

## Evaluation of mandibular first molar teeth in the context of immediate implant placement using Cone Beam Computed Tomography

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### ABSTRACT

**Objective:** During the immediate dental implant (IMI) procedure in the mandibular posterior region, some limitations caused by anatomical structures that may affect the success of implant treatment and increase the risk of complications may be encountered. Socket size, distance from root apices to the inferior alveolar canal (IAC), and lingual concavity are some of the critical conditions. This study aimed to examine the alveolar bone of mandibular first molars using cone beam computed tomography (CBCT) and to evaluate its prevalence on a subpopulation basis.

**Material and Methods:** A total of 153 mandibular first molar teeth in 100 patients who met the evaluation criteria were evaluated for cross-sectional classification of the alveolar bone, distance from root apices to IAC, and socket size using CBCT scans.

**Results:** In this study, which included 42 females and 58 males, the age range was 19-70 years (38.13±13.74 years). Of the 153 mandibular first molars analyzed, 53.6% were on the left, while 46.4% were on the right. The distances from the apices of the roots to the IAC were the least in females ( $p<0.05$ ) and U-type ridges. It was also found that this distance was positively correlated with age. The mean crestal socket width measured in the current study was suitable for choosing a dental implant with an appropriate diameter for IMI surgery.

**Conclusion:** Cross-sectional analysis of the relevant regions before surgery is important for IMI placement. This will allow clinicians to take precautions against possible complications.

**Keywords:** Anatomy, Cone Beam Computed Tomography, Dental Implant, Mandible, Risk Assessment

### INTRODUCTION

Due to the high success rates in dentistry, dental implant applications, which are highly demanded, can fulfill the deficiencies caused by the missing teeth with appropriate treatment planning (1). In traditional dental implant applications, more than one intervention is required, including waiting for the healing period after tooth removal, the placement of the implant and even requiring another surgery for exposure in order to make the prosthetic delivery (2,3). Therefore, clinicians' use of the immediate implant (IMI) procedure is increasing due to implant placement without waiting after extraction, the positive expectations for the maintenance of bone volume and aesthetics (4).

Providing primary stability, which is a very important criterion in dental implant surgery (5), especially posterior regions, may present some limitations for clinicians (6). In the posterior mandible, the use of native bone on the apical side of the extraction socket, which is important for primary stability, can be restricted by the location of the inferior alveolar canal (IAC) and the concavity of the submandibular fossa (7). In addition, the fact that the extraction socket is large compared to the diameter of the dental implant is one of the important factors in ensuring primary stability (8). Cross-sectional imaging of the mandible is critical as it provides important preoperative morphological information (9). Chan et al. (1) specified three types of lingual concavities in cross-sectional images, taking into account the mandibular first molar region. Before dental implant surgery, careful determination and detailed analysis of the position of the IAC, extraction socket size, and the mandibular lingual concavity are critical as they can cause limitations (10).

This study aimed to evaluate the morphological features of the alveolar bone of mandibular first molars in a Turkish subpopulation using CBCT images for IMI placement.

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## MATERIAL and METHODS

### Ethical approval

This study was approved by the Ethics Committee of Çanakkale Onsekiz Mart University Graduate Education Institute (project no: 2023-YÖNP-0086; app. no: 02/27).

### Data source and evaluation process

All images assessed in this study taken to diagnose patients who applied to the Faculty of Dentistry for various reasons. CBCTs were taken using a cone-beam computed unit (NewTom 5G, QR srl, Verona, Italy).

Radiographic data selected consecutively from the database were scanned. After applying the exclusion criteria (edentulism, <18 years old, poor image quality, presence of bone loss), CBCT images of a total of 100 patients were analyzed.

### Evaluations were made according to the following criteria:

- Alveolar bone cross-sectional classification (C, P, U type) (1)
- Distance from root apices to IAC
- Extraction socket size (11)

All images were analyzed under the same conditions using the NewToms' software interface.

### Statistical analysis

The data were analyzed using IBM SPSS Statistics for Windows (Version 20.0. Armonk, NY: IBM Corp.). All data were analyzed descriptively. The Kolmogorov-Smirnov test was applied to determine the normal distribution. The chi-square test was used to determine whether there was a relationship between the independent variables. ANOVA was used to detect significant differences in data sets. Pearson correlation was also performed to determine the relationship between age and distances from apices to IAC. The significance level was set at  $P < 0.05$ .

**Table 1.** Distribution of the study population by age and gender.

Age (year)	Female n (%)	Male n (%)	Total n
<20	3 (7,1)	0 (0)	3
20-29	13 (31,0)	10 (17,2)	23
30-39	10 (23,8)	16 (27,6)	26
40-49	7 (16,7)	9 (15,5)	16
50-59	7 (16,7)	16 (27,6)	23
≥60	2 (4,8)	7 (12,1)	9
<b>Total (n)</b>	<b>42</b>	<b>58</b>	<b>100</b>

## RESULTS

One hundred patients (42 females and 58 males) aged between 19-70 years ( $38.13 \pm 13.74$  years) were included in this study. A total of 153 mandibular first molar regions, 82 on the left (53,6%) and 71 on the right (46,4%), were analyzed (**Table 1**).

Figure 1 shows the distribution of three different types of ridge morphology exhibited by mandibular first molars. U-type morphology was the most common, observed in 50.3% of the study group. P-type morphology constituted 37.3%, followed by C-type morphology with 12.4%. Similar rates were also observed according to gender (**Table 2**).

While there was no significant difference between the distances from the IAC to the apices of the mesial and distal roots in both genders, these distances were statistically higher in males (**Table 3**). According to the cross-sectional morphological classification, the distance from the apices of the mesial and distal roots to the IAC was recorded as the shortest in the U-type ridge, but no significant difference was found (**Figure 2**). However, significant differences were found according to age ranges ( $p=0.000$  for both mesial and distal roots) (**Figure 3**) and the correlation between these distances and age was also significant at the 0.01 level. Accordingly, it was found that the distances from the apices of the mesial and distal roots to the IAC increased with increasing age (**Figure 4**).

The size of the socket in the coronal section did not differ significantly between mandibular locations, both in the total population and gender (**Table 4**).

**Table 2.** Frequency distribution of three types of cross-sectional morphology of the mandible.

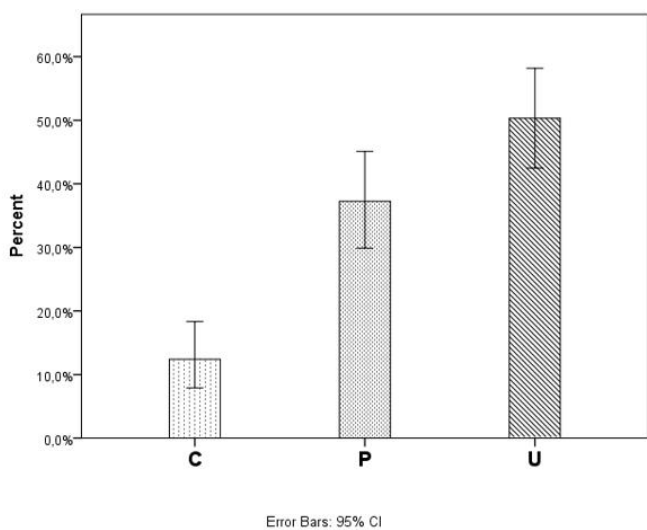
		Cross-sectional morphology of the mandible			p-value	
		C n (%)	P n (%)	U n (%)		
<b>Gender</b>	Female	13 (18,8)	27 (39,1)	29 (42,0)	0.037	
	Male	6 (7,1)	30 (35,7)	48 (57,1)	0.000	
	Total	19 (12,4)	57 (37,3)	77 (50,3)	0.000	
<b>Location</b>	Left	Female	9 (25,0)	12 (33,3)	15 (41,7)	0.472
		Male	6 (13,0)	15 (32,6)	25 (54,3)	0.003
	Right	Female	4 (12,1)	15 (45,5)	14 (42,4)	0.035
		Male	-	15 (39,5)	23 (60,5)	0.194

**Table 3.** Distance from the root apices to the IAC.

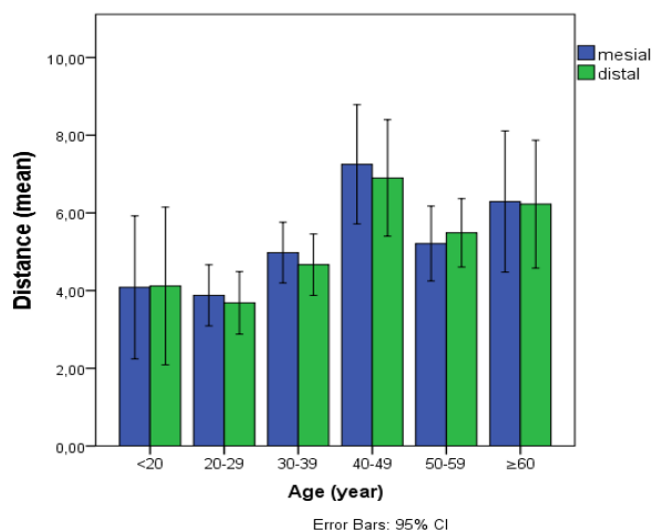
Gender	Mandibular First Molar					
	Left (mm) mean±SD			Right (mm) mean±SD		
	Mesial root	Distal root	p-value	Mesial root	Distal root	p-value
Female	4,04±2,41	4,03±2,44	0.981	4,06±2,46	4,16±2,65	0.870
Male	5,96±3,09	5,80±2,99	0.797	5,87±2,63	5,43±2,63	0.471
p-value	0.003	0.005		0.004	0.047	

**Table 4.** Socket width in the coronal section of a CBCT scan.

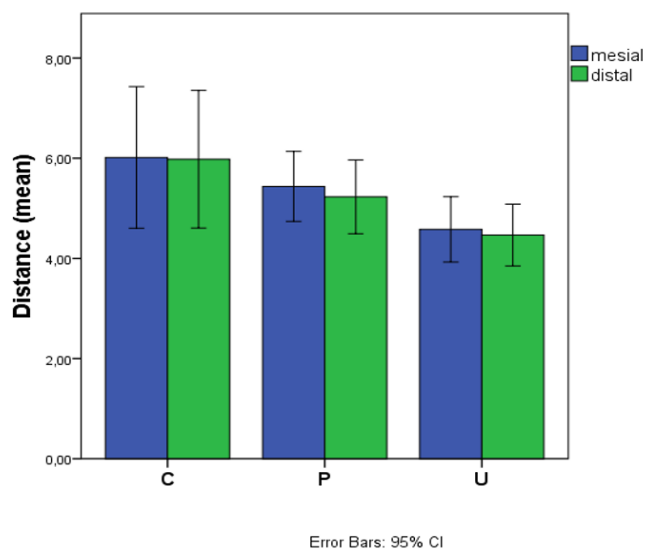
Gender	Crestal socket width		
	Left (mm) mean±SD	Right (mm) mean±SD	p-value
Female	10,31±0,92	10,62±1,13	0.220
Male	10,91±1,40	10,97±1,48	0.849
Total	10,65±1,24	10,81±1,33	0.446



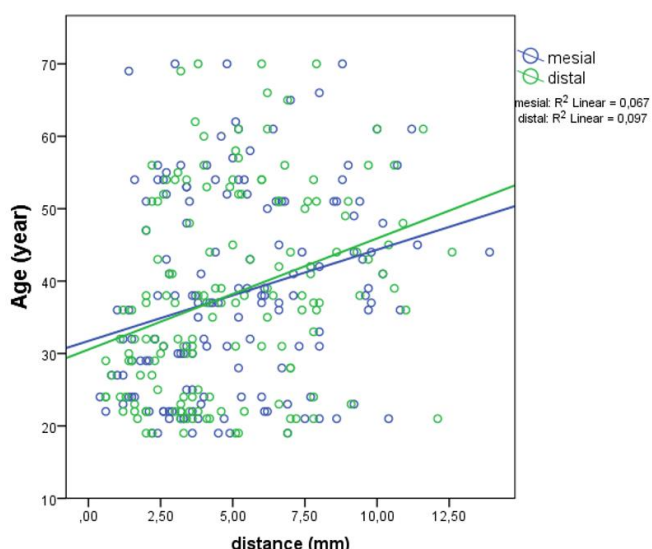
**Figure 1.** Distribution of three different types of ridge morphology exhibited by mandibular first molars.



**Figure 3.** Distribution of distances from the apices of the mesial and distal roots to the IAC, according to the age range.



**Figure 2.** Distribution of distances from the apices of the mesial and distal roots to the IAC, according to the cross-sectional morphological classification.



**Figure 4.** Correlation of distances from the apices of the mesial and distal roots to the IAC with increasing age.

## DISCUSSION

According to the literature, the extraction procedure is most frequently observed in molars due to unsuccessful endodontic treatments, the presence of caries or vertical root fractures (12-14). Mandibular first molars are the most commonly extracted posterior teeth (15), and among the mandibular molars, they exhibit the least anatomical variance in their roots (16). IMI placement is an acceptable and predictable procedure after the extraction of mandibular posterior teeth (17). Therefore, in the current study, regions of mandibular first molars were evaluated in the context of IMI placement, and data that could be beneficial for clinicians were produced.

The socket exposed after extraction is of critical importance in achieving a successful outcome in IMI treatment. The socket's size, interradicular septa, and apical bone are important structures in providing primary stability (4). In the IMI procedure, standard dental implants' diameter is usually smaller than the socket size in the molar region. In the presence of insufficient inter radicular septa in the exposed socket, it is recommended to use the bone on the apical side of the socket to ensure primary stability (18). In the current study, no significant difference existed between the distances of the apices of the mesial and distal roots of the mandibular right and left first molars to the IAC. In addition, it was found that the apices of the roots were closer to the IAC in females compared to males. In previous studies, it has also been shown that the apices of the roots are closer to the IAC as a result of the measurements made in females compared to males (19-21). This difference between the genders can be attributed to males generally having a larger body size (22).

In the literature, there are studies indicating that the distance of the teeth to the IAC is shorter in younger individuals than in older, and therefore age affects this distance (19-21). Srivastava et al. (23) reported that the age group where the distance between the root apices and IAC of the teeth they evaluated was the least was 18-35 years. This study found that the distance between the apices of the mandibular first molars and the IAC showed a positive correlation with age, similar to the information in the literature. In addition, while shorter distances were detected in individuals in their 20s, the longest distances were recorded in individuals in their 40s. Swasty et al. (24) reported that the mandible continues to mature until age 40-49, and then its thickness decreases.

The presence of bone, less than 3 mm on the apical side of the tooth apex, was considered insufficient to provide primary stability during IMI surgery (25,26). Considering the recommendation to place the dental implant no more than 1.5-2 mm close to the IAC as a safe distance (27), it can be stated that the presence of an average of 5 mm of bone on the apical side of the root apices will be sufficient to provide primary stability. In the current study, only the distance measured in males met this criterion. Therefore, based on the results obtained, it can be said that females are more likely than males to damage the inferior alveolar nerve in providing primary stability during IMI surgery.

Ketabi et al. (28) reported that ultra-wide diameter (>6-9 mm) dental implants exhibit a higher failure rate than 4-6 mm diameter dental implants. Ragucci et al. (29) stated that dental implants with a diameter of <5 mm were predictable and successful when used for IMI in the posterior region. In

addition, in IMI surgery, there is expected to be a gap between the socket wall and the dental implant in one or more points (30). Considering that 3 mm between the dental implant and the buccal wall of the socket is predictable in preserving the stability and vascularization of the buccal plate (31), the mean crestal socket width measured in the current study was suitable for choosing a dental implant with an appropriate diameter for IMI surgery.

When a dental implant is planned in the mandibular posterior region, the structure of the lingual concavity should also be evaluated because of the perforation risk (1). It has been reported that perforation of the lingual bone plate is more common in U-type ridge (32). Similar to previous studies (33-36), it was observed that the U-type ridge was more common in the current study. Moreover, the distance from the apices of the roots to the IAC was shorter in cases exhibiting this U-type ridge compared to other types. In line with these results, more care should be taken when planning IMI surgery in patients with this type of ridge.

## CONCLUSION

The present study's findings revealed that the distance from the root apices of mandibular first molars to the IAC was correlated with increasing age, and this distance was shorter in females and U-type ridges. Therefore, cross-sectional analysis of the relevant regions before surgery is important for IMI placement. This will allow clinicians to take precautions against possible complications. In addition, it should be noted that there are no absolute safety distances in surgical procedures to prevent damage to anatomical structures (37).

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**Ethical approval:** All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and/or with the Helsinki Declaration of 1964 and later versions.

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