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Original Article

# Which impacted mandibular third molar positions or bone morphology shapes can have greater risk of accidental displacement of tooth roots into the sublingual soft tissues?

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**Abstract**

**Aim:** We aimed to find out which impacted mandibular third molar (3M) positions or bone morphology types at the 3M site could lead to the potential risk of accidental displacement of 3M root fragments into the sublingual soft tissues.

**Materials and Methods:** The sample consisted of 103 patients with an impacted mandibular 3M (vertical, mesioangular, or horizontal position) seen on at least one side using cone beam computed tomography images. The bone morphology at the 3M sites were classified as round shape, lingual concavity, and lingual extended. The relationship between the roots and the sublingual soft tissues was classified as: 1) type A, in which some amount of bone appears between the root and the soft tissues; 2) type B, in which the root apex is located at the lingual cortical plate; and 3) type C, in which the root apex has penetrated into the soft tissues.

**Results:** Binary logistic regression analysis showed that the odds of lingual extended bone morphology are 2.61 times greater for potential root displacement in combined types B and C, compared to round shape.

**Conclusion:** These results suggest that impacted mandibular 3Ms with the lingual extended morphology type are more likely to cause root fragment displacement into the sublingual soft tissues.

**Keywords:** Third molar; mandible; cone beam computed tomography; iatrogenic displacement; sublingual space.

## INTRODUCTION

One of the most routinely performed procedures in the oral and maxillofacial surgery field is the surgical removal of the mandibular 3M. Many different factors may affect the success of a surgical procedure, varying from the surgeon's ability level to the anatomical position of the 3M. Common postoperative complications include pain, a limited ability to open the mouth, alveolitis, and paresthesia (1,2). Rarely, complications such as accidental displacement of a tooth or root fragment to facial spaces can be bothersome for the surgeon during the procedure (3).

Some factors that have been reported as causing to the root fragment displacement include teeth located lingually , a thin lingual cortical plate, fenestration in the lingual plate, a poor clinical and/or radiological evaluation, or excessive/uncontrolled force applied by an inexperienced surgeon during extraction (3-5).

When a tooth fragment or root piece is displaced into sublingual soft tissues, more surgical exposure may be needed to retrieve the fragment by lingual flap retraction, which increases postoperative discomfort. To minimize this intraoperative complication, the precise position of the 3M roots should be identified with additional radiologic analysis, particularly their proximity to the lingual plate (3). CBCT, an established diagnostic tool that provides better image resolution with less radiation and cost than conventional CT, is a superior method that is gaining increasing popularity in this respect (6,7). Due to advantages of the CBCT, it has been used in varying form anatomical studies (8-10) to the clinical practices in dentistry (11,12).

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There is a lack of data about which anatomical considerations (impacted mandibular 3M positions or bone morphology types at the 3M) could precipitate the risk of accidental root fragment displacement into the sublingual soft tissues. Therefore, we aimed to find out which impacted mandibular 3M positions or bone morphology types at third molar site could cause this complication using analysis of CBCT images.

## MATERIAL and METHODS

### Study design

We designed a retrospective cohort study on patients who underwent diagnostic mandibular CBCT analysis for different indications such as removal of impacted 3Ms, preoperative implant planning, or search for dental foci). The Institutional Committee for Human Research of Gaziantep University approved the present study (Protocol No. 2018/56).

The main criteria for inclusion were the presence of a unilateral or bilateral impacted mandibular 3M. With regard to the mandibular CBCT images, only those for subjects meeting the following criteria were included: 1) impaction depths of mandibular 3Ms were classified according to Pell and Gregory (13), and those with the highest portion of the mandibular 3Ms below the cervical line of the mandibular second molar were included; 2) different inclinations of mandibular 3Ms were included (mesioangular, horizontal, and vertical) (14), and 3) mandibular 3Ms that have completed the root formation process were included.

CBCT images were excluded if they had radiologic evidence of intraosseous cystic or tumoral findings around the mandibular 3M and presence of any mandibular angle fractures associated with 3M, or if they had inadequate scan quality and artifacts.

### CBCT data analysis

In accordance with the classification of Momin et al. (15), the bone morphology at the 3M site in a coronal CBCT image was classified as 1) round shape (flat shape on buccal and lingual sides), 2) lingual concavity (round on buccal side and concave on lingual side), and 3) lingual extended (bone expansion to lingual site with distinct concavity, with round shape on buccal site). Figures 1A, B, C show the bone morphology at the 3M site in a coronal CBCT image.

According to study by Emes et al. (16), the two points on each tooth root in the most lingual position were taken as reference in the coronal sections, and two distances were measured; 1) the distance from the most lingual position of the root apex of the tooth to the outermost lingual cortical edge or lingual soft tissues (Figure 2A); and 2) the distance from the most lingual point on the apical half of the root to the outermost lingual cortical edge (Figure 2B). The relationship between the root and the lingual soft tissues are classified as 1) type A, in which an amount of bone appears between the root apex and the lingual soft tissues; 2) type B, in which the root apex is located at the cortical plate but has not penetrated into the soft tissues (Figure 3) type C, in which the root apex has penetrated from the lingual into the soft tissues (Figure 4).

### Study variables

The predictor variables were grouped into anatomical and position-of-3M variables. The anatomical variables were related to bone morphology at the 3M site, including round, lingual concavity, and lingual extended. The variables of mandibular 3M position included the mesioangular, horizontal, and vertical positions. The type A and types B and C combined were considered as primary outcomes variables for this complication.

### CBCT image acquisition

The images were obtained using a CBCT device (Planmeca Promax 3Dmid, Finland) and the exposure parameters were adjusted at 90kVp, 14 mA, and 15-second scanning time. Reformatted scans were evaluated using a Romexis 3.0.2 software program. Before imaging exposure, the patients' head was adjusted to the Frankfort horizontal plane.

### Statistical analysis

The Shapiro-Wilk test was applied to determine the normality of distribution for all data. For comparing abnormal variables, the Mann-Whitney U test was used in two independent groups and the Kruskal-Wallis test was used in more than two independent groups. The relationships between categorical variables were assessed using the chi-squared test. Intraoperator reliability for measurements made by the same examiner was estimated using the intraclass correlation coefficient (ICC) with an interval of at least two months between them, which yielded a 98% agreement rate. The odds ratios of each variable, a 95% confidence interval (CI), were calculated using binary logistic regression analysis. P-values of $<0.05$ were considered statistically significant, while those in the range of 0.05–0.1 were considered to represent a tendency towards significance. All statistical analyses were performed using SPSS for Windows software (version 22, IBM, USA).

## RESULTS

The sample consisted of 139 CBCT images of mandibular 3M obtained from 103 patients with a mean age of 31.28±12.11 years, ranging from 18 to 76 years. Seventy-six cases (54.4%) were in mesioangular position, 40 (28.8%) were in horizontal and 23 (16.5%) were in vertical position. The types of bone morphology were observed as round type in 70 cases (50.3%), lingual extended in 40 cases (28.8%), and lingual concavity in 29 (20.9%). Patient and 3M characteristics are shown in Table 1.

In the type A group, the mean average distances from tooth apex to the lingual tissues and from the most lingually-positioned point on the apical half of the root to the lingual tissues were measured as 2.89±1.43 mm (range 1.4 mm to 7.12 mm) and 2.38±1.11 mm (range 0.1 mm to 6.4 mm), respectively. Sixty-four cases (46.1%) had the type A relationship. The types B and C combined were found with

53.9% frequency, comprised of type B in 38.1% and type C in 15.8% (Table 2).

Most of the cases with lingual extended morphology tended to be present in the relation of combined type B and type C groups (n = 27, 19.5%). When compared the difference between the type A group and the combined type B and C groups with the three 3M bone morphologies, only the lingual extended morphology showed a statistically significant difference (p=0.021), while others did not show any differences (p>0.05). According to binary logistic regression analysis, the relationship of the combined type B and C groups with the lingual extended morphology presented a risk of 2.61 times (95% CI, 1.16-5.89) according to round bone morphology in occurrence of accidental root displacement into soft tissues.

Of the 76 cases with mesioangular position, the frequency of the type A relationship (n=40, 28.8%) was slightly higher than the combined type B and C groups (n=36, 25.9%). In the cases of 3M with horizontal position, the combined type B and C groups (n=28, 20.2%) had a higher frequency than type A (n=12, 8.6%). In the cases of 3M with vertical position, the distributions were similar. When compared the difference between the type A group and the combined type B and C groups in three mandibular 3M positions, there were no statistically significant differences between the vertical and mesioangular groups (p>0.05), but there was a tendency towards a significant difference in the horizontal group (p=0.084). In this horizontal group, the combined type B and C groups had a marginally significant predictor for accidental root fragment displacement according to vertical 3M position (odds ratio 2.54, 95% CI, 0.88-7.34).

The results of the binary logistic regression analysis of the primary outcome variables in the primary predictor variables are given in Table 3.

According to the ICC test, the concordance index was greater than 0.98, indicating high intra-examiner concordance.

**Table 1. Patient and third molar characteristics (103 patients, 139 third molars)**

| Characteristics | (n / %) |
|---|---|
| Age range, years (mean ± SD) | 18-76, 31.28±12.11 |
| Gender | |
| Male | 56 / 54.4% |
| Female | 47 / 45.6% |
| Site | |
| Right | 67 / 48.2% |
| Left | 72 / 51.8% |
| 3M position | |
| Mesioangular | 76 / 54.7% |
| Horizontal | 40 / 28.8% |
| Vertical | 23 / 16.5% |
| Bone morphology shape at 3M | |
| Round | 70 / 50.3% |
| Lingual extended | 40 / 28.8% |
| Lingual concavity | 29 / 20.9% |

Abbreviations: 3M, third molar; SD, standard deviation

**Table 2. Details of mandibular 3M root relation with lingual soft tissues and measurements of between mandibular 3M apex and/or apical half of the apex and lingual tissues**

| Types of mandibular 3M root relation with lingual soft tissues | |
|---|---|
| Type A (n / %) | 64 / 46.1% |
| Measurements (mean ± SD, range mm) | |
| Root apex – lingual soft tissues | 2.89 ± 1.43, 1.4-7.12 mm |
| Apical half of the root – lingual soft tissues | 2.38 ± 1.11, 0.1-2.38 mm |
| Combined types B and C, (n / %) | 75 / 53.9% |
| Type B | 53 / 38.1% |
| Type C | 22 / 15.8% |

Abbreviations: mm, milimeter; SD, standart deviations; 3M, third molar

**Table 3. Binary logisic regression analysis of Type A and combined types B and C findings in different bone morphologies at 3M site and positions of 3M related to accidental displacement of root fragments into lingual soft tissues**

| | Primary Outcomes | | | |
|---|---|---|---|---|
| | Type A | Type B+C | OR [95% CI] | P Value |
| Predictive Factors | | | | |
| Patterns of bone morphology at 3M site (n / %) | | | | |
| Round | 39 / 28% | 31 / 22.3% | 1 Reference | |
| Lingual concavity | 12 / 8.6% | 17 / 12.2% | 1.78[0.74-4.28] | 0.196 |
| Lingual extended | 13 / 9.4% | 27 /19.5% | 2.61[1.16-5.89] | 0.021* |
| Positions of mandibular 3M (n / %) | | | | |
| Vertical | 12 / 8.6% | 11 / 7.9% | 1 Reference | |
| Mesioangular | 40 / 28.8% | 36 / 25.9% | 0.98[0.39-2.49] | 0.969 |
| Horizontal | 12 / 8.6% | 28 / 20.2% | 2.54[0.88-7.34] | 0.084† |

Abbreviation: OR, odds ratio; 95% CI, 95% confidence interval, *Statistically significant (P < 0.05), †Marginally statistically significant ( 0.1 > P >0 .05)

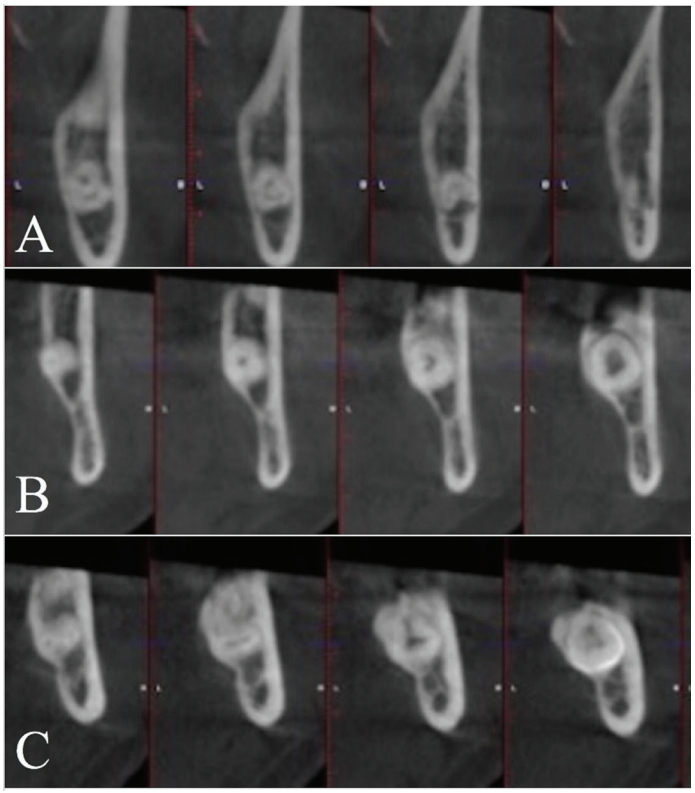


**Figure 1.** Bone morphology at the 3M site in a coronal CBCT image. A, round shape (flat shape on buccal and lingual sides), B, lingual concavity (round on buccal side and concave on lingual side), and c, lingual extended (bone expansion to lingual site with distinct concavity, with round shape on buccal site)


**Figure 2.** Type A relationship. A, the distance between the root apex of the tooth to the lingual soft tissues (double arrowhead) and arrow showing root apex. B, the distance from the most lingual point on the apical half of the root to the sublingual soft tissues (double arrowhead)

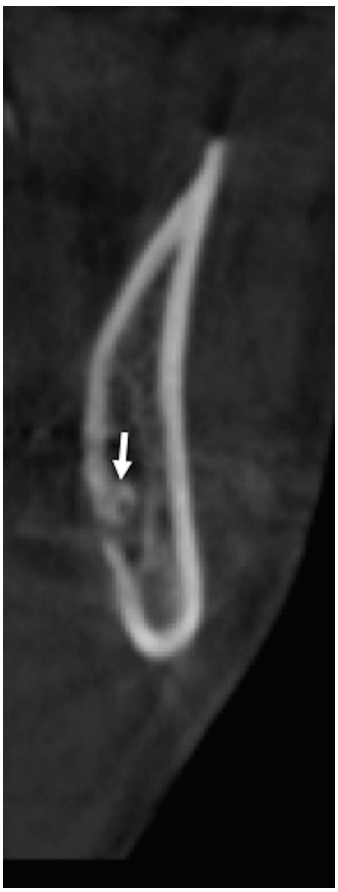

**Figure 3.** Type B relationship: root apex is located at cortical plate, but not penetrated into the soft tissues (arrow)

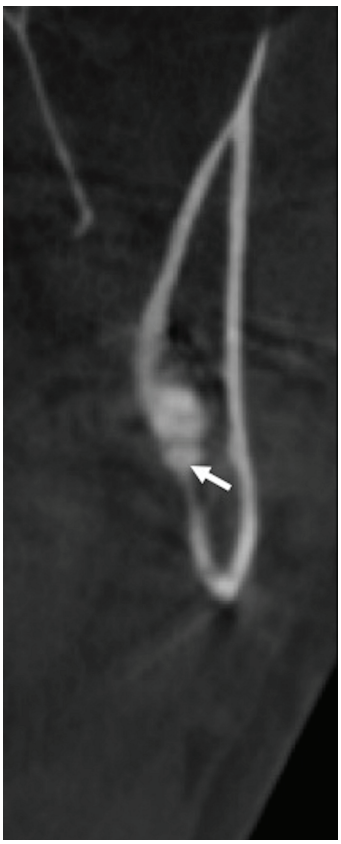

**Figure 4.** Type C relationship: penetrated root apex to the lingual into the soft tissues (arrow)

## DISCUSSION

The causative factors leading to root displacement have previously been examined only in two studies using CBCT, published in 2015 (16) and 2017 (17). In these studies, only the positional variables of the mandibular 3M root (including the vertical, mesioangular, horizontal, and distoangular positions) in relation with lingual soft tissues were evaluated. When comparing the results of these studies, the combined type B and C relationship group's prevalence in the present study (53.9%) was higher than in Emes et al. (16) (34.85%) and Mallick et al. (4.38%) (17). While the average distance between apices of the 3M and the lingual soft tissues in this study was measured as 2.89 mm, the same distance was measured as 1.03 mm in Emes et al. (16) and 3.38 mm in Mallick et al (17). The mean average between the most lingually-positioned point on the apical half of the root and the lingual soft tissues in the present study was measured as 2.38 mm, while it was measured as 0.65 mm in Emes et al. (16) and as 2.01 mm in Mallick et al (17).

The determination of posterior mandibular lingual concavity as a radiologic predictive factor plays a crucial role in the likelihood of root/tooth displacement into the floor of the mouth during surgery and/or before placing a dental implant (18). Perforation of the lingual cortical plate in surgery or any dislodgment of material such as an infected root fragment into the lingual soft tissues may lead to fatal consequences due to the spread of infection to the parapharyngeal space (19). In the present study, the frequencies of bone morphological shapes at the 3M site were found to be round in 50.4%, lingual extended in 28.8%, and lingual concavity in 20.9%. These results were roughly consistent with the report by Momin et al. (15) who found the round morphology in 49%, the lingual concavity in 32%, and the lingual extended in 18%. We thought that different bone shapes on the lingual side may affect the distance between the 3M root and the lingual soft tissues and may be closely related to a further risk of root displacement. Thus, we assessed these variables in the present study, which were not included in previous studies (16,17). The clinical significance of these radiological findings was confirmed and strengthened by the results of this study. In cases presenting with the lingual extended morphology, the frequency of the combined type B and C groups was significantly higher than type A, and the theoretical root displacement was found to be 2.61 times greater in the combined type B and C relationship groups compared to the round morphology. Clinical application of this result could enable a surgeon to determine the risk analysis of possible root displacement and to plan a risk-reducing surgical approach using a preoperative radiographic signs with CBCT or CT.

With respect to the anatomical position of mandibular 3Ms, 76 (54.7%) had the mesioangular position and 40 (28.8%) had the horizontal positions. The mesioangular and horizontal mandibular 3M impactions have been determined to be a risk factor for compromising the integrity of the lingual cortical plate in a recent study (20). The bone thickness in these impaction types was found to be 3.6 times thinner than that at mid-root of vertical and distoangular 3Ms. When compared to present results, indicating that more cases with horizontal position of 3M (20.2%) had the type B and C relationships, seem to be consistent with Tolstunov et al. (20), this tendency was marginally statistically significant in than type A relationship group ($p>0.084$). Theoretically, the possibility of accidental root displacement in horizontal 3M position according to vertical position was associated with a 2.54 fold increase in combined type B and C group. In the vertical mandibular 3M position, a similar distribution was found in type A group and the combined type B and C groups.

Concerning mandibular 3M impaction levels, studies have reported unclear data collection methods in the patient selection. In addition to this, no information was given regarding which 3M positions have greater frequency of type B or type C relationship in those studies (16,17), and this lack does not allow comparison with the present results. Moreover, Tolstunov et al. (20) did not include the variables of bone morphology types at the 3M site to ascertain the relationship between lingual bone thickness and the mandibular 3M's angulation. That factor and limited data in the assessment method might be responsible for differences between our outcomes, indicating that the vertical position indicated greater risk for accidental root displacement than horizontal position, and those of Tolstunov et al (20).

It has been reported that mandibular cortical thickness, height, and width dimensions may be influenced by gender differences, presence of edentulism, different facial types, or age changes (21-23). In this study, the age range varied between 18 and 76 years old and the wide age range increased the likelihood of edentulism occurrence. The lack of analysis of these determinants is thought to be a shortcoming of this study.

## CONCLUSION

There is no study to date evaluating how the impacted 3M inclinations and bone morphology types used in the present study affect the occurrence of the surgical complication of accidental displacement of root fragments. We suggest that these results are beneficial to clinicians to help predict the risk of this complication in impacted mandibular horizontal 3M and/or lingual extended cases using the data obtained from the CBCT records, so that they can take steps to prevent it.

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