental loop prevalence among an Egyptian population becomes a necessity.

The null hypothesis was that no differences would be found between males and females for the anterior loop of the inferior alveolar nerve in a sample of the Egyptian population.

## MATERIALS AND METHOD

Study design: A retrospective study was conducted on two hundred and sixty-seven CBCT radiographs. The study was accepted by the Research Ethics Committee of the faculty of Dentistry, Alexandria University (IRB NO: 00010556-IORG0008839). No informed consent was needed as every CBCT was taken as anonymous.

**Sample size calculation**

The sample size was calculated based on a previous study conducted by Najm etal(14),aimed to detect the presence of anterior mental loop in Iraq sample using CBCT. The sample size of the present study was calculated according to Charan and Biswas (2013) (15), it was found to be two hundred and sixty-seven patients, using a power of 80%, precision 5%, α=0.05(16).

**Criteria for patient selection:**

Inclusion Criteria:

1. CBCT images already taken for implant, endodontic treatment or root fracture

2. Subject with age ≥18 years old of both sexes.

3. Subjects with no oral-maxillofacial surgical intervention manifested in the radiographs.

4. Radiographic images free of artifacts in the site of measurements.

Exclusion Criteria

1. Poor image quality due to either artifact or patient movement or image not adequately revealing the area of interest.

2. Presence of fractures or pathological lesions in the mandible at the site of measurements.

3. Presence of implant in the mental area.

**Methods:**

**A) Data collection:** Two hundred and sixty-seven CBCT images of adult patients aged 18or above were collected randomly and anonymously from the oral radiology center of the faculty of dentistry Alexandria University in the period from 2018 to 2019.

**B) Data acquisition and image reconstruction:** All scans were obtained using the high-resolution imaging system I-CAT Next Generation (Imaging Sciences International, Hatfield, Pa) CBCT unit in faculty of dentistry, Alexandria university. A standardized protocol of the I-CAT was used for all patients using the same machine with the following exposure parameters: 120 KVP, 5 MA, and 26.9 seconds at 0.25 resolutions.

All the images examined twice by a single examiner using the same screen which is 32-inch large, with high resolution (1920×1080), under dim lighting conditions. The intra-observer reliability was also examined with the two repeated measurements. Intra class correlation coefficient (ICC) for loop measurement was 0.865 with 95% CI (0.828, 0.895), Kappa value for mental loop prevalence was 0.989 =99%.

Data from CBCT scans was exported in Digital Imaging and Communications in Medicine (DICOM) format into the OnDemand3D™ software by Cyber med Inc.

For the detection of mental loop, dental volume reconstruction (DVR) view was used. On the DVR screen, the axial plane was used to generate reconstructed panorama from which cross-sectional slices was obtained.

A precise panoramic curve was accurately drawn on a selected axial cut at approximately the mid-tooth level of the mandibular teeth. Then the panoramic x-ray thickness was adjusted to be between 5 to 10mm in order to clearly identify the mental loop. Cross section cuts anterior to mental foramen were used as confirmatory method to detect nerve extension anterior to the mental foramen (fig 1, 2, 3).

After mental loop detection, the thickness was adjusted to zero and the mandibular nerve was drawn on a panoramic x-ray and readjusted in the cross section and axial cuts.

Five lines were drawn to standardize the nerve loop length measurement in all CBCTs. One line was parallel to the occlusal plane or superior border of mandible in case of edentulous cases along the superior margin of mental foramen. The second line was parallel to the lower border of mandible along the inferior margin of IAN. The third line was perpendicular to the occlusal plane along the anterior margin of the nerve loop. The last one was perpendicular to the occlusal plane along the anterior margin of mental foramen, and the nerve loop was measured along the plane of deepest curvature of the loop (fig 4).

**Statistical Analysis of the data:**

Prevalence of anterior loop of the mental nerve was presented using percentage and a difference between males and females was assessed using Chi Square test. The length of the anterior loop was compared using independent t test. Data were analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp)

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**Figure 1:** DVR view showing anterior loop of mental foramen in axial ,cross section and reconstructed panoramic view.



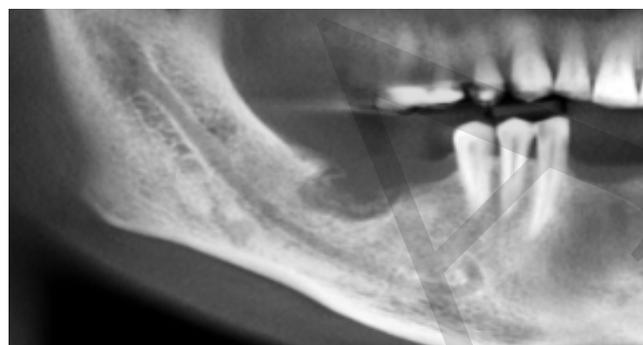**Figure 2:** reconstructed panoramic view of case without mental loop



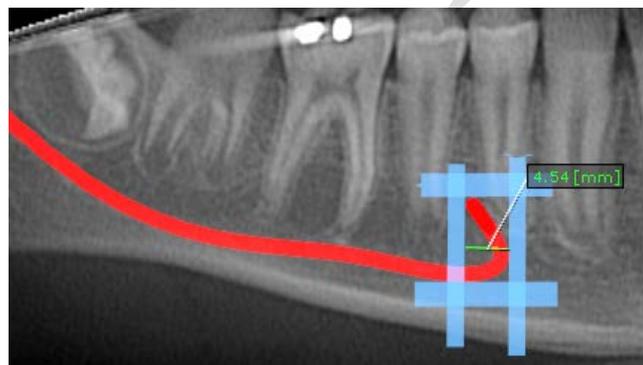**Figure 3**: reconstructed panoramic view showing mental loop



**Figure 4:** reconstructed panoramic view of mental loop measurement in male patient showing loop length 4.54mm

**RESULTS**

　　　　**Table (1)** presents prevalence of cases with and without mental loop with respect to gender. Two hundred and sixty-seven nerves were examined in which 100 were males and 167 females. In males, the mental loop was identified in 46 cases; while in females, 63 cases had mental loops which represented 40.8% of the total nerves examined. There was no statistical significance difference between males and females.

　　　　**Table (2)** presents comparison of length of mental loop (in millimeters) between males and females The mean length of the mental loop was found to be 4.36 ±.96mm with the minimum length of 2.27mm and the maximum was 7.18mm. No statistically significant difference was observed between males and females.

**Table 1:** Prevalence of the anterior loop of the mental nerve between males and females

| Gender | | Males (n=100) | Females (n=167) | Total (n=267) | *P* value |
|---|---|---|---|---|---|
| | | | n (%) | | |
| | Present | 46 (46%) | 63 (37.7) | 109 (40.8%) | 0.183 |
| | Absent | 54 (54%) | 104 (62.3%) | 158 (59.2%) | |

**Table 2:** Measurements of anterior loop of the mental nerve in respect to gender.

| Gender | Males | Females | Total | *P* value |
|---|---|---|---|---|
| **Mean (SD)** | 4.36 (1.02) | 4.36 (0.92) | 4.36 (0.96) | 0.970 |
| **Min-Max** | 2.27 – 7.13 | 2.50 - 7.18 | 2.27 – 7.18 | |

**DISCUSSION**

　　　　Different studies using diverse methods including cadaver and radiographic studies either two or three dimensional have been conducted. The incidence of the mental loop and its length was determined to clarify safety margins from mental foramen for implant placement in inter foraminal area. However, there has been great conflict in their prevalence up till now (3). The incidence of mental loop in dissected studies was found to have a wide range from (0-88%)(2, 13, 17) . That is correlated to difference in population, sex and age of the cadavers.

　　　　Due to the qualitative and quantitative bony changes that take place with age, and the superimposition of the structures, the localization of mental loop in plane radiographs is very deceptive. Furthermore, all of the studies have declared a high proportion of false negative results when using panoramic x-ray to assess the presence of mental loops(9, 11). The prevalence of mental loop in panoramic x-ray studies was found to be ranging from 11 to 40% (11, 17-20). Vujanovic et al(11), was comparing the panoramic x-ray and CBCT in detection of mental loop

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and found that CBCT showed higher identification rate of mental loop . In only 24.4%, of the cases the mental loop was identified in both panoramic x-ray and CBCT and 12.2% of the cases have shown false negative results in panoramic x-ray.

CBCT has lower radiation dose compared to traditional CT.(21, 22). Furthermore Poeschl et al(23)., stated that CBCT was as effective as traditional multi slice CT in terms of its use in implant planning. Al-Ekrish and Ekram(24) claimed that, for the overall data the mean of the CBCT absolute errors was indeed lower than that of the multi-detector CT absolute errors. So, in our study we used CBCT to identify the mental loop.

In this study mental loops were found in 40.8% of the cases. This is similar to cadaver studies as Bavitz et al(25), Solar et al (25, 26), Rosenquist et al (27), and Kuzmanovic et al (17), who found a mental loop prevalence of about 37%. Furthermore Benninger et al (2)., correlated between anatomical and radiographic examination and found that the prevalence of mental loops during dissection to be only 28% and radiographic examination had a higher prevalence with 40% false positive result . They found that in the false positive cases a large incisive nerve was detected that was misinterpreted radio graphically as mental loop.

In studies using CBCT the prevalence of mental loop was found to be up to 85%(28). This prevalence is highly correlated with the method used to detect the mental loop. It is mostly detected in studies using cross section or axial cuts to detect mental loop (29-31). The mean reason for that is the misinterpretation of incisive canal as mental loop. In our study, using panoramic view or sagittal cut facilitated the visualization of the mandibular canal, mental loop, incisive canal and mental foramen at the same cut completely. It also made distinction between the mental loop and incisive canal more convenient even if the incisive canal had the same size of the main mandibular canal.

Based on that our study was comparable to various studies using panoramic view on CBCT, these included study conducted by Demir et al(32) on two hundred and seventy nine Turkish patients that found the prevalence of mental loop to be 45.5%. similarly, Kheir et al (33) conducted a study on one hundred and eighty patient, and found the prevalence to be 32.8%. Furthermore, our findings were similar to another study by Gupta et al(31) that used axial cuts to detect the mental loop.

Mental loop prevalence is inconstant in different populations. In the literature only two studies had been established on Arabian populations. One study was conducted on one hundred and fifty CBCT images in an Iraqi sample and found the incidence of mental loop to be (48.6%)(14). That is approximately similar to our findings in males as we identified mental loops in 46% of the total male cases. The second one was established in a Saudi population utilizing three hundred and two scans and found mental loops in only 15.2% of the cases, which is less than our findings and most of the findings in studies using CBCT.(34)

After carrying out a thorough study of the methods used to measure the length of mental loop, it can be concluded that there are three methods mentioned in literature. The first method carried out measurements on panoramic reconstructions made of CBCT slices. The second used axial slices. The third one used cross section slices measurements. Measurements made on cross sections do not get an optimal result because two-dimensional slices are subjected to interpretation efficiency of the operators. On the other hand it was argued that, determining the length of the loop through panoramic views from CBCT scans with high thickness is similar to researches using panoramic radiographs (12, 35-38).

So, in our study we used panoramic x-ray first at low thickness to detect the mandibular canal completely and reduced the risk of misinterpretation. Then the panoramic x-ray was adjusted to zero thickness, so the panoramic x-ray resembles the sagittal cut and after drawing the nerve on the on-demand software. Then, the nerve point was readjusted on axial and cross section cuts. So, we can reduce the drawbacks of previous methods by using axial, cross section and panoramic views. Finally, the loop measurement was taken on the precisely drawn nerve on reconstructed panoramic view. Also, reference lines were drawn in order to stander the measurement as possible.

The mental loop average length measurements varied in the literature. Its length ranging from 0.1 mm to11 mm(25). The longest loop was detected by Neiva et al(13). they found the mean length of it was 4.13 ± 2.04 mm. Another study conducted by Uchida et al.(12) found it was 1.5mm and Kaya et al. (18) found it to be 3.75 mm.

This variations in results may be due to different diagnostic methods (cadavers, dry skulls, 2D radiographs, and 3D radiographs), different population (different age, gender, ethnicity, dental status), and different methods of measurement.

The longest loop detected in our study was 7.18mm and the minimum was 2.27mm. The mean was 4.36± 0.96mm which is similar to Mish et al(39) . In our study there was no significance difference between loop measurement between males and females and that is similar to Uchida et al (12).

Based on previous studies it was proposed to leave a ,safety margin from mental nerve for implant placement, and that safety margin was calculated and found to be 1 mm, 4 mm, or 6 mm according to Bavitz et al (5), Kuzmanovic et al (26), and Solar et al (29) respectively . This safety margin is important to prevent damage of mental nerve during an osteotomy. Since in our study we found some loops had reached up to 7.18mm. So, using stander safety margins may lead to nerve injury. Recommending a wider safety margin from mental foramen will reduce the inter foraminal space and make implant placement intricate and non-prosthetic driven.

## CONCLUSIONS

Mental loop is an anatomical landmark of critical importance. Although the mental loop anatomy was studied using various methods, CBCT can accurately demonstrate the landmark and help efficient treatment

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planning. In our study, mental loop was identified by CBCT in 40% of the total examined scans. Regarding the wide range of mental loop lengths found in our research, no defined distance from the mental foramen, mesial or anteriorly, can be considered a safe distance. Analyzing CBCT scans using the approach outlined in this study may be a valuable tool to prevent complications from the implant surgery.

**Conflict of interest:**

The authors declare that they have no conflicts of interest

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