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Evaluation of Anatomical Co-Relation between Inferior Alveolar Canal & Mylohyoid Ridge – In Vitro Study

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ABSTRACT

Aim: The aim of this study is to evaluate the distance between the apices of molars and premolars to inferior nerve canal and mylohyoid line to establish a relationshipbetween the mandibular canal and mylohyoid line.

Materials and Methods: From 100 CBCT of patient's cross-sections of 1st premolars, 2nd premolars, 1 stmolars, 2 nd molars were extracted following the inclusion criteria. Linear dimension between mylohyoid ridge to apex of the root, apex of the root to superior border of the mandibular canal, mylohyoid ridge to the superior border of the mandibular canal were measured digitally from CBCT on the left and right-side using CS 3D imaging software version 3.8.

Results: In average distance between the root apex to mandibular canal in right 1 stmolar mesial and distal root is 5.69mm &5.87mm respectively, in left 1 st molar mesial and distal root is 5.76mm & 5.80mm respectively, in right 2nd molar mesial &distal root is 4.98mm & 4.55mm respectively and in the left 2nd molar mesial & distal root is5.02 & 4.35mm respectively. The left 2nd molar distal root was closest to the mandibular canal with mean value of 4.35mm and the right first premolar root was the most distant to the mandibular canal with mean value of 5.47mm. The risk of damage to mandibular canal in the left 2nd molar region is higher.

Conclusion: This study could help the clinician by providing anatomical guidelines about the relative position of the mandibular canal to that of root apices and mylohyoid ridge. The coarse andposition of the mylohyoid line is illustrated

Keywords: Mylohyoid line; Mandibular canal; Root apices

INTRODUCTION

Knowledge of oral structures and its anatomical variation with respect to size and shape facilitate better patient evaluation and planning precise surgical protocol. The study of anatomy familiarizes the implant surgeon with the normal and atypical oral structures. A thorough understanding of anatomy enables the implant surgeon to confidently resect or augment tissues to restore form, function, aesthetics and health[1].

The inferior alveolar nerve branch of mandibular nerve enters the mandibular canal on the medial surface of the ramus by the lingula. The canal is approximately 3.4mm wide carrying the nerve, artery, vein and lymphatic vessels[1].

The inferior alveolar nerve may present in different anatomical configuration. The nerve may lower gently as it proceeds anteriorly, or there may be sharp decline, or it could drape downwards in catenary fasion[1].

The mean distance of inferior alveolar nerve to spices of mandibular 2nd molar, 1st molars, premolars is 3.7,6.9,4.7mm respectively. While developing osteotomies in mandibular posterior region for implant placement, it should be recognised, that the mean distance between the apices of teeth and mandibular canal reported may not apply universally to patients[1]. Hence to avoid untoward sequelae, the location of nerve needs to be verified before osteotomy preparation.

Inadvertent penetration into mandibular canal during osteotomy procedure may induce nerve damage. Though, the cortical bone around the mandibular canal may provide resistance to drilling, clinician should not completely rely on tactile feedback, as the twist drill can enter the canal with little warning. There is no substitute for precise radiometric safety device plan for attaining specific implant length in the posterior mandible.

Pre-prosthetic implant imaging involves radiological examination to assist the implant team in determining the dimension and angulation of implant. The objectives of this phase include all necessary surgical and prosthetic information to determine the quantity, quality and angulation of bone[2]. The relation of critical structures to the prospective implant site plays a significant role.

All radiographic evaluation showed a variation ranging from 0.2-1.9mm due to distortion[1]. These inaccuracies need to be considered, when creating an osteotomy in sensitive areas to avoid misinterpretation of vital structures on radiograph. One such anatomical structure that may be used as clinician's guidelines is the mylohyoid line.

The mylohyoid line gives origin to mylohyoid muscle. The internal surface of the mandible is divided into two regions by mylohyoid line. The shape of the mylohyoid line has been classified into 8 types and the most common pattern in Indian population is straight form. The relational position of the mylohyoid line to the root apices of the mandibular molar teeth has been reported by ishiko& kobayashi[3]. These authors reported the root apices of M2 (lower second molar) is located below the mylohyoid line. Though the distance between the mylohyoid line and alveolar crest decreases with tooth loss especially in M1 & M2 region, the neighbouring parts of the mylohyoid line as studied by Matsumoto do not seem to be affected by missing premolars and molars. The position of the mylohyoid line is not only a landmark that can be used to show the changing height of the body of mandible with loss of teeth, but it also helps in understanding dental prosthetic treatment[3].

Though the relevance of mylohyoid line to the occlusal surface of the mandible has been studies, the co – relation and significance of a mylohyoid line to inferior alveolar canal has not been acknowledged and studied[3]. The purpose of this study is to evaluate the distance between the apices of molars & premolars to inferior nerve canal and mylohyoid line to establish a relationship between the canal and line.

MATERIAL AND METHOD

Institutional Review Board of Adhiparasakthi dental college and hospital has approved this study (2019-MDS-Brl-PON-03/APDCH). None of the patients were exposed to CBCT radiation just for the purpose of the study.
In this cross-sectional study, 100 CBCT images that were acquired during one-year period from archives of a private clinic in Chennai, Tamil Nadu, were evaluated. The CBCT images were obtained with a New Tom Go CBCT machine. All CBCT images were taken using a field of view (FOV: 10 x 6 Cm) and a basic voxel size of 0.08mm. operating parameters were set at 4.0mA and 90 kV, and the exposure time was 5.6 seconds. CBCT images were screened only if they matched the following inclusion criteria.
Inclusion criteria:

- CBCT Scan report of patient above 20 years of age
- No periodontal problem in the posterior teeth
- Dentulous and partially edentulous anterior mandible scan reports
- Artifacts free scan

Exclusion criteria:

- Jawbone abnormality such as tori, bony spicules etc.
- Developmental anomalies like micrognathia
- Completely edentulous scan reports
- Scans with presence of artifacts
- Scans with Open apex, periapical pathology
- Inadequate calcification of mandibular canal
- Scans that have parallel mandibular part in cross section, in which the mylohyoid ridge is not evident
- Presence of any pathology (radiolucency's that might represent cyst and tumour or periapical lesion), fracture, supernumerary or impacted teeth.

For evaluation of CBCT scans, a 32-inch Samsung LCD monitor 1280x1024 pixel was used. Scans were imported to CS 3D imaging software version 3.8. The points (mylohyoid ridge, root apices, mandibular canal) were identified with the help of radiologist and those scan in which these points were not identifiable were eliminated from the study. The selected scanned images clearly showed the mandibular posterior teeth apices. Using panoramic view option, the mandibular canal tracing was done and then it was saved for further reference. Total of twelve cross sections of slice thickness of 1mm was used and the mylohyoid ridge was clearly shown were evaluated in the software. The cross-sectional evaluation was done in right first premolar, right second premolar, right first molar mesial part, right first molar distal part, right second molar mesial part, right second molar distal part. Left first premolar, left second premolar, left first molar mesial part, left first molar distal part, left second molar mesial part and left second molar distal part.

Three reference points were taken into consideration. They are listed below (Figure 1)

ML- mylohyoid ridge

RA- root apices

MC- superior border of the mandibular canal

Following this, these reference points were identified in each of the cross sections with the help of radiologist. Digital calliper in C3 3D imaging software was used to calculate the distance. The distance which was calculated is listed below

1. Distance A- the distance from the mylohyoid ridge to root apices.
2. Distance B- the distance from the root apices to the superior border of the mandibular canal.
3. Distance C- the distance from the mylohyoid ridge to the superior border of the mandibular canal.

The calculation of distance was done using single observer. In order to avoid bias in calculation of values, the measurements were done twice. Initially the distance measurements for all twelve sites in the each of the samples was calculated using digital calliper. The calculated values were tabulated in the Ms Excel sheet and saved as Data 1. After one month period of interval again the measurements were calculated for all twelve sites in each sample using digital calliper. Again, the calculated values were tabulated in the Ms Excel sheet and saved as Data 2.

From the values of Data 1 and Data 2 the averages values were taken. The average values from Data 1 and Data 2 the statistical analysis was performed.

RESULTS

The Normality tests, Kolmogorov-Smirnov and Shapiro-Wilks tests results reveal the study followed normal distribution. Therefore, to analyse the data, parametric test was applied. Descriptive statistics was done to assess the mean among the study variables and One way ANOVA was used to compare the mean values recorded for all the variables included in the study and to analyse pair-wise comparison, post hoc test was used. Correlation analysis was done to find out the relation between the tooths and side. To analyse the data SPSS (IBM SPSS Statistics for Windows, Version 26.0, Armonk, NY: IBM Corp. Released 2019) is used. Significance level is fixed as 5% ($\alpha = 0.05$). P-value <0.05 is considered to be statistically significant. (Table 1, Table 2, Table 3, Table 4)

CONCLUSION

This study was performed to determine the average distance between the root apices of molars and premolars to the superior border of the mandibular canal and the mylohyoid line., and to establish a relationship between three.

This study could have been done by direct measurements from cadaveric mandibles but it was not taken into consideration because studies were reported that localization of the mandibular canal using CT and compared the measurements with direct osteometry, they observed overestimation and underestimation of the distance [4].

And also, pilot study using cadaveric mandible showed subtle changes in the measurement during mechanical cross-sections. CT scan were not taken into consideration because CT based implant planning and transferring to the surgical field through a surgical guide was reported to result in approximately 1mm of mean linear deviation and 3º mean angulation difference which is a major issue[5]. The CBCT scans were chosen to overcome these drawbacks. since the images which were obtained from the CBCT and the assistance of software programs has greatly enhanced the clinician's ability to plan, and restore the implant accurately with the level of precision that was unattainable a few years ago[67,8].

Mandibular canal is considered a critically important vital structure routinely encountered during mandibular implant placement[9]. Within the mandible is mandibular canal which begins from mandibular foramen on the medial surface of the ascending ramus and then it forwards horizontally in the body till mental foramen. Inferior alveolar neurovascular bundle is carried by them, where it sends branches to the lower teeth and provides sensatio[10,11]. Inferior alveolar nerve exits in different locations and it may be present with many variations[12]. The bifid mandibular canal is of rare occurrence, it is important anatomical variant to be detected because of its clinical implication resulting in advertent bleeding during surgeries in the lower jaw[13].
For planning of dental procedures, the identification of the mandibular canal and its branching are important[12]. Inferior alveolar nerve is the most commonly injured nerve[14,15]. Possible intraoperative risk factors associated with inferior alveolar nerve injury following implant placement include protrusion through buccal or lingual cortical plate, perforation of mandibular canal, direct mechanical injury, extrusion of preparative debris into canal, extensive bleeding, slippage of drill, implant placement deeper than planned or bigger diameter implant placement, excessive force during implant drilling[16]. Serious complication can arise when there is damage of inferior alveolar nerve. The determination of the location and position of mandibular canal helps to reduce the risk of injury to the nerve during any surgical procedure. In CBCT cross sectional images the mandibular canal was readily visible [17]and thus was used to determine a more reliable distance[9].

In mandible, on the inner aspect of the body is divided into two portions by a well-defined ridge called as mylohyoid ridge which starts from the posterior border of the lingula [18] from which the mylohyoid muscle arises [19,20]. The mylohyoid muscle act as a partial barrier between the sublingual and submandibular spaces, therefore it can be related to the spread of space infections. The prominence of mylohyoid ridge may be more evident on resorption of the residual alveolar ridge [21]. Aoki et all reported that, in the edentulous patients the mylohyoid line has a clinical effect on the stability of the denture and for determination of the occlusal plane it can be used as a reference. The distance between the inferior border of the mandible and mylohyoid line increase from the anterior region to the posterior region [19].

The relative position of mylohyoid line to the mandibular canal and apices of the root has not been studied in depth, In the current study the average distance between the root apices to the mylohyoid line (A), the distance from the root apices to the superior border of the mandibular canal (B) and the distance from the mylohyoid line to mandibular canal (C) is determined. Distance between A, B and C varies from molars to premolars and also

differs from right side of the mandible to that of left side, as knowledge of this relationship is potentially useful in implant treatment.

Ishiko& Kobayashi et al reported that in lower second molar region the mylohyoid line located above the root apices[22,23]. In current study, in premolar regions, the mylohyoid ridge runs lightly inferior to the root apices. In first molar region the distance between the mylohyoid line to root apex is more or less running in same line. In second molar region the mylohyoid line runs superior to that of root apex by approximately 3.25mm. so the course of the mylohyoid line is descending below the premolars root apices and continues progressively to the root apices of 1st molar and ascending superior to that of root apices of 2nd molar.
Oliveria et al reported that in right second molars the distal root was closest to the mandibular canal with mean value of 3.41mm and the right first premolar root was the most distant to the mandibular canal with mean value of 5.87mm[24]. In current study, the left 2nd molar distal root was closest to the mandibular canal with mean value of 4.35mm and the right first premolar root was the most distant to the mandibular canal with mean value of 5.47mm. The risk of damage to mandibular canal in the left 2nd molar region is higher.

In average distance between the root apex to mandibular canal in right 1st molar mesial and distal root is 5.69mm &5.87mm respectively, in left 1st molar mesial and distal root is 5.76mm & 5.80mm respectively, in right 2nd molar mesial & distal root is 4.98mm & 4.55mm respectively and in the left 2nd molar mesial & distal root is 5.02 & 4.35mm respectively. These measurements could provide clinician a valuable information for placement of an immediate implant safely without causing damage to mandibular canal.

The mylohyoid ridge is said to be palpable region [21]. In current study, the prominence of mylohyoid line is well appreciated in the molar regions than in premolars. In first molar regions the mylohyoid line runs more or less nearer to the root apices. The distance between mylohyoid line to mandibular canal in right 1st premolar is 5.06mm, right 2nd premolar is 4.9mm, left 1st premolar is 4.9mm, left 2nd premolar is 4.7mm, right1st molar mesial aspect is 6.02mm, right 1st molar distal aspect is 6.5mm, right 2nd molar mesial aspect is 7.5mm, right 2nd molar distal aspect is 7.5mm, left 1st molar mesial aspect is 5.6mm, left 1st molar distal aspect is 6.5mm,left 2nd molar mesial aspect is 7.2mm and left 2nd molar distal aspect is 7.5mm.The distance between mylohyoid line to mandibular canal is closet in left 1st molar mesial aspect with mean value of 5.6mm. Three dimensional radiographic assessments like CT, CBCT are not available to some clinician. In condition when presurgical implant planning done using two dimensional radiographs, these mean values from mylohyoid line to mandibular canal can be taken as guidelines for knowing about the relative position of the superior border of the mandibular canal by palpation. Wolf et al reported that there is variation of inferior alveolar nerve in left and right region and also it varies from male to female[25]. Denio et al reported with regards to the radiographs, to some extent in all radiographs the mandibular canal was visible, it was easier to identify the inferior border of the canal than the superior border[26]. In the region of the second premolar and first molar the wall of the canal was less identifiable[12]. In the current study during mandibular canal tracing using CBCT, the walls of the canal can be well appreciated in the first and second molar regions than the premolars. The superior and inferior border of the canal is well distinguishable while tracing using CBCT. The mandibular canal most commonly

appears as a radiolucent shadow with margins having radio opaque lines[13]. In case of an instrument's overextension or during traumatic dental surgical procedures in the lower jaw may cause damage to the neurovascular bundle.

Tie liu et al stated that the inferior alveolar canal is closest to the inferior border of the mandible in the first molar region[13]. In our current study, the existence of the mylohyoid line is more evident in the first molar and second molar region when compared with the premolars. The position of the mylohyoid line is superior to that of root apices in molar regions, and it is inferior to that of root apices in the premolar region[29].

In presurgical implant planning along with the radiographic assessments these mean values can be taken as a guideline for safer placement of implant. But still three-dimensional radiographic evaluation is always considered as gold standard method.

CLINICAL SIGNIFICANCE

1. The relative distance between the root apices and mandibular canal guides clinician in placement of immediate implant
2. Left second molar root is closest to the mandibular canal so during planning of implant in second molar region is very critical.
3. When accessibility to 3D imaging is not feasible, since mylohyoid line is palpable region, the relative distance between mylohyoid line to mandibular canal can be used as the guidelines for placement of implant.

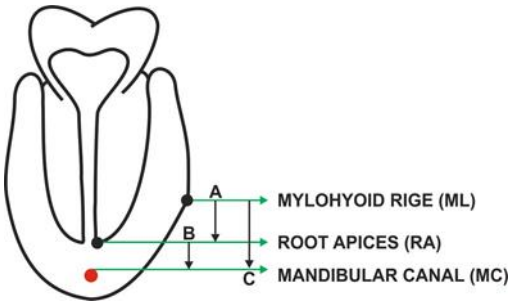

Figure 1: Anatomical reference points

Table 1: Descriptive Statistics of Right 1st Premolar

Variables	Ml-Ra	Ra-Mc	Ml-Mc
Mean	-0.369	5.47	5.063
Std.Error Of Mean	0.4492	0.2667	0.3541
Std. Deviation	4.4915	2.6667	3.5407
Variance	20.173	7.111	12.537
Range	18.8	11.5	21.2

Minimum	-9.6	0.6	-6.4
Maximum	9.2	12.1	14.8

Table 2: Descriptive Statistics Of Right 2nd Premolar

Variables	Ml-Ra	Ra-Mc	Ml-Mc
Mean	-0.302	5.231	4.932
Std.Error Of Mean	0.3869	0.2352	0.3626
Std. Deviation	3.869	2.3515	3.6264
Variance	14.969	5.529	13.151
Range	17.4	9.2	20.9
Minimum	-10	1.6	-7.6
Maximum	7.4	10.8	13.3

Table 3: Descriptive Statistics Of Right 1st Molar (Mesial)

Variables	Ml-Ra	Ra-Mc	Ml-Mc
Mean	0.627	5.697	6.021
Std.Error Of Mean	0.3324	0.2562	0.2699
Std. Deviation	3.3238	2.5621	2.6994
Variance	11.048	6.565	7.287
Range	14	11	16
Minimum	-6.4	1.4	1.6
Maximum	7.6	12.4	17.6

Table 4: Descriptive Statistics Of Right 2nd Molar (Mesial)

Variables	Ml-Ra	Ra-Mc	Ml-Mc
Mean	2.948	4.98	7.536
Std.Error Of Mean	0.3344	0.26203	0.3086
Std. Deviation	3.3436	2.62028	3.0859
Variance	11.18	6.866	9.523
Range	25.9	15.7	14
Minimum	-9.5	1.1	1.6
Maximum	16.4	16.8	15.6

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