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Root morphology and angulation analysis of mandibular first molar for the planning of immediate implants. A cross-sectional study using CBCT

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ABSTRACT

Introduction The placement of immediate implants has considerable advantages over conventional implant placement. Drilling prior to extraction of the tooth favors stabilization through the interradicular septum, which simplifies obtaining a correct three-dimensional position and good primary stability. But not in all cases the root morphology and angulation allow the use of the interradicular osteotomy for immediate molar implants.

Objective To analyze the root morphology and angulation of the first lower molar using CBCT and determine anatomical criteria for the placement of an immediate dental implant in the presence of the interradicular septum.

Materials and methods CBCTs of 91 first molars were analyzed. Coronal and axial sections were made to measure the interradicular septum thickness, the angulation of the roots in relation to the occlusal plane and the distance of the apex from the mesial root and distal to the inferior alveolar nerve canal.

Results The interradicular distance of the first lower molar at the apical level was 3.79 ± 1.18 mm, and at the medium level it was 3.70 ± 0.95 mm, these measurements corresponding to the thickness of the interradicular septum at the apical and mid-level, respectively. The distance from the apex of the mesial root to the canal of the inferior dental nerve was 4.30 ± 1.97 mm and the apex of the distal root was 4.00 ± 1.87 mm. The angle of the mesial root in relation to the occlusal plane was 101.68 ± 5.84 ° and the distal root of 105.23 ± 7.19.

Conclusion The thickness of the interradicular septum in most of the cases does not allow to stable the implant into it. To achieve apical anchorage, it is necessary to have a distance from the apices to the inferior alveolar nerve to be able to perform drilling without injuring the nerve. Root angulation complicate interradicular technique, in those situation extraction prior osteotomy is recommended.

INTRODUCTION

The placement of immediate implants has considerable advantages over conventional placement (1), since it requires fewer surgical procedures, preserves the gingival and bone architecture, reduces the treatment time and therefore reduces the cost (2,3).

Immediate implant placement is a widely accepted procedure that achieves survival rates comparable to implants placed according to conventional treatment protocols (4-6). Although the technique of immediate implant placement in the aesthetic zone is described, less information is provided on immediate implant placement in the posterior, where the aesthetic impact is lower, but surgically can be more challenging (7). For example, anatomical differences, root length, differences between implant size and post-extraction socket, root trunk height and root divergence make this surgical technique more complex (8).

In recent years, surgical techniques have undergone modifications to facilitate the immediate placement of implants in the posterior sector (9,10). Different authors (11-13), propose to perform the drilling prior to the extraction of the tooth to achieve restriction of the bur, through the remaining roots of the teeth.

It has been reported that this technique could be suitable for inexperienced clinicians which simplifies obtaining a correct three-dimensional position and good primary stability (12). However, the lack of knowledge about root anatomy and interradicular septum can compromise the drilling process and osteotomy, either due to the angulation of the roots or the size of the interradicular septum, resulting in a more apical drilling and increase the risk to damage some anatomical structures, such as the inferior alveolar nerve (8,11).

The objective of the present study was to analyze the root

morphology of the first lower molar by computed tomography (CBCT) and determine the following anatomical criteria: 1) thickness of the interradicular septum at middle and apical level, 2) distance from the mesial root apex and distal to the upper edge of the inferior alveolar nerve canal, 3) angulation of the roots in relation to the occlusal plane. The above, as part of the planning of the surgical approach for immediate dental implant placement in the presence of the interradicular septum.

MATERIALS AND METHODS

Study design and population

This descriptive, open, observational, retrospective, and cross-sectional study was approved by the Ethical Committee of the Universidad Autonoma de Nuevo Leon (SPSI-010613), the Helsinki declaration guidelines of 1975, as revised in 2008 were followed. The CBCT scans were randomly selected from the database of the Department of Periodontics. Many criteria were used to determine imaging requirements as: aged between 18 to 80 years, presence of the right and/or left lower first molar with adjacent dental teeth. CBCT scans of 91 first molars were analyzed.

CBCT scans with bone loss, lesions or pathologies in bone tissue, orthodontic treatment, with some type of dental prosthesis or restoration on the first lower molar and presence of anatomical deformities were excluded.

Description of procedures

Measurements were made with Blue Sky Bio's Blue-Sky Plan® 4 software for OS X 10.13, all measurements were made by the same operator (CM), on the same computer equipment and with the same display program (Fig.1). For the analysis of the measurements, coronal and axial sections were made to locate the following reference points:

1) Interradicular distance at apical and middle level of the first lower molar.

• Apical level in coronal view.

Distance between the mesial root and the distal root at the apical level, starting from the line angle on the inner face of each apex and the space of the periodontal ligament (Fig. 1a).

• Middle level in axial view.

Distance from the inner face of the lamina dura of the alveolar bone of the mesial root, at the middle level, to the same point in the distal root (Fig. 2b).

2)Distance from the apex of the mesial root and the distal root of the first lower molar, to the upper edge of the canal of the inferior alveolar nerve.

• Distance from the most apical point of the mesial root and distal root, following the root line angle, to the upper edge of the inferior alveolar nerve canal (Fig. 2c).

3)Angulation of the mesial root and the distal root of the first lower molar in relation to the occlusal plane.

First Lower Molar (mm)	Media	Standard deviation	Min.	Max.
Interradicular distance at apical level	3.79	1.18	1.24	5.93
Interradicular distance at middle level	3.70	0.95	1.73	6.03
Distance from mesial root to inferior alveolar nerve canal	4.30	1.97	0.99	13.60
Distance from root distal to inferior alveolar nerve canal	4.00	1.87	1.27	11.78
Mesial root angle	101.68	5.84	76.72	114.07
Distal root angle	105.23	7.19	72.97	120.19

TABLE 1. Descriptive statistics of the variables

First Lower Molar (mm)	Correlation	P-value
Interradicular distance at apical level vs Interradicular distance at medium level	0.746	0.0001
Distance from mesial root vs. distal root inferior alveolar nerve canal	0.879	0.0001
Mesial root angle vs distal root angle	0.558	0.0001

TABLE 2. Pearson's correlation coefficients between variables

A line was drawn on the occlusal plane extending to the occlusal faces of the adjacent teeth. Taking this line as a base, a perpendicular line was drawn to the occlusal plane, following the longitudinal axis of the distal root and the mesial root, to the most apical point. The angle between these two lines was measured (Fig. 2d).

RESULTS

1) Interradicular distance at apical and middle level of the first lower molar.

The measurements obtained, which reflect the thickness of the interradicular septum at the apical level, showed 3.79±1.18 mm and at the middle level of 3.70±0.95 mm (Table 1).

In the statistical analysis with Pearson's correlation coefficient, between interradicular distance at apical level, coronal view vs interradicular distance at middle level in axial view, a positive correlation was observed between the 2 groups (r = 0.746) (p = 0.0001), reflecting a proportional relationship in the distance of the 2 roots in the coronal section and the cross-section (Table 2).

2) Distance from the apex of the mesial root and distal root of

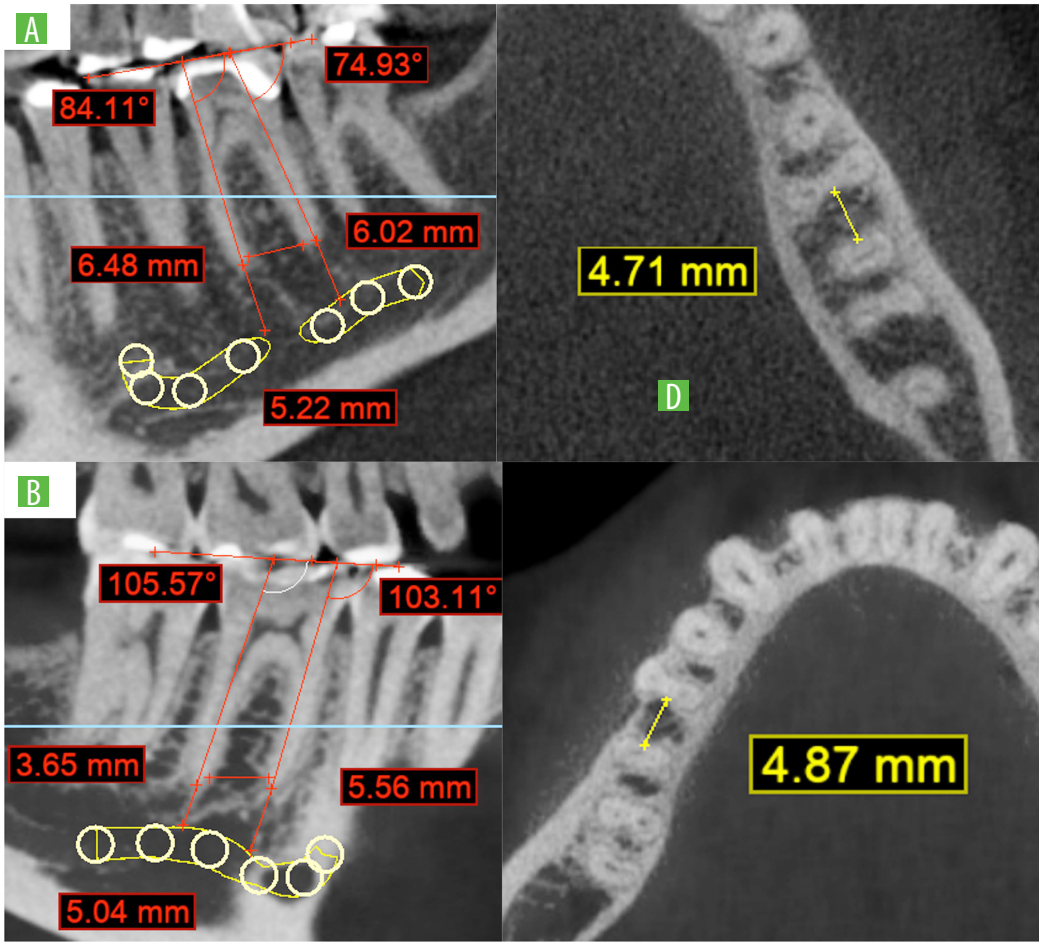

FIG.1
Measurements made with Blue Sky Bio's Blue-Sky Plan® 4 software for OS X 10.13

the first lower molar, to the upper edge of the inferior alveolar nerve canal.
In the mesial root a mean distance of 4.3±1.97 mm was obtained and the distal root of 4±1.87 mm towards the upper border of the canal of the inferior dentary nerve was obtained (Table 1).
A positive correlation between mesial and distal root distance to the upper edge of inferior alveolar nerve canal was found in the statistical analysis of Pearson's correlation coefficient (r = 0.879) (p = 0.0001), reflecting a proportional relationship in the distance of the 2 roots to the upper edge of the inferior alveolar nerve canal (Table 2).

3) Angulation of the mesial and distal root of the first lower molar in relation to the occlusal plane.
The measurements of the angles generated from the occlusal plane and a line to the most apical point of the roots, reflected in the angle of the mesial root an average of 101.68±5-84°, with a minimum of 76.72° and maximum of 114.07°. In the angle of the distal root, a mean of 105.23±7.19° was found, with a minimum of 72.97° and a maximum of 120.19° (Table 1).
Correlation between the angle of the mesial root and the angle of the distal root of the first lower molar in relation to the occlusal plane, has a positive correlation between the 2 groups (r = 0.558) (p = 0.0001), reflecting a proportional relationship in the measurement of the angles of the distal root and the mesial root, which reveals a similar anatomical behavior in the root trajectory (Table 2) in the statistical analysis of Pearson's correlation coefficient.

DISCUSSION

The placement of immediate implants is considered a predictable surgical technique to replace one or more teeth (14,15). The post-extraction socket has been described as having greater osteogenic potential than alveolar ridge (16).
Rebele et al. (2013) presented a surgical approach for immediate implants at sites of molars by a restricted implant bed preparation in the presence of the interradicular septum. The osteotomy is guided by the remaining roots of the molars, allowing precise implant positioning angulation (11). The complexity of the surgery depends on the morphology of the interradicular septum, which completely influences the stability of the implant. As an attempt is made to create an osteotomy in the desired position in the interradicular septum, alveolar morphology can cause the bur to shift to an unwanted position (8). In the present study, the root morphology of the first lower molars was analyzed by CBCT to determine as an anatomical criterion the thickness and angulation of the interradicular septum, in addition to the anatomical characteristics and its importance during

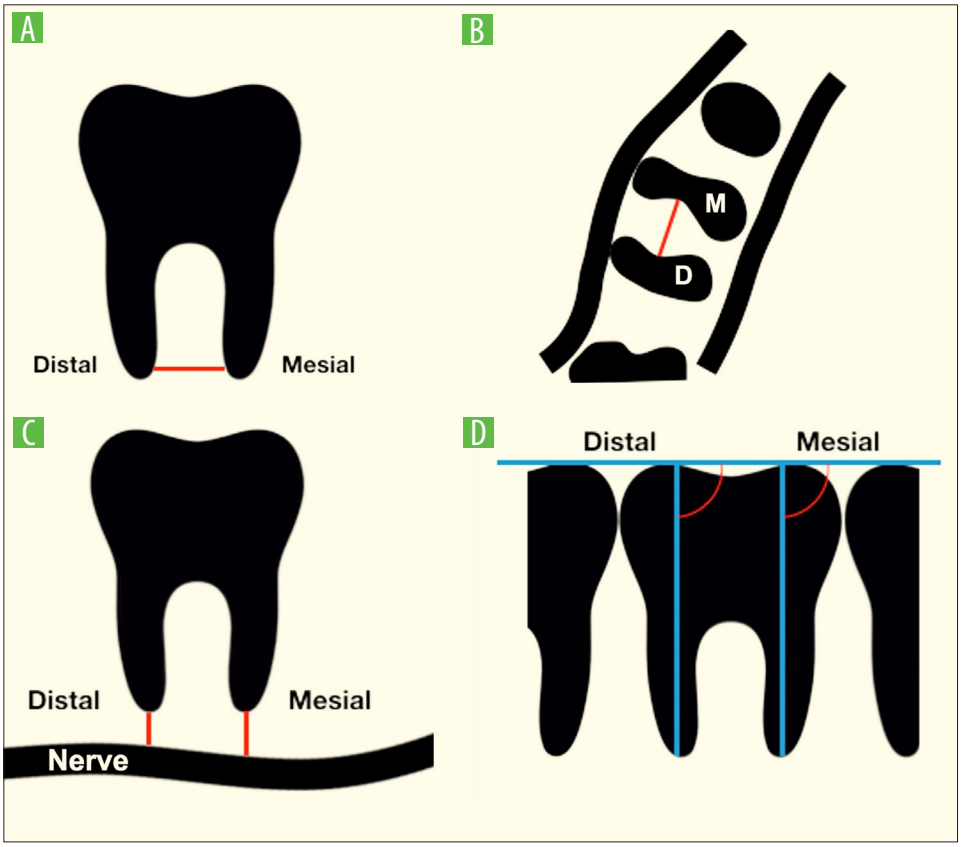

FIG. 2
Reference points to obtain the measurements.
a) Interradicular distance at apical level in coronal view
b) Distance from the apices to the inferior alveolar nerve
c) Angle of the roots in relation to the occlusal plane and longitudinal axis of the tooth
d) Interradicular distance in cross section view.

the planning of the surgical approach to the placement of immediate dental implant in first mandibular molars.

In a study by Agostinelli et al. (2018), interradicular septum thickness measurements at the apical level were made by axial CBCT sections and a thickness of 2.35±1.10 mm was reported (17). In the present study, the same measurement was made at the apical level in a coronal view, reporting a thickness of 3.79±1.18 mm. In addition, a measurement was made in an axial section at middle level of the height of the interradicular septum and a thickness of 3.70±0.95 mm was found. However, the success of the site preparation using the interradicular technique not only depends on the bone thickness, the anatomical configuration of the roots is extremely important for the correct position of the implant (17). Root proximity and angulation >100 reduce the thickness of the interradicular septum, in those cases an apical anchorage must be planned.

Bouwens et al. (2011) measures all teeth roots angulation, taking as reference the occlusal plane and the longitudinal axis of the tooth. In multiradicular teeth, a single line was drawn through the interradicular bone obtaining an average angulation of the septum of the first lower molar of 97.8° (18). The present study agrees with Bouwens et al. (2011), reference points to obtaining the measurements and differs in that it reports separate measurements of the angulation of the mesial root and the distal root. Peck et al. (2007) conducted a study in which they analyzed the root angulation in relation to the interradicular septum and found that the average angle of the septum was 97.0° in mandibular molars (19). In the present study, an angulation was found in relation to the occlusal plane of 101.68±5-84° in the mesial root and 105.23±7.19° in the distal root.

Sammartino et al. (2013) have described the need for a minimum of 2 mm margin of safety between the implant and the inferior alveolar nerve (20), Lin et al. (2014) made a study evaluating the risk of injury to the inferior alveolar nerve during implant placement, described that the average distance in CBCT between the 2 roots of the first lower molar and the inferior alveolae nerve canal was 7.0±2.9 mm (21). Froum et al. (2011) reported that the average distance between the canal of the inferior dental nerve and the most apical point of the roots of the first lower molar was 5.76±3.07 (22). In the present study, the distance of the roots of the first lower molar and the upper edge of the canal of the inferior dentary nerve was analyzed, these measurements were made in a coronal section, a distance of the mesial root of 4.3±1.97 mm and the distal root of 4±1.87 mm was obtained, both measurements greater than the minimum distance described by Sammartino et al. (2013) to preserve the integrity of such anatomical structure.

CONCLUSION

The thickness of the interradicular septum in most of the cases does not allow to stable the implant into it. To achieve apical anchorage, it is necessary to have a distance from the apices to the inferior alveolar nerve to be able to perform drilling without injuring the nerve. Root angulation complicate interradicular technique, in those situation extraction prior

osteotomy is recommended.

The distance and angulation between the roots of the first lower molar, the thickness of the interradicular septum and the distance of the apices towards the upper edge of the inferior alveolar nerve canal, have anatomical characteristics that must be analyzed by CBCT, during the planning of the surgical approach for immediate implant placement in the presence of the interradicular septum.

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