COMPARITIVE ASSESSMENT OF THE RELATIONSHIP BETWEEN THE THIRD MOLAR AND THE INFERIOR ALVEOLAR NERVE USING PANORAMIC RADIOGRAPHS AND 3-DIMENSIONAL OBJECT RECONSTRUCTED FROM CT DATA

Dissertation submitted to

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In partial fulfillment for the Degree of

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BRANCH III

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CERTIFICATE

This is to certify that this dissertation titled **"COMPARITIVE ASSESSMENT OF THE RELATIONSHIP BETWEEN THE THIRD MOLAR AND THE INFERIOR ALVEOLAR NERVE USING PANORAMIC RADIOGRAPHS AND 3-DIMENSIONAL OBJECT RECONSTRUCTED FROM CT DATA"** is a bonafide record of work done by **Dr. SAILEESH BEZAWADA** under our guidance and to our satisfaction during his postgraduate study period **2009-2012.**

This Dissertation is submitted to **THE TAMILNADU Dr.M.G.R. MEDICAL UNIVERSITY,** in partial fulfillment for the award of the Degree of **MASTER OF DENTAL SURGERY – ORAL AND MAXILLOFACIAL SURGERY, BRANCH III.**

It has not been submitted (partial or full) for the award of any other degree or diploma.

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INTRODUCTION

The precise anatomic definition of the mandibular canal with respect to the lower third molar is of the utmost importance in preventing injury to the Inferior Alveolar Nerve during surgical extraction of impacted lower third molars. The Inferior Alveolar Nerve, descending in an anterior direction, presents important intra-osseous relationships with the roots of the molars. Between the apex of the third molar and the mandibular canal, several types of relationships may be established that should be identified before surgical intervention by means of diagnostic imaging.

Preoperative assessment should be carried out radiologically in an attempt to identify the proximity of the impacted tooth to the mandibular canal. This evaluation is the first step in assessing the possible postoperative occurrence of labial sensory impairment and thus its prevention. The Orthopantamograph is used frequently as the radiologic investigation of choice before third molar surgery.

Magnification and distortion on the panoramic radiographs in the different parts of jaws vary because of changing distance between the rotational centre and film and because of the changing rate of movement of the film. Therefore, linear measurements obtained from panoramic radiographs may not represent the actual dimensions of the jaw.

Moreover panoramic radiograph is a projected view and not a actual representation of the region, and are two dimensional images. They do not show bucco- lingual dimension. Validation studies have shown that the panoramic radiograph as a test for nerve injury has a relatively low sensitivity (24%-38%) and a relatively high specificity (92%- 98%).[20] These studies indicate that, while there are discretely defined parameters on panoramic radiographs that are suggestive of nerve injury, only a minority of patients who sustain nerve injuries will have these signs. Conversely, absence of these radiographic signs is of greater diagnostic utility for assuring a patient that they are at decreased risk for Inferior Alveolar Nerve injury. To locate the mandibular canal various techniques of cross-sectional imaging are used.

COMPUTED TOMOGRAPHY (CT) is the gold standard for disclosing an anatomic relationship between the third molar roots and the mandibular canal, particularly if the roots are believed to surround the nerve. CT has become instrumental in delineating the relationship between the apices of mandibular third molar to the Inferior Alveolar Nerve. CT allows the surgeon to achieve a realistic impression of the overall anatomic situation preoperatively, thereby minimizing nerve injury.

Recent advances in computer hardware and software have permitted CT to produce higher resolution 3-D reconstructed images that yield the anatomical and pathological detail of interest. The evolution of MED CAD in 3-D object reconstruction provides clinical accuracy and all necessary information. Hence the 3-D object reconstruction provides help with diagnosis, planning of surgical interventions and evaluation of several maxillofacial lesions like trauma, evaluation of TMJ, enhance pre- surgical treatment planning of craniofacial surgery and aid in measurement of distances of vital structures from its surrounding structures. By means of 3-D object reconstruction, it is possible to visualize and measure directly the distance between the apices of the mandibular third molar to the inferior alveolar nerve accurately, rotate the image in all the axis and can see the bucco-lingual relationship, visualize transparency of different structures and relation of one structure to the other, simulate the entire course of the nerve, move the tooth in its path of exit and virtual movement of sectioning the tooth can be seen.

AIMS AND OBJECTIVES

The aim of this study was to predict the accurate relationship between the lower third molars and the inferior alveolar canal by comparing conventional panoramic radiographs with 3-Dimensional-object reconstructed CT data before performing third molar surgery.

The objective of this study is to evaluate and broadly understand the inter-relationship of intra bony structures with conventional and newer technologies.

REVIEW OF LITERATURE

BADRI AZAZ (1976) made observations on 200 impacted mandibular third molars that were removed from 200 unselected patients under local anaesthesia. 60% of the teeth were found to be in apparent relationship with the inferior dental canal: 19% in true relationship and 41% in superimposition. The vertical impacted molars were mainly found to be in true relationship with the inferior dental canal. On comparison of the clinical postoperative diagnosis with the radiographic preoperative findings an error of only 0.8% was shown. Most of the molars showed fully developed roots in the third decade of life. Most of the teeth in this series were vertically impacted having mostly fully developed roots. There was a significant correlation between the patients suffering from pain, trismus and swelling. Swelling and trismus were the most affected postoperative sequelae.

T.TAMMISALO, HAPPONEN (1992) The position of the mandibular canal in relation to the superimposed roots of 173 impacted lower third molars were evaluated radiographically. A recently developed, multiprojection narrow beam Radiography (MNBR) was applied in this study. The mandibular canal was located buccally to the roots of 105(61%) teeth, lingually to the roots of 57(33%) teeth, and between the roots of 6(3%) teeth. The canal was visible at operation in 23 (29%) cases, which was predicted at stereographic examination in 21 (91%) cases. This method enables stereoscopic examination of the area of interest. With MNBR the bucco-lingual relationship and close proximity of the roots and canal can be determined with high sensitivity. The MNBR stereographic technique is a useful method with high sensitivity for evaluating the bucco-lingual relationship of the mandibular canal to the roots of third molar.

F.A.CARMICHAEL (1992) conducted a survey to record both initial and long term effects on the lingual and inferior alveolar nerves following third molar removal. 825 patients were included and 1339 third molars removed. Changes in sensation were recorded by direct questioning at 6 to 24 hr and 7 to 10 days, and by postal questionnaire at 12-18 months. The incidence of lingual nerve damage was found to be 155 of operated sides at 6 to 24 hours, 10.7% at 7 to 10 days, and 0.6% after 1 year. The incidence of inferior alveolar nerve damage was 5.5% of operated sites at 6 to 24 hours, 3.9% at 7 to 10 days, and 0.9% after 1 year.

S.SCHULTZ-MOSGAU (1993) conducted a prospective study to assess and follow-up the recovery from sensitivity disturbances after dentoalveolar surgery. As a new method of evaluation and follow-up, computer-aided pain and thermal sensitivity (PATH) testing was introduced. Pre-operatively, the sensitivity status was assessed in all patients by clinical means, by the pointed-blunt test discrimination method. At post-operative day 7, the sensitivity status was established once again. First the pointed blunt test was applied. Second, in cases of damage the computer-aided PATH test was used. The time-consuming PATH test was applied only to patients who had shown sensitivity changes in clinical testing before. In cases of damaged lingual lingual nerve, a conventional gustatory test with flavourings was conducted on both sides. To evaluate the course of the resensitization, these examinations were repeated after 4 weeks, 3 months and 6 months. In this study 24(2.2%) temporary sensitivity disturbances of the inferior alveolar nerve and 16(1.4%) of the lingual nerve were found. Permanent disturbances were not present. Complete recovery had occurred by 6 months in all cases. According to our results, the probability of spontaneous recovery of neural dysesthesia within 3-6 months is very high. Sensitivity disturbances should thus be considered to be permanent after 1 year. The decision to do a microsurgical repair should be made when no signs of recovery are present. According to the results from the PATH method, this should be considered 3-4 months after injury.

B.LUKA, D. BRECHTELSBAUER (1995) reviewed 314 out of 1262 CT examinations of the midface and jaws in spiral mode. They critically reviewed and made a guideline for the use of spiral CT scanning of the midface and jaws for various diagnostic purposes is established: complex midface fractures require axial spiral CT scanning with secondary coronal reconstructions. Dental CT scans with calculation of panoramic images provide important information about the Inferior Alveolar Canal and other vital structures prior to surgery. In conclusion of a critical review of the spiral CT examinations performed within last 12 months led to the following diagnostic scheme: 1. In all cases of complex fractures of the midface an axial spiral CT with secondary coronal reconstruction is performed. 2. In trauma cases 3D reconstructions are applied in the case of rotatary dislocation only. 3. 3D CT imaging is an important supplementary diagnostic tool for cranio-maxillofacial malformations. 4. Dental CT is useful prior to dental implant surgery and surgical repair of alveolar clefts and cysts.

A.FALK, S. GIELEN (1995) conducted a study in CT data acquisition as a basis for modern diagnosis and therapy in maxillofacial surgery. More than 20 years after its introduction CT has become a routine method in the diagnostic work-up of traumatic and neoplastic disorders in maxillofacial surgery. Short acquisition times of 1sex per image reduce motion artifacts and permit increased number of patient examinations. Fast volume data acquisitions associated with spiral scanning proves to be of special benefit in trauma patients. The resulting data set can be used for reconstruction of single slices, 2D reformatted images in all planes and 3D surface rendering. CT is of special importance in reconstructive surgery. In tumor patient examination good visualization of soft tissue structures is of utmost importance, so that the axial single slice technique is employed. Intravenous contrast bolus application gives an excellent vessel and tissue contrast. For primary diagnosis of midfacial and mandibular joint fractures direct coronal slices are advantageous in case spiral scanning is not feasible. Spiral data acquisition is of special benefit if multiple different planes and short scanning times are required.3D surface reconstruction of both, bone and soft tissue, permit a realistic impression of the overall pathoanatomical situation.

SUNDER DHARMAR (1997) The entire course of the mandibular canal is normally not visible on a panoramic radiograph. Locating the course of the mandibular canal can be more clearly visualized by tilting the patients head approximately 5 degrees downward with reference to the Frankfort horizontal reference bar of the OPG machine. In 91% of the radiographs taken in this position, the mandibular foramen, mandibular canal, and mental foramen were visible. The angulation of the patients head reduced the chances of superimposition on the contralateral sides, making these structures clearly visible.

K.J.BUTTERFIELD (1997) Accurate assessment of alveolar ridge morphology and inferior alveolar canal location is critical in the presurgical planning phase for dental implant therapy. This study examined the accuracy and validity of linear tomography in the presurgical assessment of potential mandibular implant sites. Seven subjects (six oral and maxillofacial surgeons and one oral radiologist) traced the mandibular cortical bone and inferior alveolar canal on linear tomographic images taken from five mandibles on five separate occasions over 5 weeks. Tracings and the sectioned mandibles were scanned into a computer and assessed for eight measurement criteria. Statistically significant findings were present for intraobsever variability, interobsever variability, and differences between the perceived and actual anatomic structures within the assessed plane of section. These findings demonstrate that the inherent dimensional instability of linear tomography severely limits its diagnostic and clinical role in preoperative implant site assessment.

BRAD.J.POTTER (1997) conducted a study to evaluate the ability of two different panoramic imaging systems to produce cross-sectional images with accurate vertical dimensions of the posterior mandible. Three partially edentulous human cadaver mandibles were used for this study. On each mandible, three potential implant sites were arbitrarily identified in an area between the mental foramen and the ascending ramus. Each site is imaged using two different panoramic machines. Using each image, the mandible's outline, cortical thickness, and position of the mandibular canal were traced on clear acetate film. The mandibles were then sectioned at each site to serve as a gold standard. The cadaver sections and tracings were measured, recording the overall mandibular height, distance from the crest of the ridge to superior aspect of the mandibular canal, and the thickness of the cortical bone at the most inferior aspect of the mandible. There were no significant differences between either of the system's image measures and the gold standard when considering the distance between the crest and the mandibular canal.

JIE YANG, G.P. CAVALCANTI (1999) compared and validated the accuracy of measurements on 2-dimensional and 3-dimensional reconstructions from spiral computed tomography in localization of the inferior alveolar canal. Four edentulous human cadaver heads with intact mandibles were imaged in a spiral computed tomography scanner. The data were transferred to a networked computer workstation to generate 2-dimensional orthoradially reformatted and 3-dimensional volumetric images. Linear measurements of the images were made from the superior border of the inferior alveolar nerve to the alveolar crest. The specimens were then dissected at corresponding locations, and physical measurements were made. They concluded that both 2-D and 3-D CT images allow accurate measurements for localization of the inferior alveolar canal.

KAZUHIRO YAMAMOTO (2000) To compare depth discrimination by using Tuned-Aperture Computed Tomography (TACT) variously with linear horizontal, linear vertical, combined linear horizontal and linear vertical, and conical beam projection arrays. The first test object was a metallic mesh angled at 30 degrees to the surface of a computed dental radiography size No.1 x-ray sensor. The second test object was dry human mandible. The sensor was mounted on an optical bench constructed to permit free and precise geometrical settings for the horizontal and vertical angulations of the x-ray beam. The extent of blurring of horizontal and vertical wires in each TACT reconstructed image slice was observed for each of the tested beam projection arrays. With a linear horizontal beam projection array, it was not possible to determine the depth of structures parallel to the horizontal dimension, such as the mandibular canal. With a linear vertical beam projection, it was not possible to determine the depth of structures parallel to the vertical dimension. A conical array of beam projections was best suited to the task of depth discrimination of objects in all planes. The best second alternative was a combination of linear vertical and linear horizontal projections. They concluded that beam projection geometry is important for the accurate depth discrimination of TACT reconstructed images. A conical beam projection array is ideal.

EDUARD VALMASEDA-CASTELLON (2001) conducted a study to determine the incidence of inferior alveolar nerve (IAN) damage after surgical removal of lower third molars, to identify the causes, and to construct a predictive model to assess the risk of IAN injury. They concluded that patient age, ostectomy of the bone distal to the third molar, the radiologic relationship between the roots of the third molar and the mandibular canal, and deflection of the mandibular canal increases the risk of IAN damage and were included in predictive logit model. The lingual split technique has been reported to reduce the incidence of IAN damage to approximately 1% to 2%. In cases of close relationship between the third molar and the mandibular canal, a technique consisting of trimming the roots until only a few millimetres remain, instead of extracting them has been proposed. We do not recommend both the techniques. Prevention of IAN damage should be based on a thorough understanding of the anatomy, as well as on accurate planning of surgery, avoiding impingement of the third molar roots or surgical instruments in the mandibular canal. Only on the basis of these principles can the rate of IAN damage be minimized.

C.M.HILL (2001) In this study 201 patients had unilateral removal of the lower third molars under local anaesthesia and a further 234 patients had either bilateral or unilateral removal under general anaesthesia. A total of 634 lower third molars were extracted by four experienced surgeons. All patients were reviewed independently 1-week postoperatively and any sensory disturbance and its location was recorded. Patients with sensory disturbance were subsequently reviewed at 1 month and again at 6 months if recovery was not complete. This study demonstrated little difference in the adverse event rate per tooth extracted between procedures under local and general anaesthesia. However, within the general anaesthetic group, the few unilateral procedures showed evidence of higher risk, but the number was too small for valid satisfactory analysis. The risk of nerve morbidity was also greater where the duration of the procedure was longer than 15 minutes in unilateral cases.

RICARDO D. MORANT (2001) conducted a study to compare Tuned-Aperture Computed Tomography (TACT) image sets made with linear vertical, linear horizontal, conical, and x-shaped x-ray projection arrays with regard to observer accuracy in 1) measuring the distance from the apex of a tooth root to the middle of the inferior alveolar canal, 2) measuring the shortest distance from the surface of a tooth root to the surface of the IAC , and 3) determining whether the root is buccal or lingual to the IAC . The same relationshipwere also examined by means of pairs of images and the buccal object rule. For TACT, images acquired with conical and x-shaped beam projection arrays are preferred to those acquired with linear arrays for assessing the relationship between tooth roots and the IAC . TACT was found to be significantly more accurate than standard application of the buccal object rule for the relationships investigated.

HUI LIANG (2011) compared 5 modalities with respect to accuracy in mandibular cross-sectional imaging. The modalities tested were tuned-aperture computed tomography (TACT), iteratively reconstructed TACT, multidirectional tomography, linear tomography, and transverse tomography. Twenty sites were selected from 3 dry mandibles, and cross-sectional views were imaged through use of each of the 5 modalities. There was significant difference in measurement error for maximum height but not for width. There was also a significant difference in qualitative image evaluation results. Of the 5 modalities tested, the narrow-layer multidirectional tomographic technique produced the greatest diagnostic accuracy and quality in cross-sectional imaging. The transverse panoramic tomographic technique produced the least diagnostic accuracy and quality. Linear tomography, TACT, and iteratively reconstructed TACT were intermediate in accuracy and quality.

NICHOLAS A. DRAGE (2002) Perforation of the lower third molar roots by the inferior alveolar nerve is uncommon and can be difficult to determine by conventional radiographic methods. He presented a case of perforation that was treated by coronectomy, and showed an unusual complication in that the retained root erupted, moving the canal with it. The radiographic assessment of root perforation and the imaging modalities used to assess such cases are discussed. They concluded, with the use of standard radiographic criteria, a peri-apical or panoramic radiograph is adequate in most cases to identify whether the IDC is in close association with the tooth. Cross-sectional imaging by spiral tomography or CT can be used to determine the exact position of the canal. Coronectomy is an acceptable method of managing the perforated root, but occasionally the root fragment retains its eruptive potential.

LEENA YLIKONTIOLA (2002) compared the panoramic radiographs, computerized tomography (CT), and conventional spiral tomographic (scanora) radiographs for their ability to locate the mandibular canal in the buccolingual direction. Furthermore, the relationship between the cortication of the mandibular canal in panoramic radiographs and the location of the canal in both CT and Scanora was assessed. The buccolingual location of the mandibular canal was determined bilaterally in 20 consecutive patients. CT gave better visualization of the mandibular canal than Scanora imaging. Cortication of the canal on the panoramic radiograph did not serve as a predictor of the proximity of the mandibular canal to the cortices of the mandible.

J.PAWELJIK, M.COHNEN (2002) The results showed that the VCT paraxial images gave a significantly clearer perception of the mandibular nerve than conventional panoramic radiographs. The visual grading scores for conventional panoramic images were significantly better on all 7 assessed anatomic sites compared with the reconstructed VCT panoramic images. The position of the apices in relation to the mandibular canal could be assessed in 70% of the cases using the automatic tracking device (toolbar marker), which conceivably influenced the image and diagnostic quality. So conventional panoramic radiographs were shown to be better than the VCT reconstructed panoramic images and were therefore an invaluable tool and posed the potential for identifying the need for further VCT diagnostic procedures.

GARMON W. BELL (2003) DPTs of 300 mandibular third molar teeth were assessed by 9 oral surgeons for root morphology and proximity to the inferior alveolar neurovascular bundle. The sensitivity and specificity for observation of root curvatures were 29% and 94% respectively. The sensitivity and specificity of determining an intimate relationship between the root and the neurovascular bundle were 66% and 74% respectively. This study has demonstrated that there is a significant difference between the preoperative radiologic assessment with a DPT of the anatomy of third molars and their relationship with the neurovascular bundle and the findings at surgery.

BART F. BLAESSER (2003) The predictor variable was the presence or absence of 1 or more preoperative panoramic radiographic findings:

1) Diversion or bending of the canal. 2) Darkening of the tooth root. 3) Interruption of the cortical white line of the canal. These 3 radiographic signs were selected because they have been shown to be associated with IAN injury. Patient with 1 or more high risk radiographic findings has a significantly increased risk for nerve injury. Conversely, in the absence of any positive findings, the risk for nerve injury is negligible. In the absence of high-risk radiographic signs, there is little preventive value in obtaining additional imaging. However, when 1 or more high risk radiographic signs are present, an additional imaging, such as CT imaging in the axial, coronal and sagittal planes, may be indicated to better establish the anatomic relationship between the IAN canal and third molars.

HIDENOBU MAEGAWA (2003) sought to evaluate the relationship between the mandibular third molar and mandibular canal by using axial computed tomography with coronal and sagittal reconstruction for third molar surgery. 47 impacted third molars in 41 patients were found in close association with the mandibular canal during a panoramic radiographic assessment. The relationship was evaluated by using CT and compared in terms of operative exposure of IAN and postoperative labial dysesthesia. 24 (51%) mandibular canals were buccal relative to the third molar, 12 were lingual, 9 were inferior, and 2 were between the roots. Postoperative lower lip dysesthesia occurred in 1 patient whose mandibular canal was in the lingual position. Axial CT with coronal and sagittal reconstruction provides useful information to surgeons regarding the relationship between the third molar and mandibular canal and proposed further CT study when a panoramic radiograph reveals the following conditions: 1) a root apex is at the lower half or under the inferior wall of the mandibular canal or 2) either the white line or black line is not seen clearly. They concluded that the mandibular canal is often positioned buccal to the root. Disappearance of cortication around the mandibular canal on coronal CT was seen most often when the canal is in lingual position relative to the root or between the roots. Thus CT should be performed when cortication of the cranial or caudal border of the mandibular canal and periodontal membrane space of the lower third molar are not seen on panoramic radiographs.

T.RENTON (2005) conducted a randomised study who required operations on mandibular third molars and who had radiological evidence of proximity of the third molar to the canal of the IAN to one of 2 operations: extraction and coronectomy. They concluded that , in patients judged to be at risk of iatrogenic injury to the IAN , coronectomy reduces the chance of injury with no adverse effect on morbidity and without increasing the risk of dry socket or infection.. There is also evidence that specific radiographic features may indicate proximity of the nerve, including deviation of the canal in association with crossing the canal and one that has not previously been described, the juxtra- apical radiolucency.

G.W.BELL (2004) conducted a study to compare preoperative radiological observations from dental panoramic tomographs (DPT) , with surgical findings at removal of third molars with respect to the IAN. A total of 300 teeth were removed and the neurovascular bundle was directly observed the root was grooved, or root apices were deflected by the bundle in 35 (12%) cases. Postoperatively no patient had altered labial sensation. There was an intimate relation between the mandibular third molar in 12(51%) cases when darkening of the root was observed, and in only 11 cases when interruption of the radiopaque outline of the IAN bundle was observed.

HADAR BETTER (2004) conducted a study to assess the indications for patient referral for computed tomography (CT) scan before third molar extraction. Within the limits of the present study, it can be concluded that the main reason for CT scan referral is the proximity of the third molar root to the inferior alveolar canal (<1 mm) . The data obtained from the CT scan had minimal effect on final surgical outcome. The routine use of CT scan in cases of third molar extractions cannot be recommended.

ANDREW BAN GUAN TAY (2004) conducted a prospective study to determine the incidence of inferior alveolar nerve parasthesia in patients with an exposed IAN bundle seen intraoperatively. 166 patients with 187 operation sites were included in this study. 38 operation sites (20.3%) showed parasthesia at 1 week after surgery. By 3 months from surgery, 57.9% of nerves had recovered to normal sensation, 65.8% of nerves recovered by 6 months, and 71.1% of nerves recovered by 1 year. They concluded that sighting an exposed intact IAN bundle during third molar surgery indicates its intimate relationship with the third molar and carries a 20% risk of parasthesia, with a 70% chance of recovery by 1 year from surgery. Sensory alteration that fails to resolve after 1 year is more likely to persist , although gradual recovery is still possible.

ELENA QUERAL- GODOY (2005) The recovery rate is high in the first 3 months, but subsequently decreases, in coincidence with the observation that the probability of recovery beyond 6 months is very low. In our study almost half of the patients with lesions persisting for more than 6 months effectively recovered, though in some cases recovery took more than a year. The rate of recovery increases after 6 months and again after 9 months, exhibiting a bimodal pattern.this could be explained by the fact that IAN injuries differ in type. Lesions that recover within the first 3 months are probably Neuropraxias or Sunderland first or second degree injuries which are more common and long-standing injuries could represent more severe Axonotmesis or Sunderland third or even fourth degree injuries. Recovery from IAN injuries after more than 1 year has been reported in the literature. It is difficult to achieve early identification of injuries with poor prognosis, especially if damage to the nerve has not been seen during surgery. Nevertheless, it seems that compression should not cause anaesthesia for more than 4 months, and sectioning should not cause fine touch anaesthesia for more than 8 months.anesthesia without improvement after 1 month is also very likely to leave some permanent residual impairment. Older patients are at an increased risk of incomplete recovery of chin and lip sensibility after third molar extraction.

MICHAEL MILORO (2005) 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. 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 (-0.97mm) , vertical (-0.61mm) , distoangular (-0.31mm) , and horizontal (-0.24mm) . They concluded that Unerupted mandibular third molar teeth are closer to the inferior alveolar canal than are erupted teeth and Mesioangular mandibular third molar impactions are most closely positioned to the inferior alveolar canal, and this may represent an independent risk factor for postoperative parasthesia.

MICHAEL SEDAGHATFAR (2005) Five radiographic signs have been suggested as indicative of close relationship between M3 and IAN canal. 1. Darkening of the root. 2. Deflected roots. 3. Narrowing of the root. 4. Interruption of the white line. 5. Diversion of the IAN canal. During this study only 4 radiographic signs were found to be statistically related to the IAN exposure except deflected roots. The results of this study confirm the clinical impression that as the number of radiographic signs increases, so does the likelihood that a nerve exposure will occur during extraction. In the setting of negative radiographic findings, the risk of IAN exposure and associated IAN injury are very low.

RICHARD H. HAUG (2005) conducted a study to assess the frequency of complications of third molar surgery, both intraoperatively and postoperatively, specifically for patients 25 years of age or older. This prospective study evaluated 3760 patients. The predictor variables were categorized as demographic (age, gender), American Society of Anesthesiologist's classification, chronic conditions and medical risk factors, and preoperative description of third molars (present or absent, type of impaction, abnormalities or association with pathology). Outcome variables were intraoperative and postoperative complications, as well as quality of life issues (days of work missed or normal activity curtailed). Alveolar osteitis was the most frequently encountered postoperative problem (0.2% to 12.7%). Postoperative inferior alveolar anaesthesia/ parasthesia occurred with a frequency of 1.1% to 1.7%, while lingual nerve anaesthesia/ parasthesia was calculated as 0.3%. All other complications occurred with a frequency of less than 1%. They concluded that third molar surgery in patients 25 years of age or older is associated with minimal morbidity, a low incidence of postoperative complications, and minimal impact on the patients quality of life.

DONALD J. HULL (2006) conducted a study to test the hypothesis that removal of lower third molars below the occlusal plane and in close proximity to the IAC delays recovery after surgery as compared with lower third molars below the occlusal plane yet not close to the IAC. If radiographic signs for a patient at presurgery evaluation indicated close proximity of a lower third molar to the IAC, odds were significantly increased for delayed HRQOL recovery for worst pain, lifestyle, and oral function.

A.OHMAN (2006) studied radiographic findings of examinations with CT of impacted lower third molars with an intimate relation to the mandibular canal and to investigate how findings of a dark band across the roots of the lower third molar on panoramic views correspond to the CT findings. CT images of 90 lower third molars in which plain radiography was insufficient to allow determination of the precise anatomical relations were reviewed retrospectively. Panoramic views of 88 teeth existed; these images were interpreted independent of the CT examinations with respect to presence of a dark band across the roots. In 31% of the CT images, the course of the mandibular canal was buccal, in 33% lingual, in 26% inferior, and in 10% inter-radicular. The tooth was in contact with the mandibular canal in 94% and with the lingual cortex in 86%. In 23%, grooving of the root by the canal was judged to be present. In 63% of the cases where a dark band across the roots was observed on panoramic radiographs, CT revealed grooving of the root. Pre-operative CT of lower third molars is motivated in selected cases where plain radiography is inconclusive. The finding of a dark band across the roots on panoramic radiographs is an indicator of grooving of the tooth by the canal and justifies a pre-operative CT examination. The absence of dark bands on panoramic views does not exclude grooving of the roots.

DANIELA GUIMARAES DE MELO ALBERT (2007), made a comparative analysis of the relationship between impacted lower third molars and the mandibular canal by means of orthopantomography and conventional mandibular topography. Consideration was given to the association between the existence or absence of a close relationship according to gender, age, and tooth involved, as well as the resolution of the mandibular canal tomography of the mesial and distal roots. A close relationship with the mandibular canal was found on the tomography in 77.4% of cases. The reported data showed that the most common relationship criterion was darkening of the roots (14 cases, 45.2%). A true relationship was confirmed on the tomography in 92.1% of these cases. They concluded that the most common type of radiologic sign was darkening of the roots, followed by the island-shaped apex.

MARCI. H.LEVINE (2007) conducted a study to document a clinically relevant position of the inferior alveolar nerve (IAN) in dentate patients and identify patient factors associated with IAN position. The investigators used a cross-sectional study design and a study sample of subjects who had a radiographically identifiable IAN canal and at least 1 mandibular first molar was enrolled. Predictor variables were age, gender and race. Outcome variables were the linear distances between the buccal aspect of the IAN canal and the outer buccal cortical margin of the mandible, and the superior aspect of the IAN canal and the alveolar crest. The study sample was composed of 50 patients with a mean age of 42 years, 42.0% were male, and 73.2% were white. The results of this study found that, on average, the canal was 4.9 mm from the buccal cortical margin and 17.4 mm from the alveolar crest. In this study the results suggested that older patients and white patients tended to have less distance between the buccal aspect of the nerve canal and the mandibular buccal border. When using monocortical plates, data regarding the buccal and vertical position of the IAN canal should be considered in an effort to minimize injury to the IAN.

YOICHI NAKAGAWA (2007), conducted a study to determine whether panoramic radiographs could predict physical contact between the third molar and the mandibular canal on limited Cone-beam CT. 73 lower third molars in 65 patients were examined. Findings of absence or presence of the white line of the mandibular canal wall on panoramic radiographs and contact or separation between the tooth and the mandibular on dental 3D-CT were compared. The presence or absence of the superior white line of the canal on panoramic radiography may be related to the extent of cortication of the superior wall of the mandibular canal. Absence of a superior white line on panoramic radiography was associated with an increased risk of contact between the third molar and the mandibular canal on dental 3D-CT, even when the effects of tooth position, age, and gender were taken into account. Women were more likely to have contact between the structures on dental 3D-CT when their panoramic radiographs showed absence of the white line. Panoramic radiography is useful for predicting to a limited extent physical contact between the mandibular third molar and mandibular canal on dental 3D-CT.

SRINIVAS.M.SUSARLA (2007) conducted a study to examine the role of preoperative computed tomography (CT) imaging of the inferior alveolar nerve(IAN) for patients at increased risk for nerve injury during mandibular third molar extraction. The predictor variable was the preoperative assessment of risk for IAN injury based on panoramic imaging. The outcome variable was the preoperative assessment of IAN injury risk after reviewing the CT studies. The sample consisted of 23 patients who had bilaterally impacted wisdom teeth. After reviewing the panoramic radiographs, 80.4% of M3s were classified as having an increased risk for IAN injury. Upon examining the CT imaging, 32.6% were classified as high risk for IAN injury. After reviewing all imaging studies, 71.7% of the teeth in the sample were extracted. Intraoperative IAN visualization occurred in 21.2% of the cases. At 1 week postoperative, 3 patients had dysesthesia (9.1%); none had permanent injury. The senior author derives 2 important pieces of information from the CT scan. First, he can assess the anatomic relationship between proximity of the IAN canal and the M3 roots. Second, he can ascertain the location of the

IAN canal relative to the roots, eg, the canal is buccal to the M3 apices. He finds this information very useful for planning the operation and determining where it is “safe” to remove bone. They concluded that the additional information provided by CT imaging studies has, in this select sample, showed effectiveness in changing the majority of patients from elevated risk to low risk. There is, however, a valuable role for CT imaging in the appropriate clinical setting. It does provide important information in the management of the M3, ie, observation versus removal, and informs the operative approach.

MIET LOUBELE (2007) compared the jaw bone width dimensions and quality assessments of bone characteristics with Cone-Beam CT, Spiral Tomography, and multi-slice Spiral Tomography. This study included 25 dry human mandibles for the dimensional study and 1 formalized maxilla for image quality assessment and results indicate that on dry mandibles, jaw bone width measurements by means of CBCT and Spiral Tomography are reliable, even if on average they slightly underestimate the bone width. For the subjective image quality, the CBCT offered better visualization of details of the small bony structures. Spiral Tomography offered better visualization of the cortical bone and the gingiva.

ANA CLAUDIA AMORIM GOMES (2008) After an analysis of the predictability of panoramic radiography in this study and in others in the literature, it was concluded that only with computed tomography is it possible to discover the true relationship of the tooth root with the mandibular canal .

However in view of the socioeconomic conditions, the high cost of CT scans and the amount of radiation, the use of panoramic radiography is justified in planning surgery of impacted teeth, despite the fact that its predictability is low with regard to the emergence of nerve lesions during the procedure. It may be concluded from the present study that panoramic radiography does not provide the reliable images required for predicting nerve lesions.

KENJI NAKAMORI, KUMIKO FUJIWARA (2008), conducted a retrospective cohort study to predict the relationship between lower third molars and the Inferior Alveolar Canal (IAC) from panoramic radiographs, and establish criteria for using Computed Tomography. Predictor variables were the distance between the third molar and the IAC, and findings according to the ROOD'S criteria. Outcome variables were the absence of cortication between the third molar and the IAC on the CT image, and injury of the IAN. They concluded that if an attached relationship is recognised on the panoramic image, the presence of "narrowing of the canal" is considered to be a predictor for a contact relationship and is an indication for CT examination. In cases with a superimposed relationship between the tooth and IAC, another finding is needed to predict a contact relationship.

BERNARD FRIEDLAND (2008) conducted a study to identify the use of 3-Dimensional reconstructions to evaluate the anatomic relationship of the mandibular canal and impacted mandibular third molars. In 3-D reconstructions, the clinician can specify the densities to all structures.

Depending on the parameters specified, the bone and teeth can be included in a single mask (colour). Alternatively, the bone can be done in 1 mask and the teeth in another mask. The program reaches its full potential, however, with the ability to rotate the image, allowing the clinician to view any structure from any perspective and to hide or separate the masks in any combinations. This feature adds a dimension that provides information well beyond that provided by the radiographic part of the CT only. It not only aids the clinician, but also makes informed consent far more meaningful, because the patient is able to see the problem and does not need to try to visualize it. In conclusion, advanced 3D reconstructions to evaluate impacted M3s provide information beyond that provided by radiographic images. Clinicians should consider the use of CT in selected cases, chiefly when 1 or more of the telltale signs are present on the panoramic image.

KEISUKE NAKAYAMA (2009) conducted a study to assess the capacity of dental 3-dimensional computed tomography (3D-CT; limited cone-beam CT) to predict the exposure and injury of the inferior alveolar nerve (IAN) after mandibular third molar extractions. Subjects eligible for study enrolment were those who underwent preoperative dental 3D-CT because the mandibular third molars were determined to be extremely close to the IAN on panoramic radiogram. The predictive variable was the anatomic relation of the IAN and third molar apices and was a binary variable, contact or noncontact. The primary outcome variable was IAN exposure, and secondary outcome variable was IAN injury. The mandibular third molars were judged to make contact with the mandibular canal on dental 3D-CT images in 35 cases (66%). Intraoperative IAN exposure was observed in 17 (49%) contact cases and 2 (11%) noncontact cases on dental 3D-CT images. IAN injury occurred in 8 cases (15%). All 8 cases with IAN injury were included in contact areas. When viewing anatomic relation between the IAN and mandibular third molar root apices using dental 3D-CT, contact of the 2 anatomic structures results in an increased risk for IAN exposure or injury.

H. GHAEMINIA (2009) This study investigated the diagnostic accuracy of cone beam computed tomography (CBCT) compared to panoramic radiography in determining the anatomical position of the impacted third molar in relation with the mandibular canal. The study sample consisted 53 third molars from 40 patients with an increased risk of IAN injury. The IAN was exposed in 23 cases during third molar removal and injury occurred in 5 patients. No significant difference in sensitivity and specificity was found between both modalities in predicting IAN exposure. To date lingual position of the mandibular canal was significantly associated with IAN injury. CBCT was not more accurate at predicting IAN exposure during third molar removal, however, did elucidate the 3D relationship of the third molar root to the mandibular canal; the coronal sections allowed a bucco-lingual appreciation of the mandibular canal to identify cases in which a lingually placed IAN is at risk during surgery.

AAKARSH JHAMB (2009) conducted a study to assess the relationship of inferior alveolar neurovascular canal (IANC) and the impacted mandibular third molar on spiral computed tomography (SCT), to determine the validity of this assessment and compare it with that for an orthopantomogram (OPG). Patients were operated on and actual clinical findings were compared with the SCT findings. Objective evaluation of the SCT showed that the number of positive clinical findings (marking on tooth surface, visualization of the neurovascular bundle, intraoperative excessive hemorrhage, and IAN parasthesia) were significantly more in patients with no measurable distance between the tooth and the canal. Also, the positive clinical findings were observed significantly more in patients who had the following features observed on spiral CT: lack of cortication of the canal and lingual or interradicular course of the inferior alveolar neurovascular bundle. They concluded that the SCT images definitely enhanced the visualization of the relation of the tooth to the IANB, which might provide a higher level of intrasurgical safety and safeguard the interests of both the surgeon and the patient.

MUNETAKA NAITOH (2009) The course of the mandibular canal was observed and the length of the bifid canal was measured. In 65% of patients they have observed bifid mandibular canal in the ramus region. Bifid mandibular can be classified into 4 types: Retromolar, Dental, Forward, and Buccolingual.

SRINIVAS M. SUSARLA (2010) conducted a study to evaluate the association between computed tomographic (CT) assessment of inferior alveolar nerve (IAN) canal cortical integrity and intraoperative IAN exposure. This was a retrospective cohort study. The study sample included patients considered at high risk for IAN injury based on panoramic findings. The primary predictor variable was IAN canal integrity (intact or interrupted) assessed on coronal CT images. The secondary predictor variable was length of the cortical defect, in millimetres. The primary outcome variable was intraoperative visualization of the IAN. Other variables were demographic and operative procedures. The mean cortical defect length was 2.9± 2.6 mm . Loss of cortical integrity had a high sensitivity but low specificity as a diagnostic test for IAN visualization. A cortical defect size ≥ 3mm was associated with an increased risk for intraoperative IAN visualization with a high sensitivity and specificity for predicting intraoperative IAN exposure during third molar removal.

NIEK L. GERLACH (2010) Five dentate and edentate patients were selected at random from the CBCT database. Two independent observers traced both the left and the right mandibular canal using 3-dimensional image-based planning software. All mandibular canals were traced using 3 different methods. Method 1 was based on coronal views, also known as cross sections. Panorama-like reconstructions were the starting point for method 2. The method 3 combined 1 and 2. Method 1 depicts the mandibular canal exclusively in a buccolingual direction, method 2 depicts only in an anterior-posterior direction. The difference between 2 tracings was the lowest for the combined method; within a range of 1.3 mm in 95% of the course of the canal. The most obvious deviations were mainly seen in the anterior part of the canal. The best reproducible method for mandibular canal tracing is the combined method 3. Between observers, still a mean 95th percentile deviation threshold of 1.3 mm is noted, indicating that a safety zone of 1.7 mm should be respected. When planning surgery on CBCT-based data, surgeons should be aware of the obvious deviations located in the region of the anterior loop of the canal.

GARY ORENTLICHER (2010) With recent introduction of in-office cone-beam volumetric tomography scanners and 3-dimensional software programs, the precision, accuracy, and 3-dimensional visualization capabilities of these technologies open avenues for the oral and maxillofacial surgeon in the diagnosis, planning, and surgical management of many non implant-related cases. For the removal of impacted third molars, anatomic variations in the positioning of the mandibular nerve canal, especially in the buccal-lingual dimension, are difficult to assess using conventional 2-dimensional radiographic techniques. The use of these technologies to preoperatively evaluate impacted third molars provide the surgeon with the 3D information necessary to better determine the locations, angulations, and positions of these teeth as they relate to vital structures and adjacent teeth in the areas.

MOMEN A. ATIEH (2010) the aim of this review was to determine the diagnostic accuracy of panoramic radiographic markers in the detection of the relationship between the mandibular canal and third molar roots. A literature search of electronic databases, Cochrane oral health group's trials register, national research register, conference proceedings, and abstracts was performed to identify studies that had investigated the diagnostic accuracy of the 3 panoramic radiographic markers (ie, darkening of the root, interruption of the radiographic borders, and diversion of the mandibular canal). A total of 5 studies were included, involving 894 observations. The overall pooled sensitivity and specificity for darkening of the root was 51.2% and 89% respectively. The overall pooled sensitivity and specificity for interruption of the radiopaque borders was 53.5% and 80% respectively and for diversion of canal was 29.4% and 94.7% respectively. Despite its limitations, panoramic radiography has always been recommended as the radiographic investigation of choice in the practice of third molar surgery. It has been suggested that the radiographic finding of 2 or more markers might improve the sensitivity in predicting a true intimate relationship and hence an indication for applying other imaging techniques such as computed tomography to confirm the diagnosis and provide the surgeon with additional detailed information about the anatomy of the mandibular canal and third molar roots.

JOZSEF SZALMA (2011) conducted a study to examine the association between the darkening of the root on the preoperative panoramic radiograph and intraoperative inferior alveolar nerve (IAN) exposure. In this study, 116 mandibular third molar surgical extraction cases with darkening of the third molar roots on the preoperative panoramic radiographs were selected for a case group, and 193 patients with one or more of the following " high risk" signs, indicating a close relationship between the root and dental canal, were selected for the control group : interruption of the white line, diversion of the canal, and/or narrowing of the canal. In conclusion, they suggested that cases of root darkening and one or more adjacent "high-risk" panoramic signs simultaneously present on the panoramic radiographs have the greatest risk of IAN exposure.

ABDULKADIR BURAK CANKAYA (2011) This article describes two mandibular angle fractures that occurred in two patients during the surgical extraction of one erupted and one unerupted third molar, including a brief review of the literature. Common complications of mandibular third molar surgery include alveolar osteitis (dry socket), secondary infection, nerve dysfunction, and hemorrhage. The incidence of these complications varies from 0.2% to 6%. The most severe complication of third molar surgery is mandibular fracture. Iatrogenic mandibular fracture associated with the removal of teeth, which can occur during the procedure or at a later time, is rare; reported incidences range from 0.0034% to 0.0075%. Iatrogenic fractures may occur during an operation or within 4 weeks after the procedure (classified as pathological fractures), and most are associated with third molar removal. The mandible is fractured 2-3 times more frequently than other facial bones because it has less bony support. The body of the mandible is naturally strengthened by a system of buttresses extending onto the rami. On the lateral surface, the strong external oblique ridge extends from the body obliquely upward to the anterior border of the ramus. Although the medial surface is thinner than the lateral surface, both are composed of dense, thick, compact cortical bone. The mylohyoid line extends diagonally downward from the area of the third molar and forward toward the genial tubercles at the midline. Because stress is localized primarily on the external oblique ridge, it is important to protect this region during surgery. We believe that the fracture occurred primarily due to the position of the third molar, which occupied a large osseous space and thereby weakened the mandibular angle by decreasing the cross-sectional area of bone and causing the loss of supporting bone, especially in the external oblique ridge.

MATERIALS AND METHODS

This study is an upgrade of the study conducted in our department in which a total no of 5 anatomic sites were preoperatively assessed on 9 patients using conventional panoramic radiographs and these were compared with computed tomographic images.

This study composed of 9 patients of both genders aged 22-32 years. All patients were preoperatively assessed through conventional panoramic radiographs using PEDERSON'S Difficulty Index & ROOD'S Criteria and these were compared with 3-Dimensional Object, reconstructed from CT data.

DIAGNOSTIC RECORDS FOR EACH PATIENT:

1. Preoperative conventional panoramic radiograph (Orthopantomograph) .
2. 3D-object reconstruction of the CT data.

A) ASSESSMENT OF MANDIBULAR THIRD MOLAR USING PANORAMIC RADIOGRAPH :

1. **PEDERSON'S** difficulty index used for assessing the mandibular third molar removal difficulty.

Classification	Difficulty Index Value
Spatial relationship/Angulation	
Mesioangular	1
Horizontal	2
Vertical	3
Distoangular	4
Depth	
Position- A	1
Position- B	2
Position- C	3
Ramus relationship	
Class- 1	1
Class- 2	2
Class- 3	3
Difficulty Index	
Very difficult	7-10
Moderately difficult	5-6
Minimally difficult	3-4

2. **ROOD'S** criteria used for assessing the relationship between mandibular third molar and the Inferior Alveolar Nerve.

ROOD'S criteria consists of 4 tooth related findings and 3 canal related findings.

- Tooth-related findings are

1. Darkness of the root
2. Narrowing of the root
3. Deflection of the root
4. Dark and bifid apex

- Canal-related findings are

1. Interruption of the white line
2. Narrowing of the canal
3. Diversion of the canal

B) ASSESSMENT OF MANDIBULAR THIRD MOLAR AND INFERIOR ALVEOLAR NERVE USING 3D-OBJECT RECONSTRUCTION :

1. 3-Dimensional Object visualization with Rotation

2. Transparency and separate view of different structures

3. Simulation and reconstruction of Inferior Alveolar Nerve

4. Simulation of Movement of Tooth on the path of elevation

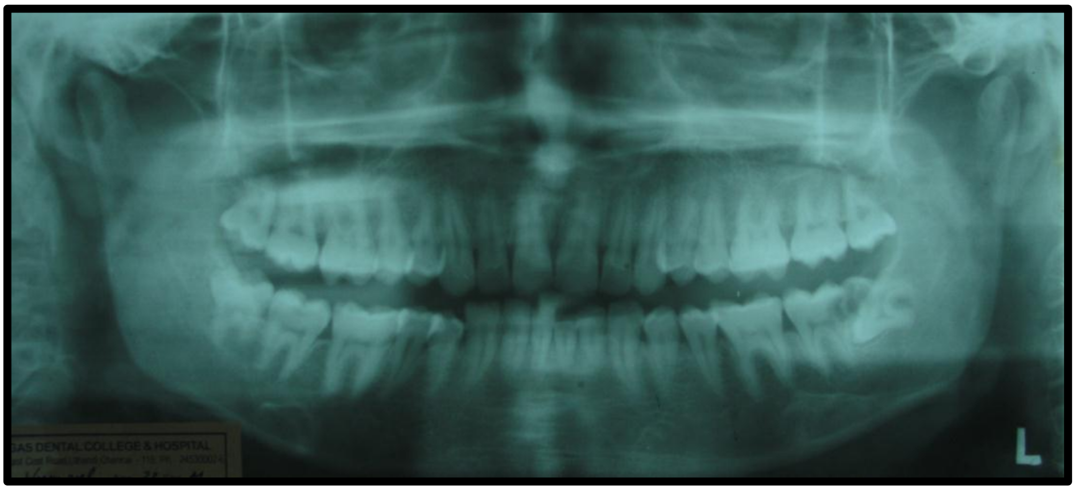
5. Virtual Tooth sectioning

6. Measuring the Distance from third molar tooth apex to the Inferior Alveolar Nerve.

7. Presence of cortication by accessing the bone density of the region

8. Bucco-lingual relationship of the root apex to the nerve canal

PATIENT - 1



48 : DISTOANGULAR - 4

CLASS- 2 - 2

POSITION- A - 1

DIFFICULTY INDEX - 7 - VERY DIFFICULT

ROOD'S CRITERIA - INTERRUPTION OF THE WHITE LINE

38 : HORIZONTAL - 2

CLASS- 2 - 2

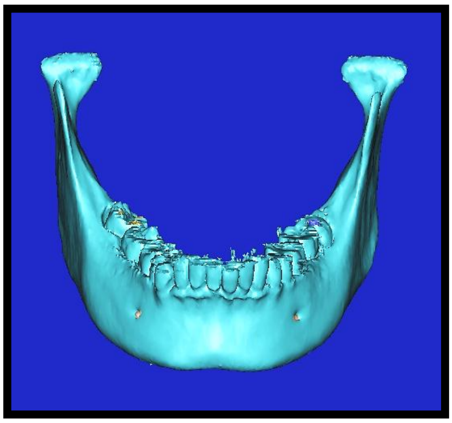
POSITION- A - 1

DIFFICULTY INDEX - 5 - MODERATELY DIFFICULT

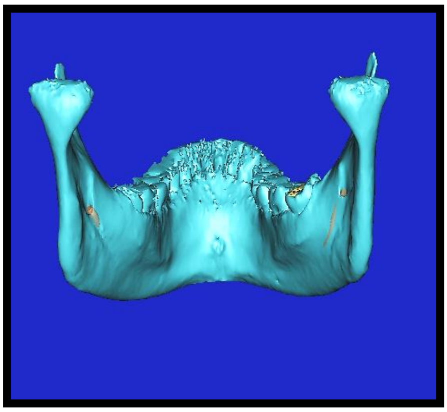
ROOD'S CRITERIA - DARKNESS OF THE ROOT

3-Dimensional Object Reconstruction for Patient-1

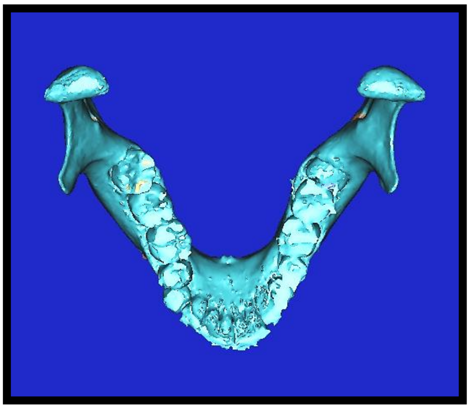
ROTATION OF THE 3-D OBJECT IN X, Y AND Z - AXIS



FRONT VIEW

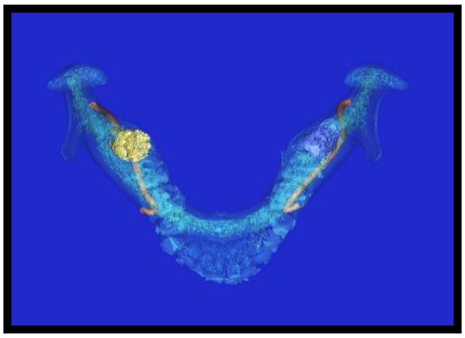


BACK VIEW

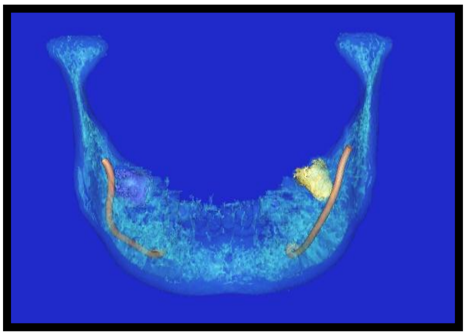


SUPERIOR VIEW

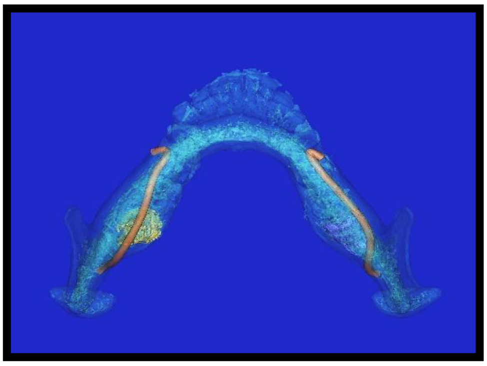
TRANSPARENCY



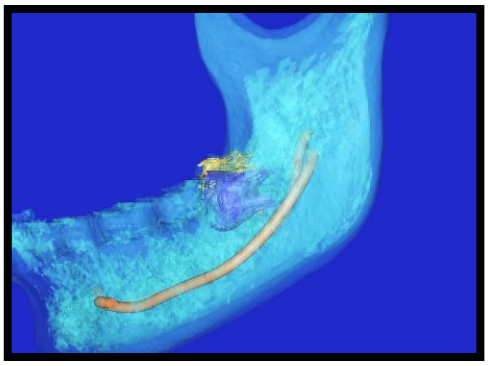
SUPERIOR VIEW



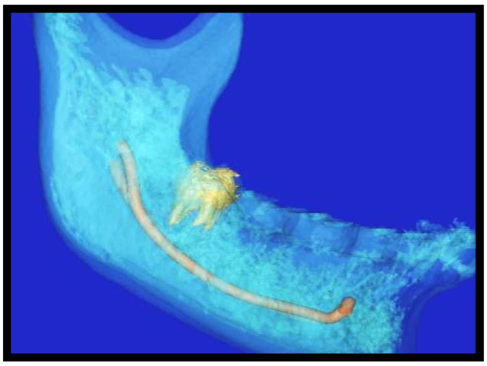
FRONT VIEW



BACK VIEW



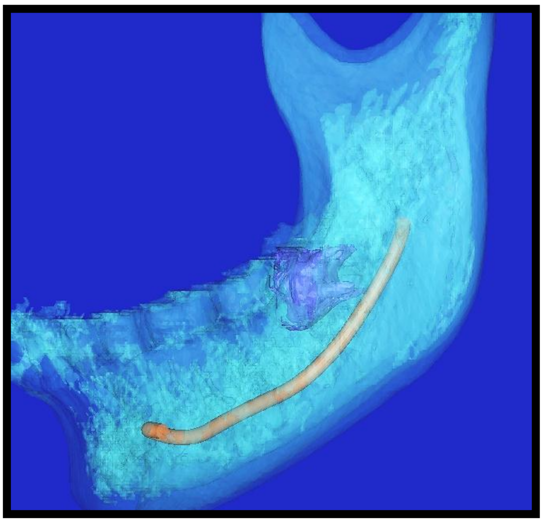
LEFT VIEW



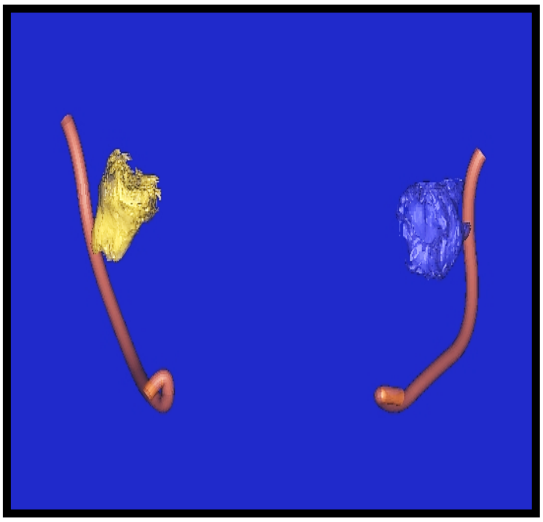
RIGHT VIEW

Transparency of all the structures can be seen.

SIMULATION OF INFERIOR ALVEOLAR NERVE

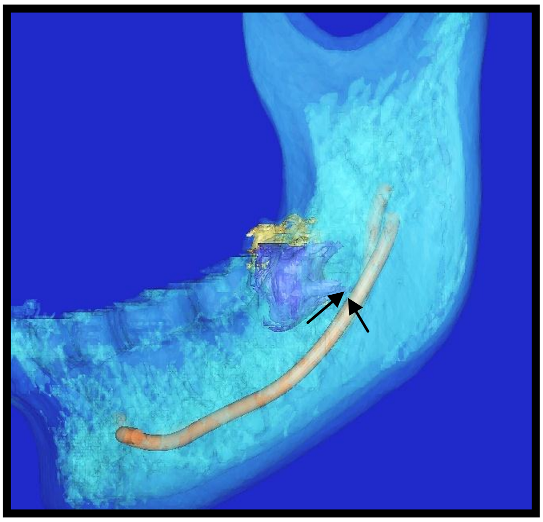


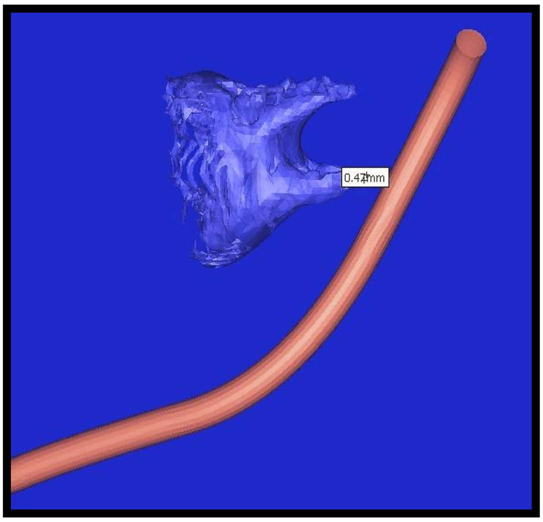
INFERIOR ALVEOLAR NERVE SIMULATED WITH MANDIBLE



INFERIOR ALVEOLAR NERVE SIMULATED WITH HIDDEN MANDIBLE

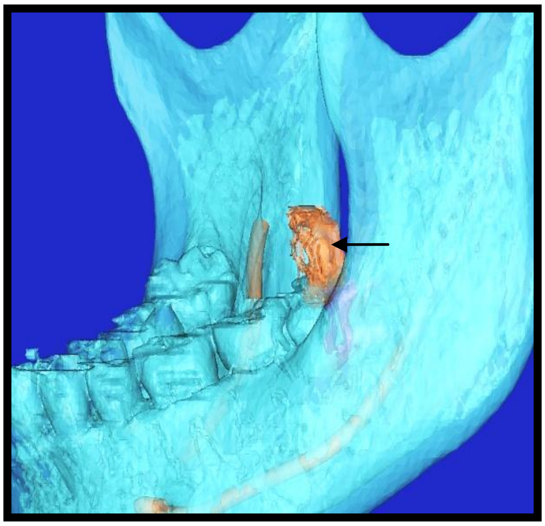
MEASUREMENT OF DISTANCE FROM NERVE TO TOOTH ROOT





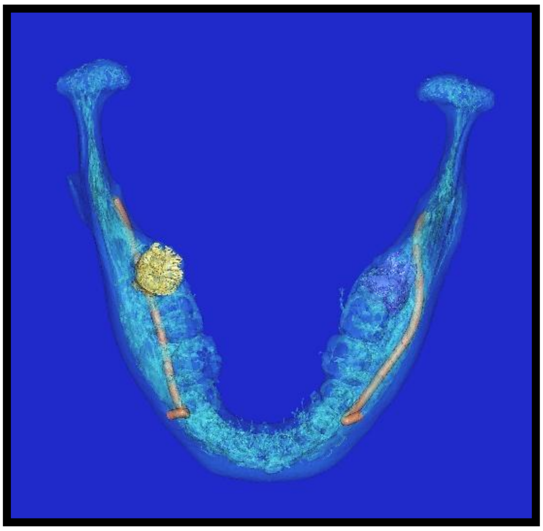
The distance between the Inferior Alveolar Nerve and Third Molar is 0.42mm.

SECTIONING OF THE TOOTH



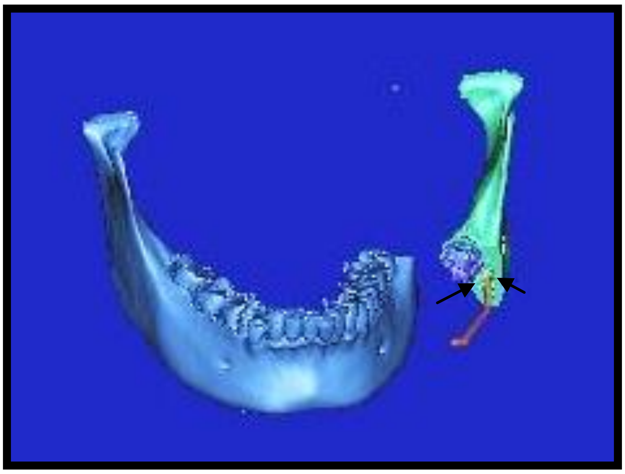
The crown portion of the tooth is sectioned and elevated virtually.

BUCCO-LINGUAL RELATIONSHIP



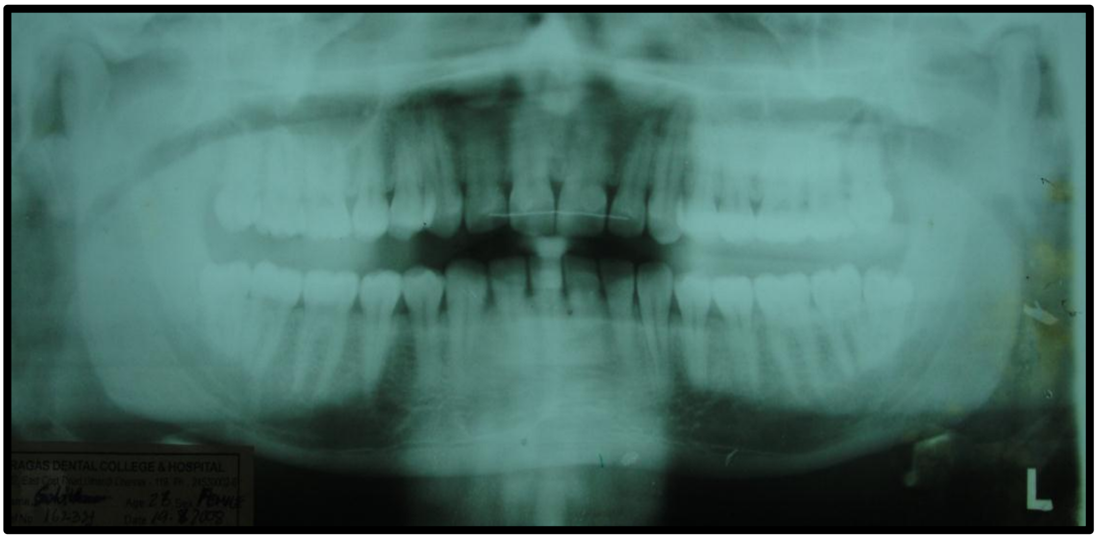
The bucco-lingual relationship of 48 to nerve is inferior to the apices of the tooth and relationship of nerve to 38 is buccal to it.

CORTICATION



Cortication around the nerve can be clearly seen.

PATIENT - 2



48 : DISTOANGULAR - 4

CLASS- 2 - 2

POSITION- A - 1

DIFFICULTY INDEX - 7 - VERY DIFFICULT

ROOD'S CRITERIA - DARKNESS OF THE ROOT

38 : DISTOANGULAR - 4

CLASS- 2 - 2

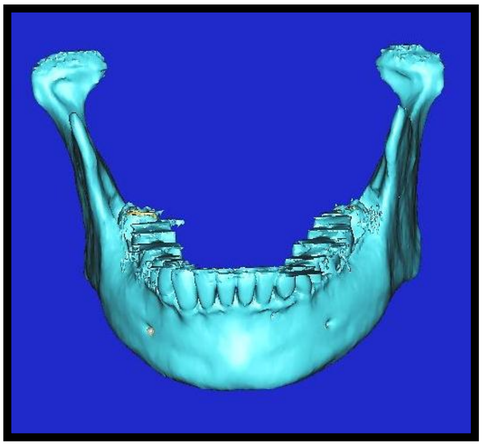
POSITION- B - 2

DIFFICULTY INDEX - 8 - VERY DIFFICULT

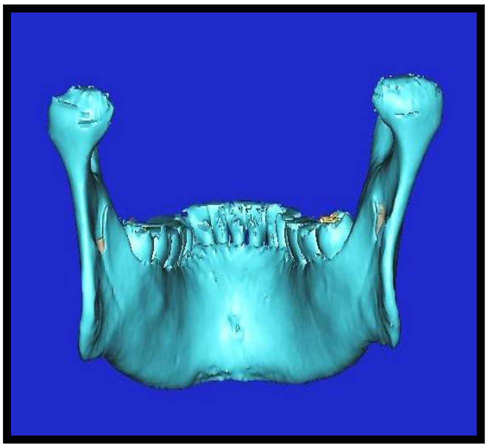
ROOD'S CRITERIA - NIL

3-Dimensional Object Reconstruction for Patient-2

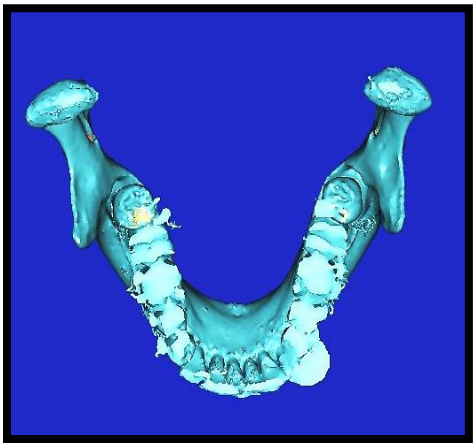
ROTATION OF THE 3-D OBJECT IN X, Y AND Z - AXIS



FRONT VIEW

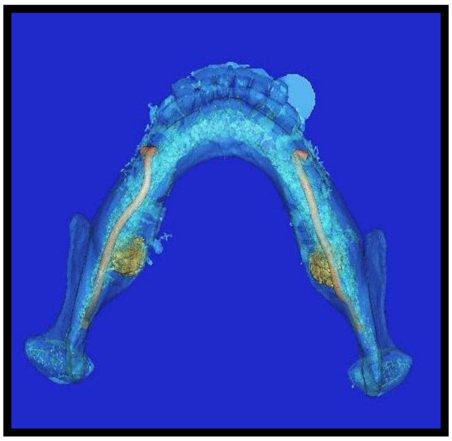


BACK VIEW

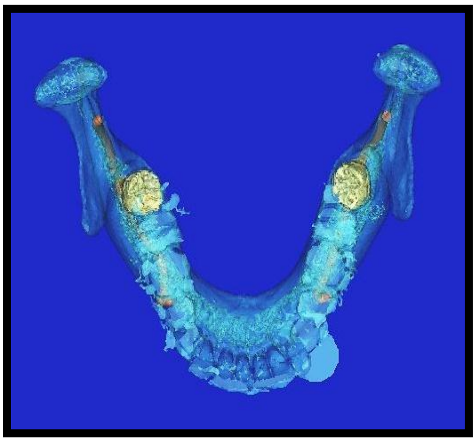


SUPERIOR VIEW

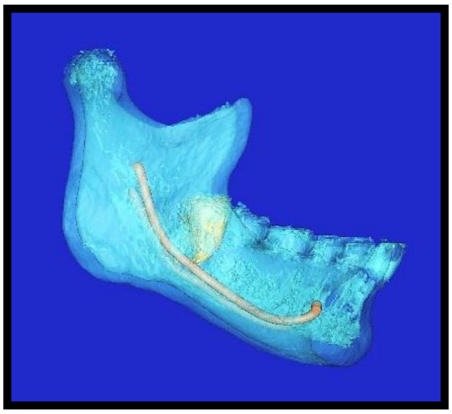
TRANSPARENT



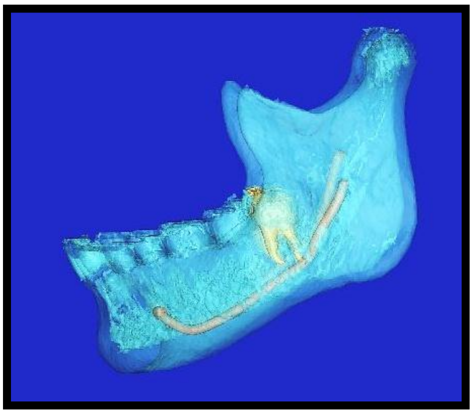
BACK VIEW



SUPERIOR VIEW



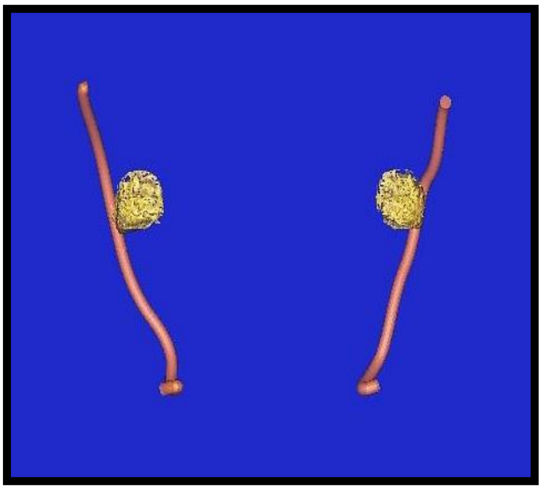
RIGHT VIEW



LEFT VIEW

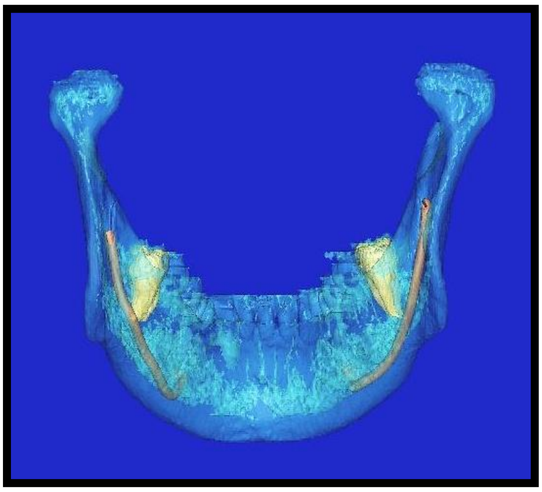
Transparency of all the structures can be seen.

SIMULATION OF INFERIOR ALVEOLAR NERVE



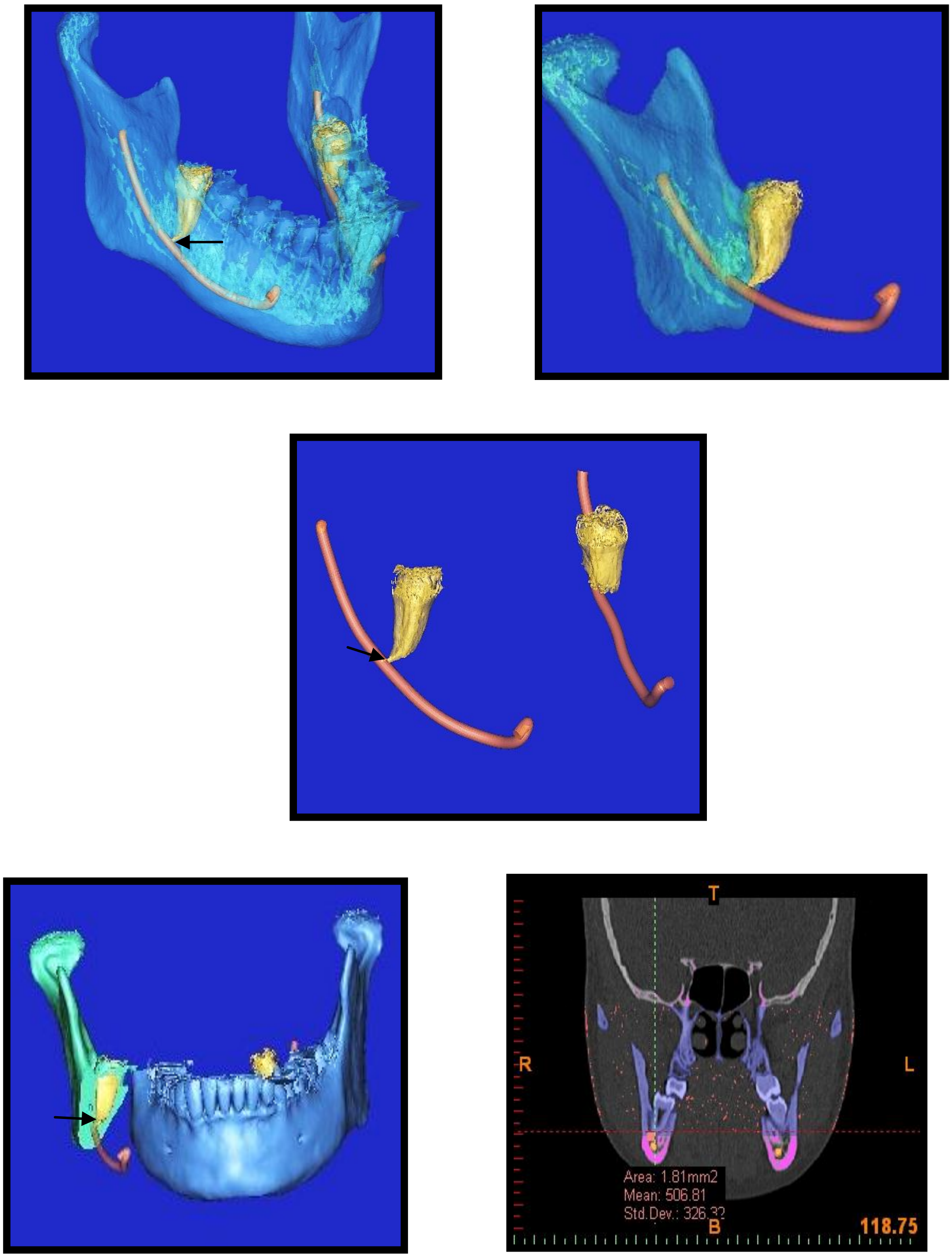
INFERIOR ALVEOLAR NERVE SIMULATED WITH HIDDEN MANDIBLE

BUCCO-LINGUAL RELATIONSHIP



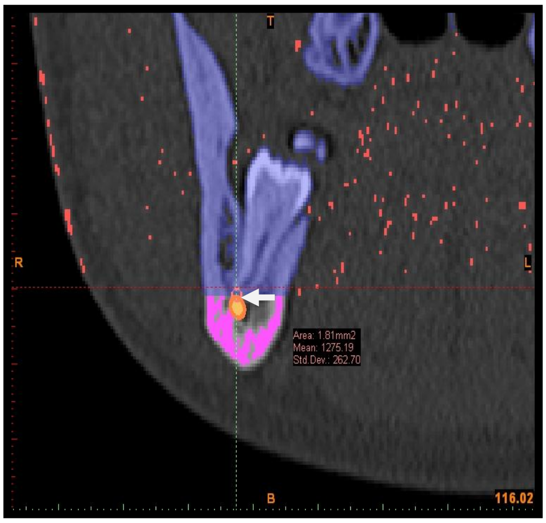
The bucco-lingual relationship of 48 and 38 to the nerve is buccal.

CORTICATION



Cortication absent around the nerve.

BONE DENSITY



The bone density for the cortication around the nerve is 1.81 mm^2.

RESULTS

In this study, 18 mandibular third molars and Inferior Alveolar Nerves from 9 patients' conventional panoramic radiographs and 3-Dimensional Object Reconstructed from CT data were compared to clearly visualize the relation between the third molar and Inferior Alveolar Nerve.

In conventional panoramic radiographs the Inferior Alveolar Nerve and Mandibular Third Molars were assessed by using PEDERSON'S DIFFICULTY INDEX and ROOD'S criteria.

In conventional radiography by using PEDERSON'S difficulty index, 48 is very difficult to extract and using ROOD'S criteria 48 is having interruption of the white line. In 3-dimensional object reconstruction, there is 0.42 mm gap between the tooth apices and nerve and cortication present. So 48 can be extracted and can be changed from high risk to low risk.

In conventional radiography by using PEDERSON'S difficulty index, 48 is very difficult to extract and using ROOD'S criteria 48 is having darkness of the root. In 3-dimensional object reconstruction, there is almost no gap between the tooth apices and nerve and cortication absent. So 48 extraction will be difficult with more chances of nerve injury. Both Conventional panoramic radiographic and 3-dimensional object reconstruction inferences are coinciding in this case.

DISCUSSION

Dysesthesia caused by inferior alveolar nerve injury after the surgical removal of mandibular third molars usually disappears within a few months; however, it can be distressing, especially if it persists. The risk for postoperative dysesthesia becomes higher if the mandibular canal and the tooth root are in proximity.[23] Thus, preoperative radiographic assessment is necessary for surgeons to plan operative approaches and procedures.

In general, a panoramic radiograph can help to determine the location of the mandibular canal; however, sufficient diagnostic information related to accurate anatomy is lacking with this method ie., presence or absence of cortication around the mandibular canal, the buccolingual relationship between the mandibular canal and the lower third molar, and the detailed shape of the root might not be clearly evident on a panoramic radiograph, this imaging technique provides limited information because it gives only a 2-dimensional image of an intricate 3-dimensional anatomic relationship[23].

According to BART F. BLAESSER et.al[9], patient with 1 or more high risk radiographic findings (Diversion or bending of the canal, Darkening of the tooth root, Interruption of the cortical white line of the canal) has a significantly increased risk for nerve injury. However, when 1 or more high risk radiographic signs are present, an advanced imaging, such as CT imaging which can be viewed in the axial, coronal and sagittal planes, may be indicated to better establish the anatomic relationship between the IAN canal and third molars.

According to HIDENOBU MAEGAWA et.al[23], further CT study is proposed when a panoramic radiograph reveals the following conditions: 1) a root apex is at the lower half or under the inferior wall of the mandibular canal or 2) either the white line or black line is not seen clearly.

According to MOMEN A. ATIEH et.al[37], the radiographic finding of 2 or more markers might improve the sensitivity in predicting a true intimate relationship and hence an indication for applying other imaging techniques such as computed tomography to confirm the diagnosis and provide the surgeon with additional detailed information about the anatomy of the mandibular canal and third molar roots.

According to HADAR BETTER et.al[22], the main reason for CT scan referral is the proximity of the third molar root to the inferior alveolar canal (<1 mm).

A relatively new modality, Computed Tomography, should allow the clinician to localize and determine the liaison of the impacted tooth and the inferior alveolar neurovascular canal in 3-dimensions.[11] These details may help in unravelling the complexity of the anatomic relationship and are also beneficial for a preoperative assessment of the surgical difficulty because of high resolution quality of CT.

According to SRINIVAS.M.SUSARLA et.al[44], the additional information provided by CT imaging studies has, showed effectiveness in changing the majority of patients from elevated risk to low risk.

According to AAKARSH JHAMB et.al[1], the spiral computed tomography (SCT) images definitely enhanced the visualization of the relation of the tooth to the IANB when compared to orthopantomograph, which might provide a higher level of intrasurgical safety and safeguard the interests of both the surgeon and the patient.

3-Dimensional Object Reconstructions from CT data has opened up new avenues for the diagnosis, evaluation, visualization and treatment planning.[11] Although no dental image processing program has been designed specifically or primarily for use in the evaluation of impacted mandibular third molars, CAD based medical software's are readily adapted for such use. All programs imports DICOM format images (Digital Imaging and Communications in Medicine). Once imported into the programs, the images can be reformatted to show the jaw in the axial and coronal planes, and also can display a panoramic reconstruction. The images are true representation of the jaws, allowing accurate measurements. With the aid of the "nerve tool" program allows the examiner to trace the mandibular canal[11].

The greatest strength of all these programs lies in its ability to display 3-D object images; virtual replicas of the bone, teeth, canal, and other structures can be created. The program works by separating tissues by density- in the jaws, bone, and teeth. The clinician can specify the densities to include any 3-D object reconstruction. Depending on the parameters specified, the bone and teeth can be created as a mask (a mask corresponds to a colour of a particular threshold of grey value). Alternatively, the bone can be done in a mask and the teeth in another mask[11]. The program reaches its full potential, however, with the ability to rotate the image, allowing the clinician to view any structure from any perspective and to hide or separate the masks in any combinations (Fig.1). This feature adds a dimension that provides information well beyond that provided by the radiographic part of the CT only. It is not only beneficial to the clinician, but also makes informed consent far more meaningful, because the patient is able to see the problem and need not try to imagine it[11].

According to A.FALK, S. GIELEN et.al[5], CT is of special importance in reconstructive surgery. 3D surface reconstruction of both, bone and soft tissue, permit a realistic impression of the overall pathoanatomical situation.

According to GARY ORENTLICHER et.al[19], the use of 3-dimensional software programs and technologies to preoperatively evaluate impacted third molars provide the surgeon with the 3D information necessary to better determine the locations, angulations, and positions of these teeth as they relate to vital structures and adjacent teeth in the areas

In this study, the relationship of third molar roots to the Inferior Alveolar Nerve were compared with conventional panoramic radiographs and 3-Dimensional Object reconstruction. The difficulty in extracting the impacted third molars can be assessed in panoramic radiographs by using Pederson's difficulty index and relationship between the third molar root to the Inferior Alveolar Nerve by using Rood's criteria. Using Pederson's difficulty Index, the impacted third molar extraction difficulty is classified into Very difficult, Moderately difficult and Minimally difficult (Fig.2).

Panoramic radiograph is not an actual view. It is a projected view. It is an 2-dimensional view and does not show buccolingual direction of both tooth and nerve. It does not show the exact anatomy of the third molar ie., it does not show the exact angulation of the tooth and whether the tooth is lingually or buccally tilted and it does not show the lingual side anatomy ie., lingual root (if present). The exact relationship between the third molar roots to the nerve cannot be predicted correctly, but can only be guessed by some predictable radiographic variables using Rood's criteria.

In our study 3-Dimensional Object reconstruction was done from CT data to visualize the impacted mandibular third molar and its relation to the inferior alveolar nerve. Using 3-Dimensional object reconstruction, rotation of the image in all axis and zoom in and zoom out can be done to visualize the impacted third molar through which bucco-lingual relationship (Fig.3) of the third molar to the Inferior Alveolar Nerve can be seen clearly.

Tooth morphology can be seen clearly; its angulation and whether it is buccally tilted or lingually tilted, lingual perforation if present, number of roots present and if any lingual root present, root angulation whether bulky, bent/curved or hooked root present can be visualized which will be seen as blunt root and can never be able to predict using the conventional panoramic radiograph.

Depth of impacted tooth in relation to the second molar, amount of bone present between distal surface of second molar to the impacted tooth and need to be removed from mesial and distal to the impacted tooth also can be predicted. It also helps in flap designing[6] (Fig.4) and knowing where to make purchase point of application which will predict and reduces chances of periodontal pocket formation and second molar sensitivity.

Presence of impacted tooth, on or involving the external oblique ridge can be predicted and helps in knowing the difficulty of removal as bone density is more in the external oblique ridge region. As per literature, there are chances of dry socket formation when bone removal includes external oblique ridge. Fracture can also occur primarily due to the position of the third molar, which occupied a large osseous space and thereby weakened the mandibular angle by decreasing the cross-sectional area of bone and causing the loss of supporting bone, especially in the external oblique ridge can also be predicted[2].

The reconstructed 3-Dimensional object can be viewed in Transparency, so that we can clearly visualize the relation of one structure to the other. Inferior Alveolar Nerve can be simulated all along its length and can clearly see its relation to the apices of the teeth. The mandible can be hidden and only nerve with tooth can be seen (Fig.5).

Tooth can be moved in the path of elevation and can access the severity of tooth lock. Tooth can be sectioned and the movement of its path of exit can be virtually seen (Fig.6).

The distance between the root apex to the nerve, buccal and lingual cortical thickness, lower border thickness, bone density etc.., can be measured (Fig.7, 8 & 9)

3-Dimensional Object Visualization shows all the necessary information clearly. It does not need any expertise to interpret and any one can visualize the exact anatomy/ position of the third molar roots to the inferior alveolar nerve existing.

SUMMARY AND CONCLUSION

Conventional Panoramic Radiograph is a projected view, only shows limited information whereas 3-Dimensional Object Reconstruction shows all the information regarding mandibular third molar apices to the Inferior Alveolar Nerve. Rotating the image can show its bucco-lingual relation, distance also can be measured between them. Simulation can be done by moving the tooth in its path of exit, can plan and view sectioning of tooth preoperatively.

Definitely 3-Dimensional Object reconstruction is better than Conventional Panoramic radiograph as confirmed by the similarity between our data and those in the literature. As Conventional Panoramic radiograph is not showing adequate and necessary information, CT scan can be prescribed as a routine radiographic investigation and 3-Dimensional object reconstruction can be done from CT data and visualize actual anatomy present. But for clinicians and patients the only disadvantage of CT scan is its high radiation which can be overseen when compared to its advantages.

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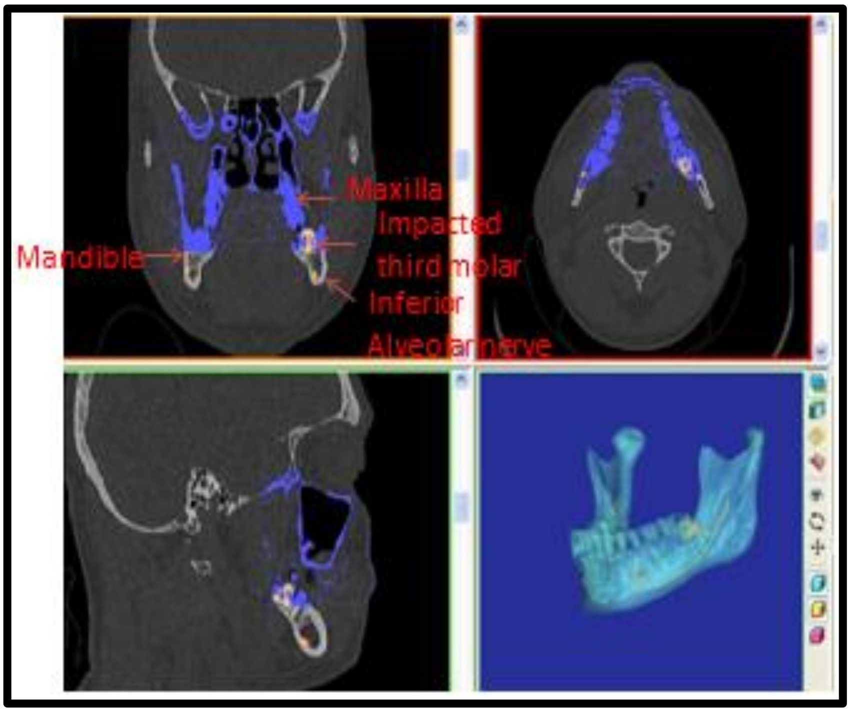


Fig.1: Mask created for different structures to particular threshold of grey value

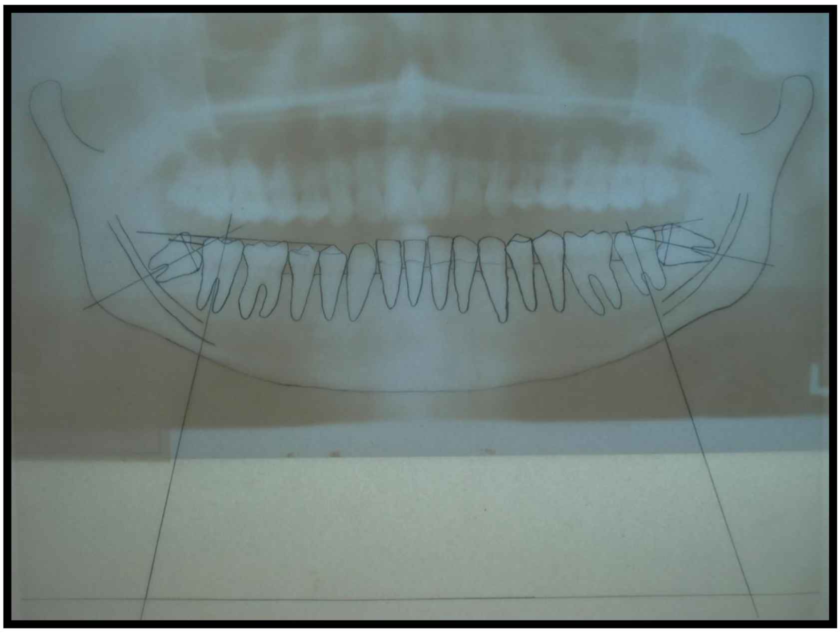


Fig.2:TRACED PANORAMIC RADIOGRAPH TO SHOW PEDERSON'S DIFFICULTY INDEX AND ROOD'S CRITERIA

Tracing done to predict the angulation, space available and position of mandibular third molar and relation between the mandibular third molar apices to the nerve.

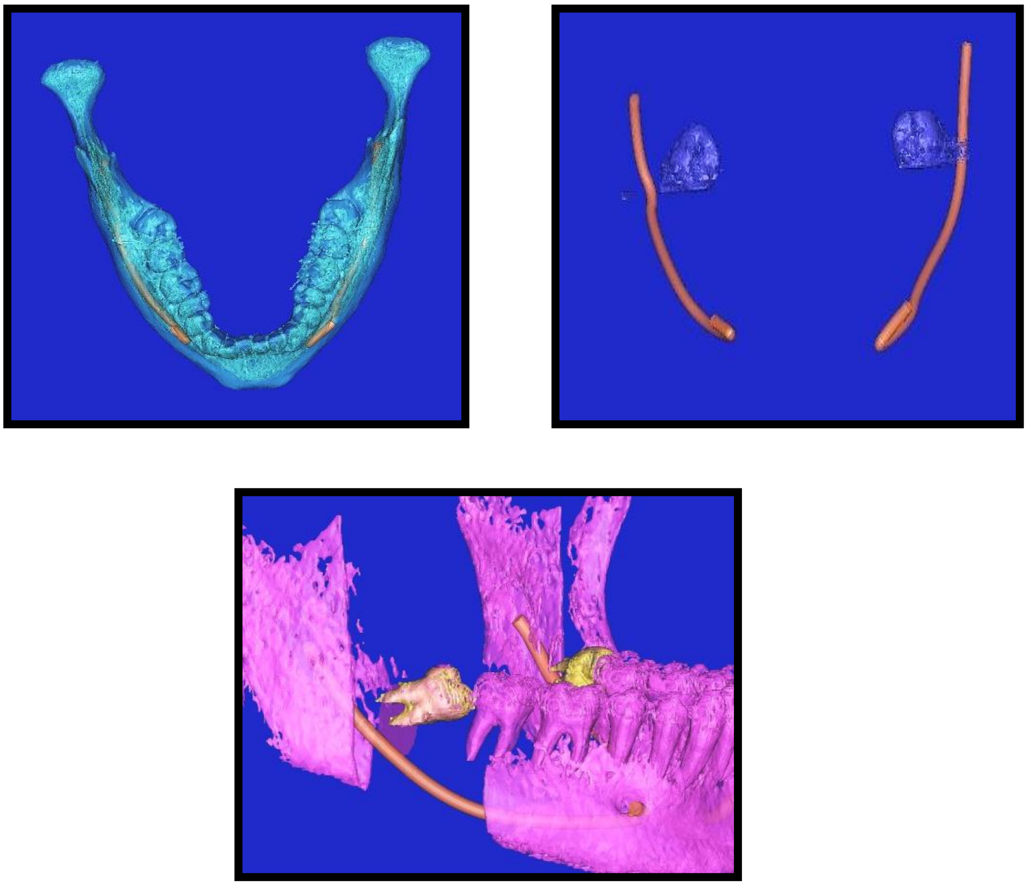


Fig.3: BUCCO-LINGUAL RELATION

The bucco-lingual relation can be visualized clearly.

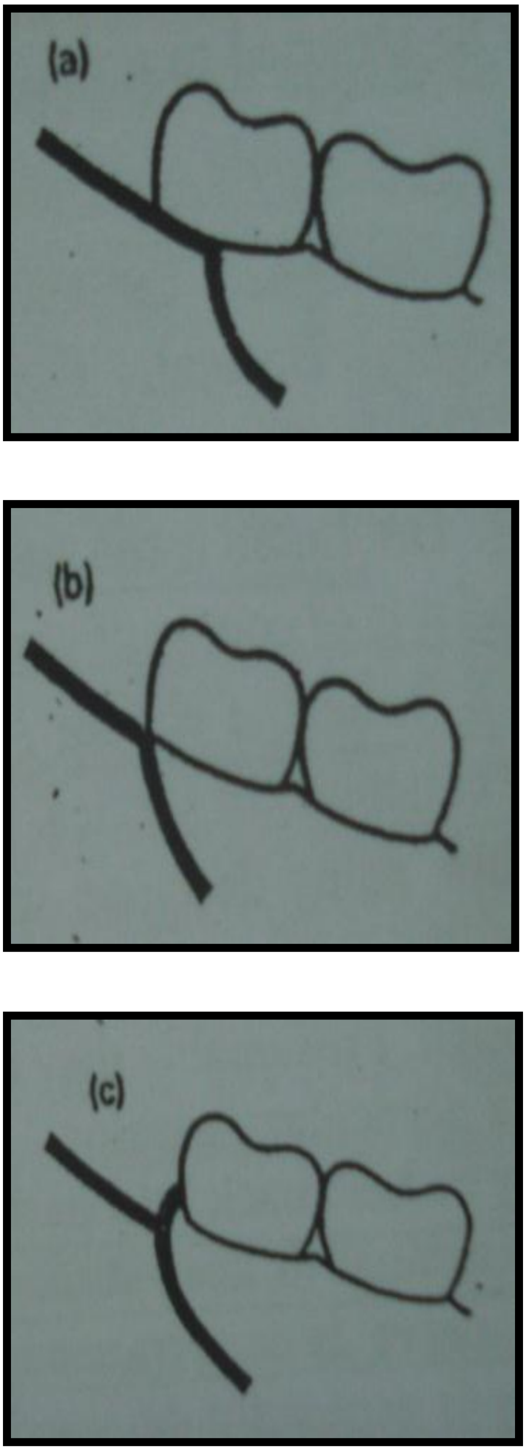


Fig.4: FLAP DESIGNS

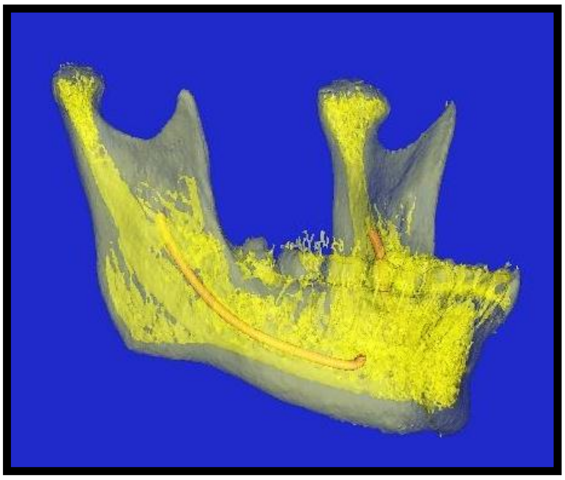


Fig.5: SIMULATION OF THE NERVE

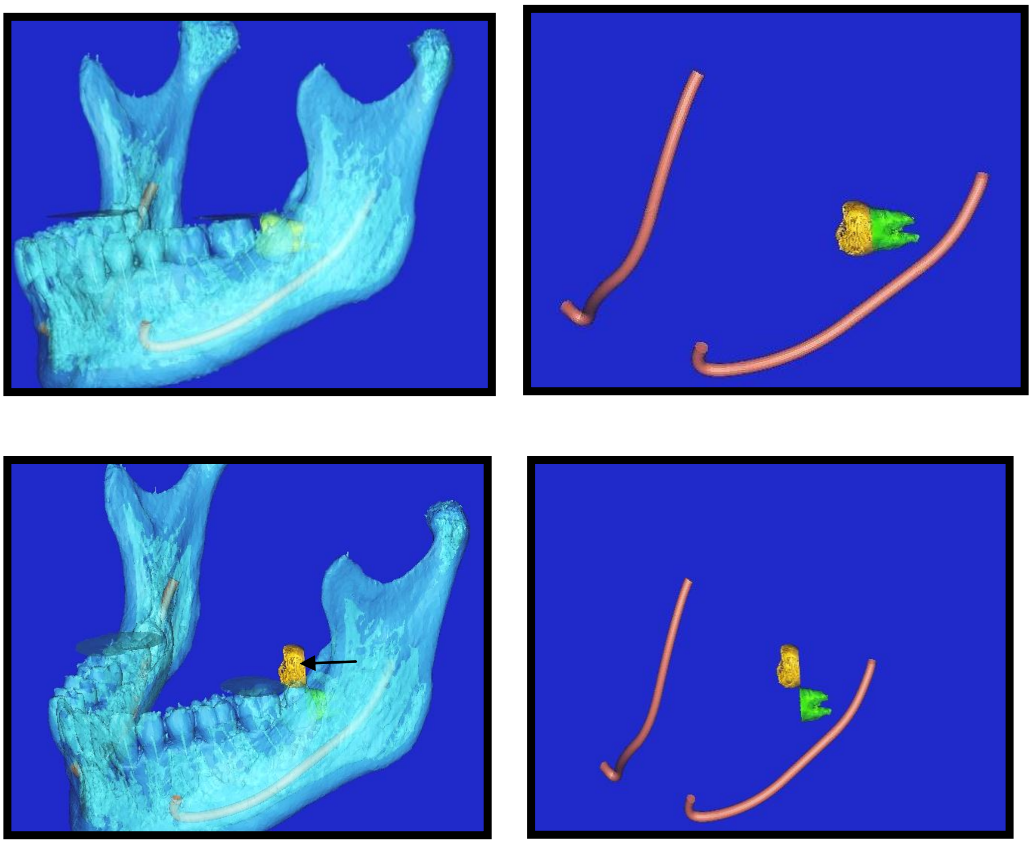
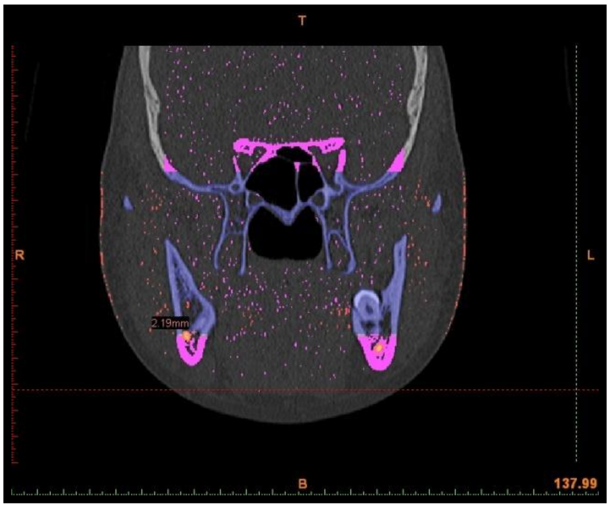


Fig.6: SECTIONING OF THE TOOTH

The crown portion of the tooth is sectioned and elevated virtually.



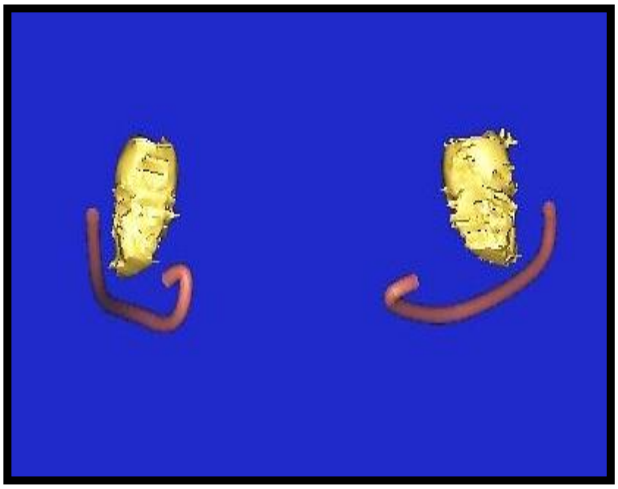


Fig.7: MEASUREMENT OF DISTANCE FROM TOOTH TO NERVE

Fig.8: CORTICATION

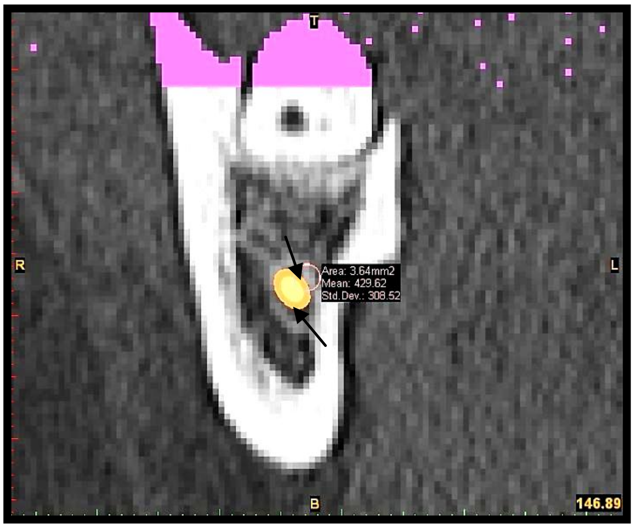


Fig.9: BONE DENSITY