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ORIGINAL ARTICLE

Assessment of Relation and Course of Inferior Alveolar Nerve using CBCT : A Retrospective Study of 120 cases

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Abstract

Introduction: Inferior alveolar nerve injury is most common post-operative complications while performing surgical procedures in close proximity to the Inferior alveolar neurovascular bundle such as Extraction of third molar, Placement of intraosseous implants, Placement of screws, Bilateral sagittal split osteotomy, Genioplasty in orthognathic surgery, Inferior Alveolar Nerve lateralization, Body Osteotomy, Distraction Osteogenesis, Massetric hypertrophy. So the relation and course of the inferior alveolar nerve is important to avoid injury to the nerve.

Aim: The aim of the study is to assess the course of mandibular nerve from its entry to exit from mental canal and to evaluate the distance of the inferior alveolar nerve canal with 3rd molar.

In this study, 120 patients from Department of Oral and Maxillofacial Surgery, Thai Moogambigai Dental College and Hospital, Dr. M.G.R Educational & Research Institute (Deemed to be University) who underwent investigations with CBCT were recruited. All these patients had lower third molars. CBCT of each patient was taken. Slice thickness maintained was - 2mm.

Results: In this CBCT study of 120 cases, most common type of course of inferior alveolar nerve was Progressive Descent type. The mean distance between the inferior alveolar nerve to the Impacted third molar root apex was 0.8 mm.

Conclusion: Most common course of mandibular canal is progressive descent type and is most commonly seen in mesioangualr type of impactions. In this study, the distance from the Third mandibular molar to the inferior alveolar nerve is found to be 0.8mm. This CBCT study helps to know the distance of inferior alveolar nerve to the third molar which is considered to be important while performing minor oral surgeries in the third molar region.

Keywords : Inferior Alveolar Nerve (IAN), Impacted Third Molars (ITM), Inferior Mandibular Third Molar (IMTM), Mental Foramen (MF), Mandibular Canal (MC), Panoramic Tomography (PTG) Cone Beamed Computed Tomography (CBCT)

Introduction

Mandibular canals (MC) are anatomical structures that extend bilaterally from the Mandibular foramen to the Mental Foramen (MF) carrying the inferior alveolar nerves, arteries, and veins [1].

Interestingly, the most commonly affected nerve is the mandibular nerve (ie, reports indicate up to 64.4% of complications are related to this nerve), followed by the lingual nerve [2]. Encroachment into this vital structure is a most unpleasant experience for both the patient and the dentist [3].

Complications, such as changes in sensation, numbness, pain, and excessive bleeding, can affect the patient's overall quality of life. The iatrogenic nature of this condition significantly increases the psychological effects related to this damage [4,5].

The assessment of the location of the mandibular canal, its course as well as the relation of the third mandibular molar to the Inferior alveolar nerve is often a prerequisite for an appropriate planning. Hence, the radiographic examination has to, in some patients, include cross-sectional tomography [6]. Several studies report the frequency of

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postoperative IAN injury ranges from 0.4% to 8%, with less than 1% reporting permanent numbness. However, the probability of injury could be more than 10% in higher-risk individuals. Clinical studies have investigated the risk factors related to IAN injury, such as age, sex, the depth of impaction, and angulation. It has also been reported that the proximity of the LM3 to the inferior alveolar canal (IAC), the relative position between the IAC and the roots of the LM3, and the shape of the IAC in the panoramic tomography (2d) and saggital (3d) view of cone beam computed tomography (CBCT) are important factors to avoid IAN injury [7].

Materials and Methods

The present retrospective study was conducted at Department of Oral & Maxillofacial surgery, Thai Moogambigai Dental College and Hospital, Dr. M.G.R Educational & Research Institute (Deemed to be University), Chennai – 600037. Modern Lab & X-rays, East Moggapair, Chennai.

The study protocol was approved by the Institutional Ethical Committee.

A total of 120 cases Mandibular CBCT were obtained and assessed in this study. All were in the age group of 16 to 46 years (mean age = 31years) of either gender.

Inclusive criteria and Exclusive criteria

Inclusion Criteria

1) Patients having age group ranging from 16 years to 46 years (mean age = 31 years) of either gender.
2) Presence of one or both impacted mandibular third molar.
3) Good quality images with respect to geometric accuracy and contrast of the image.
4) No deep caries, large restorations, root canal treatment in the lower teeth.
5) No supernumerary tooth.
6) Devoid of positioning errors.
7) Images free from the presence of implants or any artifacts.

Exclusive Criteria

1) Presence of artifacts
2) Presence of maxillofacial trauma
3) Presence of pathological lesion in the mandible
4) Completely edentulous mandible

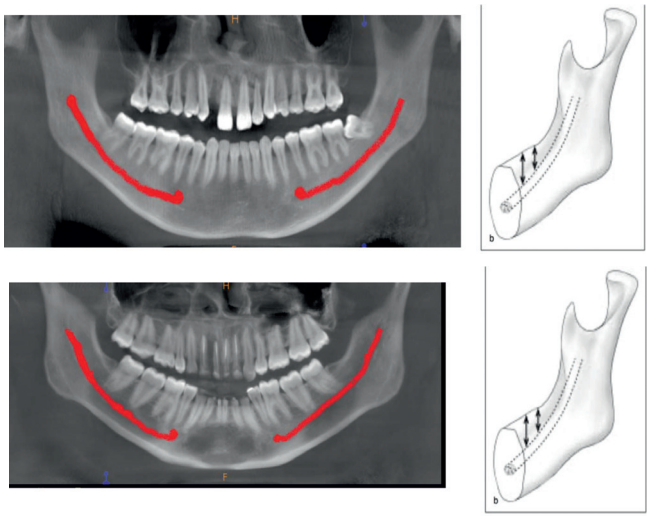
Methods

Radiation exposure: Single CBCT scan – 36.9 to 50.3 ìSv. The radiographic exposure for patients was well below the maximum permissible dose of 2.4 mSv as per the NCRP guidelines [8].

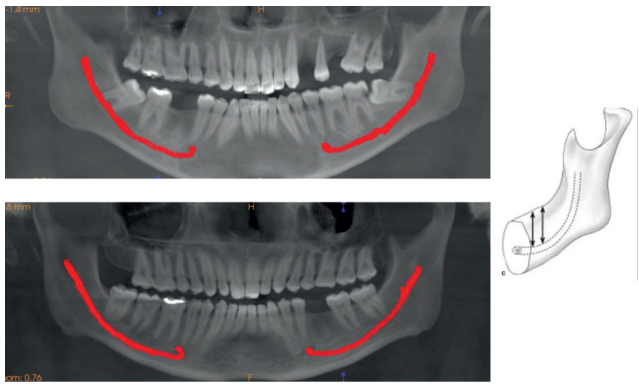
- In panoramic tomography (2d) images, the inferior alveolar nerve course is marked from the point it starts from the mandibular foramen till the exit of the nerve through mental foramen.

  In Saggital Sections of CBCT, the distance from the inferior alveolar nerve to the third mandibular molar is measured .

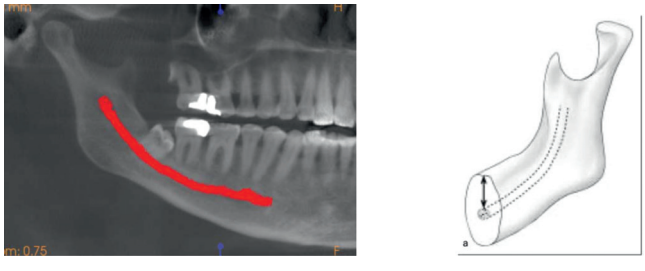
CBCT Images



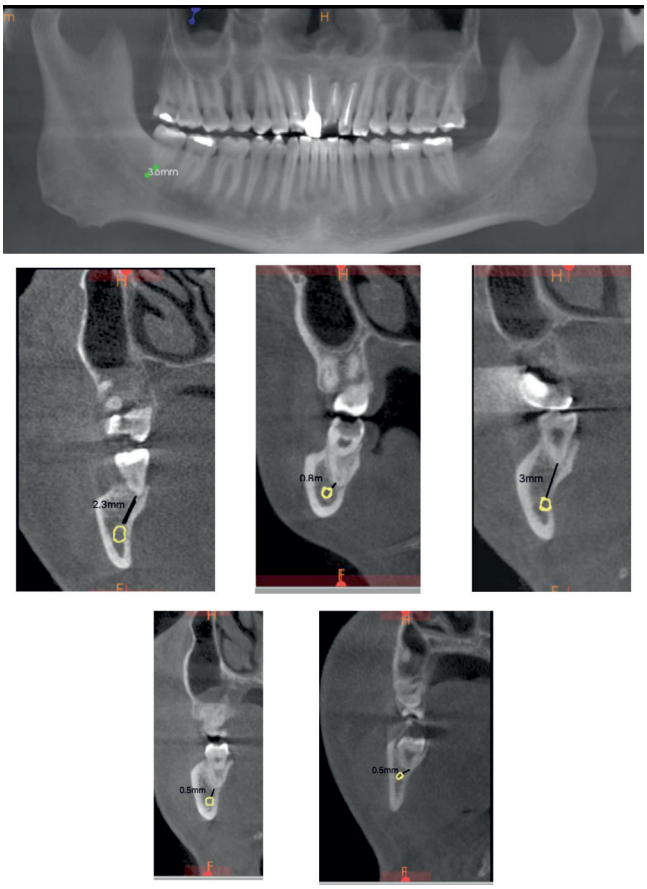
Progressive Descent Type



Caternary



Linear



Relation of Inferior Alveolar Nerve

Statistical Analysis and Results

The collected data were analysed using Statitical package for social sciences (SPSS) version 24.0, IBM Corporation. The categorical data were analysed using chi square statistical test for testing the association between the categorical variables. And the continuous data were analysed using Non parametric Kruskal wallis test for significance testing as the data were non- normally distributed which is checked by Shapiro- wilkis testing.

Results

Out of 120 cases, we found most frequently occurring type of impaction is Mesioangular (66%) type of impaction followed by Vertical (14%), Horizontal (11%) and Distoangular (9%) - Fig1.

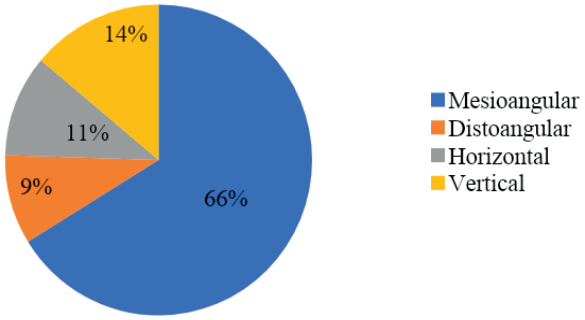


Figure 1: Distribution of type of impaction among study population

Most common type of course of inferior alveolar nerve is found to be Progressive Descent (56%), Caternary (30%), Linear (14%) -Fig 2.

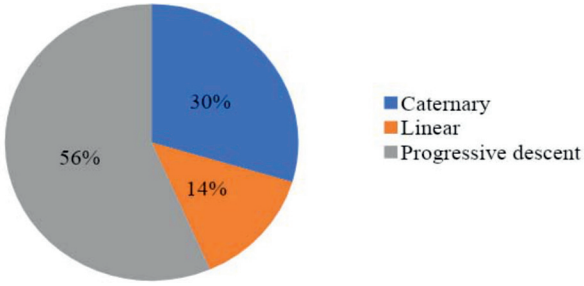


Figure 2: Distribution of type of course of alveolar nerve among study population

The Mean distance of the mandibular canal to the root apices of the mandibular third molar is found to be 0.8 mm.

There exists no significant association between the type of impaction with the course of alveolar nerve. The course of alveolar nerve were statistically equally distributed with all types of impaction in our study subjects.

Normality testing with Shapiro Wilki test reveals that as there exist a significance value of less than 0.05, it means that the continuous measurements data were not normally distributed.

CBCT images showed that the Inferior alveolar nerve descends downwards from the mandibular foramen and the course of the inferior alveolar nerve progress more lingually near the third molar region, and near the second molar region more centrally and near the first molar region the nerve courses towards the buccal bone and while reaching the premolar region the nerve further progress more bucally and exits out through the mental foramen in buccal bone.

Discussion

In CBCT reconstructed 3D images, the morphology of alveolar ridge and the height of alveolar bone can be accurately displayed, [9,10] showing buccolingual thickness, mesiodistal width, clear local bone structures and their anatomical relationship with surrounding anatomical structures, especially inferior alveolar nerve tube and the maxillary sinus. These images can assist to determine the volume of the bone, and the position, direction and volume of the implants, which are of great value for pre implanting planning [11,12].

Three-dimensional views acquired by cone beam computed tomography (CBCT) have been introduced because of the improbability and limitations of 2-dimensional plain radiography. Also the prognosis of the impaction can be accurately assessed when the exact position of an impacted tooth and its relationship with the surrounding anatomical structures is well known [13].

Table 1: Association between the types of impaction with the course of alveolar nerve

TYPE OF IMPACTION	COURSE OF ALVEOLAR NERVE			Total	Significance value
	Caternary	Linear	Progressive Descent		
Mesioangular	34(15.7)	23(10.6)	86(39.8)	143(66.2)	0.280
Distoangular	8(3.7)	2(0.9)	10(4.6)	20(9.3)	
Horizontal	10(4.6)	2(0.9)	11(5.1)	23(10.6)	
Vertical	12(5.6)	3(1.4)	15(6.9)	30(13.9)	

Table 2: Descriptive characterstics of the continuous variable

VARIABLE	N	Mean	Standard deviation	Minimum	Maximum
Relation to IAN in mm	216	0.8	1.48	-6	5

Table 3: Normality testing of the continuous variable

VARIABLE	N	Shapiro- Wilki	
		Statistic	Significance
Relation to IAN in mm	216	0.925	0.00

The present study was done to evaluate the intimate relationship between mandibular canal and impacted mandibular third molar such as distance from the third molar root apex to the mandibular canal, course of mandibular canal and type of impaction.

In our study, 216 Impacted mandibular third molars were assessed according to angulation (Winter's classification) into four groups namely mesioangular, distoangular, vertical and horizontal depending upon the long axis of third molar in relation to the long axis of second molar [14] in CBCT images and it was found that most common was Mesioangular type (66.3%), followed by Vertical (13.8%), Horizontal (10.6%) and Distoangular (9.3%) (Fig 1). Our results co-relates with Gulicher et al [15] (Mesioangular - 46.48%, Vertical - 33.2%, Distoangular - 15%, Horizontal - 5%), T.Hasegawa et al [16] (Mesioangular - 40.6%, Vertical - 28.1%, Hoizontal - 28.1%, Distoangular- 3.12%). Tachinami et al [17] (Mesioangular - 52.4%, Horizontal - 28.2%, Verrtical - 19.35%), S.L. Quek et al [18] (Mesioangular - 62.7%, Horizontal - 18.5%, Distoangular - 10.36%, Vertical - 10%), Musthafa et al [19] (Mesioangular - 56%, Vertical - 18.6%, Horizontal - 16.6%, Distal -8.6%) Venta et al [20] (Mesioangular - 64.2%, Vertical - 21%, Distoangular - 7.1%, Horizontal - 7.1%). The study of Peterson et al (1993) [21] concluded that the most common mandibular third molar impaction is mesioangular type (43%), then vertical (38%), distoangular (6%) and horizontal (3%). Sedaghatfar et al (2005) [22] in their study found maximum number of mandibular third molars to be mesioangular. Hazza'a et al (2006) [23] found highest number of vertically placed mandibular third molars followed by mesioangular, distoangular, and horizontal third molars. Chu et al (2003) [24] found that maximum number of third molars (80% of 3178 mandibular third molars) was horizontal or mesioangular. These variations in angular position of mandibular third molars may be because of the fact that the studied population in each study was quite different from each other.

Ozturk et al [25] confined classified the canal's course in the mandibular body as three types:

1) Straight projection (12.2%),

2) Catenary-like configuration (51.1%) and

3) Progressively descending from posterior to anterior (36.7%).

This study classified the course of the mandibular canal into linear, spoon-shaped, elliptic, and turning curve types, as in the study conducted by Liu et al. [26] A linear curve (22.9%) in our study was very similar to the straight projection (12.2%) observed by Ozturk et al, and the other curves were not similar to their findings.

Yun-Hoa Jung et al [27], In their study the distribution of course of nerve canal was Linear - 22.9%, Elliptical - 64.6%, Spoon - 6.8%, Turning - 5.5%. Elliptical curves were most frequently observed along the course of the mandibular canal. The percentage of clearly visible mandibular canals was the highest among the spoon-shaped curves and the lowest among the linear curves. Sanam Mirbeigi et al [28] in his study on 156 patients - found 33.3% canals was straight type, 33.3% had Catenary type and 33.3% of them were presented with Progressive descending type. There was not statistically significant difference between two genders (Pv=0.092).

Ayla Ozturk et al [25] classified course of mandibular canal into 3 types: straight projection (12.2%), catenary-like configuration (51.1%), and progressive descent from posterior to anterior (36.7%). In our study, we found Progressive descent as most frequently occurring pattern - 56.48%, followed by Caternary pattern - 29.6%, Linear pattern - 13.8%.

Trustiya et al [29] in their study found the average distance from the IMTM to the superior border of the IAC (LT-SC) was 1.76 ± 0.96 mm in women and 1.69 ± 1.05 mm in men.

The previous study of Momin et al [30] found the mean distance from apex of IMTM roots to canal to be 1.99 mm. The study of Liu et al [26] found that the distance from distal root of the IMTM to the superior border of the IAC was 1.27 ± 1.66 mm. From the previous studies, it can be concluded that the average distance from tooth to canal is ap- proximately 1-2 mm, and this value can be used for evaluation and prediction before surgical removal of the IMTM.

Prasannasrinivas Deshpande et al [31] stated that the overall mean distance from the impacted mandibular third molars to inferior alveolar canal was -0.50 mm. Most of the samples (61.8 %) extended beyond the superior border of the inferior alveolar canal with a mean distance of -1.40 mm. Mesioangular impactions were found to be in the close proximity (-1.14 mm) to inferior alveolar canal than any other type. Michael Miloro et al [32] stated that the mean distance from erupted mandibular third molar teeth to the inferior alveolar canal is 0.88 mm. This distance was significantly different from unerupted teeth (P = 0.002). The mean values for unerupted teeth indicated that the most inferior portion of all teeth measured was below the superior border of the canal (negative values) as follows: mesioangular (20.97 mm), vertical (20.61 mm), distoangular (20.31 mm), and horizontal (20.24 mm). The position of mesioangular impactions were significantly different than all other impaction groups (p = 0.0125). In our study the mean distance from the tooth apices of third molar to the mandibular canal was 0.8mm. which co-realtes with Trustiya et al, Momin et al, Liu et al, Micheal Miloro et al and other previous studies.

Conclusion

The present study was aimed to assess the course of mandibular nerve from its entry to exit from mental canal and to evaluate the relation and distance of the inferior alveolar nerve canal to 3rd molar, and type of impaction. In this study, frequency of mesioangular impaction is 66.3%, Vertical is 13.8%, Horizontal is 10.6% and Distoangular is 9.3%. The saggital sections of cbct showed alveolar nerve course - with Progressive descent type - 122 (56.45%), Caternary type – 64 (29.6%), Linear type -30 (13.8 %). In our study it is known that there exists no significant association between the type of impaction with the course of alveolar nerve. The course of alveolar nerve was statistically equally distributed with all types of impactions in our study subjects (P value <0.05).

In this study, the mean distance from the root apices of third molar to the mandibular canal is 0.8mm. which states that the mandibular canal passes more lingually in the third molar region. There is no significant difference in distance of inferior alveolar nerve with the impacted tooth among type of impaction and also there is no significant difference in distance between mandibular canal to buccal and lingual bone with the impacted tooth among different type of impaction.

CBCT images showed that the inferior alveolar nerve descends downwards from the mandibular foramen and the course of the inferior alveolar nerve progress more lingually near the third molar region, and near the second molar region more centrally and near the first molar region the nerve courses towards the buccal bone and while reaching the premolar region the nerve further progress more Bucally and exits out through the mental foramen in buccal bone.

In conclusion, our study can guide oral surgeons and can be applied to evaluate and predict the relationship between the IMTM and the IAC before surgeries such as Extraction of third molar, Placement of intraosseous implants, Placement of screws, Bilateral sagittal split osteotomy, Inferior Alveolar Nerve lateralization, Genioplasty in orthognathic surgery, Body Osteotomy, Distraction Osteogenesis, Massetric hypertrophy.

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Ethics:	There is no ethical violation as it is based on voluntary anonymous interviews
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References

1. Christiano de Oliveira-Santos, Paulo Henrique Couto Souza, Soraya de Azambuja Berti-Couto - Assessment of variations of the mandibular canal through cone beam computed tomography - Clin Oral Invest 2012;16:387–39
2. A. B. G. Tay, J. R. Zuniga - Clinical Characteristics of Trigeminal Nerve Injury referrals to a university Center - Int. J. Oral Maxillofac. Surg. 2007;36:922–927
3. Shokri A, Shakibaei Z, Langaroodi AJ, Safaei M. Evaluation of the mandibular canal visibility on cone-beam computed tomography images of the mandible. J Craniofac Surg. 2014 May;25(3):e273-7.
4. Kim IS, Kim SG, Kim Y-K, et al. Position of the mental foramen in a Korean population: a clinical and radiographic study. Implant Dent 2006;15:404Y411.
5. Cagirankaya L, Kansu H. An accessory mental foramen: a case report. J Contemp Dent Pract 2008;9:98Y104
6. Lofthag-Hansen S, Gröndahl K, Ekestubbe A. Cone-beam CT for preoperative implant planning in the posterior mandible: visibility of anatomic landmarks. Clin Implant Dent Relat Res. 2009 Sep;11(3):246-55.
7. Jin-Woo Kim, In-Ho Cha, Sun-Jong Kim, Myung-Rae Kim. Which Risk Factors Are Associated With Neurosensory Deficits of Inferior Alveolar Nerve After Mandibular Third Molar Extraction?. Journal of Oral and Maxillofacial Surgery 2012;70(11):2508-14.
8. Frederiksen NL. Health Physics. In White SC, Pharoah MJ(eds) Oral Radiology, - Principles and Interpretation.5th ed. pp 47-68. New Delhi, India:Elsevier, 2004.
9. Loubele M, Van Assche N, Carpentier K et al. Comparative localized linear accuracy of small-field conebeam CT and multislice CT for alveolar bone measurements. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008;105(4):512–8.
10. Suomalainen A, Pakbaznejad Esmaeili E, Robinson S. Dentomaxillofacial imaging with panoramic views and cone beam CT. Insights Imaging. 2015;6(1):1–16.
11. Arai Y, Tammisalo E, Iwai K, Hashimoto K, Shinoda K. Development of a compact computed tomographic apparatus for dental use. Dentomaxillofac Radiol. 1999;28(4):245–8.
12. Mozzo P, Procacci C, Tacconi A, Martini PT, Andreis IA. A new volumetric CT machine for dental imaging based on the cone-beam technique: preliminary results. Eur Radiol. 1998;8(9):1558–64.
13. Novak PD. In Dorland's illustrated medical dictionary.27thed. pp 496. - Philadelphia:Saunders,2004.
14. Winter, GB. Impacted mandibular third molar. St Louis, American Medical Book Co., 1926.
15. Gulicher D, Gerlach KL. Incidence, risk factors, and follow up of sensation disorders after surgical wisdom tooth removal: Study of 1,106 cases. Mund Kiefer Gesichtschir 2000;4:99-104.
16. T. Hasegawa, S. Ri , T. Shigeta et al. Risk factors associated with inferior alveolar nerve injury after extraction of the mandibular third molar—a comparative study of preoperative images by panoramic radiography and computed tomography - Int. J. Oral Maxillofac. Surg. 2013;42:843–851.
17. H. Tachinami, K. Tomihara, K. Fujiwara, K. Nakamori, M. Noguchi. Combined preoperative measurement of three inferior alveolar canal factors using computed tomography predicts the risk of inferior alveolar nerve injury during lower third molar extraction - Int. J. Oral Maxillofac. Surg. 2017;46(11):1479-1483.
18. S. L. Quek, C. K. lay, K. H. lay,S. L. loh, K. C. Lim. Pattern of third molar impaction in a singapore chinese population: a retrospective radiographic survey. International J. Oral Maxilla/ac. Surg. 2003;32:548-552.
19. Mustafa Alkhader, Fadi Jarab. Visibility of the mandibular canal on cross-sectional CBCT images at impacted mandibular third molar sites - Journal of Biotechnology and Biotechnology Equipment. 2016; 30:3, 578-584
20. Irja Venta, Lauri Turtola, Pekka Ylipaavalniemi.Radiographic follow-up of impacted third molars from age 20 to 32 years. Int. J. Oral Maxillofac. Surg. 2001;30:54–57
21. Peterson LJ, Ellis E, Hupp J, and Tucker M. Contemporary Oral and Maxillofacial Surgery, 2nd ed., C.V. Mosby Co., St. Louis, 1993;237-242.
22. Sedaghatfar M, August MA, Dodson TB. Panoramic radiographic findings as predictors of inferior alveolar nerve exposure following third molar extraction. J Oral Maxillofac Surg 2005;63(1):3-7.
23. Hazza'a AM, Albashaireh ZS, Bataineh A. The relationship of the inferior dental canal to the roots of impacted mandibular third molars in a Jordanian population. J Contemp Dent Pract. 2006 May 1;7(2):71-8.
24. Chu FC, Li TK, Lui VK, Newsome PR, Chow RL, Cheung LK. Prevalence of impacted teeth and associated pathologies—a radiographic study of the Hong Kong Chinese population. Hong Kong Med J. 2003 Jun;9(3):158-63.
25. Ozturk A, Potluri A, Vieira AR. Position and course of the mandibular canal in skulls. Oral Surg Oral Med Oral Pathol Oral Radiol. 2012 Apr;113(4):453-8.
26. Liu T, Xia B, Gu Z. Inferior alveolar canal course: a radiographic study. Clin Oral Implants Res. 2009 Nov;20(11):1212-8.
27. Jung YH, Cho BH. Radiographic evaluation of the course and visibility of the mandibular canal. Imaging Sci Dent. 2014 Dec;44(4):273-8.
28. Sanam Mirbeigi, Maryam Kazemipoor, Leila Khojastepour. Evaluation of the Course of the Inferior Alveolar Canal: The First CBCT Study in an Iranian Population. Pol J Radiol, 2016;81:338-341.
29. Tudtiam T, Leelarungsun R, Khoo LK, Chaiyasamut T, Arayasantiparb R, Wongsirichat N. The Study of Inferior Alveolar Canal at the Lower Third Molar Apical Region With Cone Beam Computed Tomography. J Clin Med Res. 2019 May;11(5):353-359.
30. Momin MA, Matsumoto K, Ejima K, Asaumi R et al. Correlation of mandibular impacted tooth and bone morphology determined by cone beam computed topography on a premise of third molar operation - Surg Radiol Anat. 2013;35:311–318.
31. Deshpande PS, Guledgud MV, Patil K. Proximity of Impacted Mandibular Third Molars to the Inferior Alveolar Canal and Its Radiographic Predictors: A Panoramic Radiographic Study. J. Maxillofac. Oral Surg. 2013;12(2):145–151.
32. Miloro M, DaBell J. Radiographic proximity of the mandibular third molar to the inferior alveolar canal. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2005 Nov;100(5):545-9.