COMPARATIVE ASSESSMENT OF IMPACTED MAXILLARY CANINE USING DIGITAL PANORAMIC RADIOGRAPHS AND 3-DIMENSIONAL OBJECT RECONSTRUCTED FROM CT DATA

Dissertation Submitted to

THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY

In partial fulfillment for the Degree of

MASTER OF DENTAL SURGERY

BRANCH III

ORAL AND MAXILLOFACIAL SURGERY

APRIL 2013

CERTIFICATE

This is to certify that this dissertation titled **"COMPARATIVE ASSESSMENT OF IMPACTED MAXILLARY CANINE USING DIGITAL PANORAMIC RADIOGRAPHS AND 3-DIMENSIONAL OBJECT RECONSTRUCTED FROM CT DATA"** a bonafide record of work done by **Dr.VIMAL.K** under our guidance and to our satisfaction during his postgraduate study period **2010-2013.**

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.

Guided by:

Dr. B.Vikraman, M.D.S
Professor
Department of Oral &
Maxillofacial Surgery,
Ragas Dental College & Hospital,
Chennai ,

RAGAS DENTAL COLLEGE & HOSPITAL
Dept. of Oral & Maxillofacial Surgery
Ph: 2453 0003 Ext. - 17

RAGAS DENTAL COLLEGE & HOSPITAL CHENNAI

Dr. M.Veerabahu, M.D.S, IBOMS.,
Professor and Head,
Department of Oral &
Maxillofacial Surgery,
Ragas Dental College & Hospital,
Chennai,

Dr. M. VEERABAHU, MDS,IBOMS
Professor & HOD
Dept of OMFS
RAGAS DENTAL COLLEGE & HOSPITAL
Uthandi, Chennai - 600 119.

Dr. S. Ramachandran M.D.S.,
Principal,
Ragas Dental College & Hospital,
Chennai.

PRINCIPAL
RAGAS DENTAL COLLEGE & HOSPITAL
CHENNAI

ACKNOWLEDGEMENT

I wish to thank my loving mother ***Mrs. K. Vijayalakshmi*** *for giving me a great foundation for my life and being with me in all circumstances as almighty.*

With deep satisfaction and immense pleasure, I present this work undertaken as a Post Graduate student specialising in Oral & Maxillofacial Surgery at Ragas Dental College and Hospital. I would like to acknowledge my working on this dissertation which has been a wonderful and enriching learning experience.

I am greatly indebted to ***Dr. M. Veerabahu****, MDS.,My Professor and Head of the Department, Oral and Maxillofacial Surgery, Ragas Dental College and Hospital, Chennai, for his guidance and support and criticism. His constant guidance in the academic front as well as in surgical aspect during my studies has helped me a lot. I have been fortunate to study under his guidance and support. These memories definitely would cherish throughout my life.*

I would like to extend my heartfelt gratitude to professor ***Dr. S. Ramachandran****, MDS., Principal, Ragas Dental College and Hospital, for allowing us to use the, scientific literature and research facilities of the college.*

I wish to convey my heartfelt thanks to my guide and Professor, ***Prof.Dr. B. Vikraman,*** *MDS., Head of Virtual Lab and Unit II, a great teacher* *who has always been a source of inspiration. I express my personal thanks for being so tolerant, encouraging and understanding. I shall forever remain indebted for his valuable guidance and input throughout the making of this dissertation without which I would have never accomplished this particular research. It was an enriching experience to have spent three years of my life under her guidance.*

I owe enormous debt of gratitude to my teacher, ***Dr.MaliniJayaraj*** *for her unstinted guidance, moral support, encouragement and helping me in all ways throughout my curriculum.*

I also express my sincere and profound thanks to ***Prof. Dr. J . A. Nathan*** *and* ***Dr. Radhika Krishnan*** *for their guidance and share of knowledge.*

I sincerely thank my teachers ***Dr. D. Shankar, Dr. J. VenkatNarayanan ,Dr. T. Muthumani, Dr.Karthick, and Dr.Prabhu*** *for their valuable guidance, constant support, encouragement and help during my Post graduation period.*

I would also extend my gratitude to ***Dr.Seema*** *and* ***Dr.Anusha*** *for their valuable suggestions and support.*

I sincerely thank my colleagues ***Dr. D. Abhishek Johnson Babu, Dr.Brian.F.Pereira, Dr.Krishna Kumar M.G, Dr. G. Manikandan, Dr.Saravanan.B,*** *for their constant support, constructive criticism at every step* and selfless co-operation during my course and being with me in all my ups and downs in my course. I would also like to thank my juniors **Dr.Abhishek.R.Balaji, Dr.A.Alphonse Christy Raja, Dr.N.Kingsen Blessly Isaac, Dr.Ashish, Dr.Jay, Dr.Sindhu** for their encouragement and the timely help they have rendered during my course.

I would also thank all the staffs and nurses in my department, minor and major operation theatre for helping me throughout my post graduate period.

It would be ungrateful if I don't thank my father **Mr.P. Kothandaraman**, my brother **Mr.C.K.Ashwin Kumar ,**my sis-in-law and friend **Mrs.Sindhu** , my friend and philosopher **Dr.T.T.Saravanan and Dr.A.Mahalakshmi** for being a pillar in all my success and giving me a helping hand during my downfall in my entire life and my **Family and Cousins**.

I would like to dedicate this dissertation to my loving mother **Mrs.K.Vijayalakshmi**, who always wanted me to reach great height in my life and see me in the position where I am today.

CONTENTS

LIST OF TABLES

ABSTRACT

Purpose: The purpose of this study is to compare the ability and reliability of evaluating, completely impacted maxillary canine with conventional digital panoramic radiograph and 3D reconstructed CT data.

Materials and Methods: This prospective study was done with a total of 5 patients aged 12 to 28 years of age and patients were informed about the need for CT radiological assessment and consent was obtained. They were pre operatively assessed using, Conventional Digital Panoramic Radiographs with Stivaros and Mandall (2000) assessment criteria and 3 Dimensional Reconstructed Object from the Computed Tomographic data.

Results: Digital panoramic radiographs are 2 Dimensional image of a 3 Dimensional object with less accuracy and more distortion. 3-Dimensional object reconstructed CT data can be used to visualize the impacted maxillary canine in transparency and opaque views, 3-Dimensional object visualization with rotation in all axis, transparency and separate view of different structures, virtual tooth sectioning and sectional view of the crown or root alone, measuring the distance from impacted maxillary canine to the occlusal plane and adjacent structures, presence of cortication by accessing the bone density of the region, simulation of movement of tooth on the path of elevation, assessment of surgical approach to the impacted tooth.

Conclusion: 3-Dimensional object visualization from CT data does not need any expertise to interpret and any one can visualize the exact anatomy and position of the impacted maxillary canine when comparing and evaluating with the digital panoramic radiographs.

Keywords: Impacted Maxillary Canine, Digital Panoramic Radiographs (OPG), Computed Tomography (CT), 3 Dimensional CT Data, MIMICS, Periapical Radiograph, Lateral Cephalogram.

INTRODUCTION

The impaction of canines presents a special challenge in the practice of orthodontists and oral maxillofacial surgeons. It is very important in determining the location of the impacted canine, its anatomical relation to the adjacent tooth and anatomical structures, to plan treatment modality which should be dealt for that specific impacted canine and its advantage to retrieve and align the tooth in occlusion or for extraction with minimal morbidity to the adjacent anatomical structures.

Therefore, oral maxillofacial surgeons and orthodontists have relied on the use of radiographic images. Many authors have described various methods to evaluate the position of impacted canines, Ericson and Kurol (1988)[16], Stivaros and Mandall (2000).[36] Orthopantomograms (OPG) are used as radiologic investigation of choice for impacted maxillary canines though (intraoral periapical radiographs) IOPA and lateral cephalogram were also helpful.

The main disadvantages of these panoramic radiographs are magnification and distortion, because of the change in distance between the rotational centre and film and change in rate of movement of the film. Therefore, linear measurements obtained from these panoramic radiographs may not represent the actual dimensions.

Moreover panoramic radiograph is a projected view and are two dimensional images not an actual representation of the region. They do not show bucco-lingual dimension. However, the weaknesses of conventional radiographic techniques have been thoroughly documented in the literature.

In recent years, the use of medical computed tomography (CT) and cone beam computed tomography (CBCT) has gained popularity and acceptance, especially in cases involving impacted teeth. The distortion-less, three-dimensional visualization has greatly improved the ability of the surgeons and orthodontist to precisely locate impacted canines in relation to the surrounding anatomical structures.

Computed Tomography also allows the surgeon to achieve a realistic impression of the overall anatomic situation preoperatively, thereby minimizing treatment time and surgical morbidity.

Recent advances in computer hardware and software technology has permitted CT to produce higher resolution 3-D reconstructed images that could yield the anatomical and pathological detail of interest. MIMICS, a CAD based medical software is used to reconstruct the CT data of impacted canines into virtual objects which can be visualized in all the three planes normally and in transparency, distance can be measured between objects and the path of eruption can also be simulated with much accuracy, so this technique is gaining popularity among the surgeons and orthodontist.

AIMS AND OBJECTIVES

The aim of this study is to compare the ability and reliability of evaluating, completely impacted maxillary canine with conventional digital panoramic radiograph and 3D reconstructed CT data of 4 patients with the following parameters

Digital Pantomogram:

Stivaros and **Mandall's** (2000) criteria

- Canine angulation to the midline.
- Vertical height of the canine crown.
- Antero-posterior position of the canine root apex.
- Canine crown overlap of the adjacent incisor.
- Root resorption of adjacent incisor.

3 Dimensional Reconstructed CT data:

Inclination of impacted canine to the midline.

- Mesio-distal position of the apex.
- Vertical level of the clinical crown.
- Overlap with the lateral incisor.
- Labio-palatal position of the crown.
- Orientation of the impacted tooth to the nasal floor and palate.

- Root resorption of adjacent incisors.
- Assessment of surgical approach to the impacted tooth.
- Simulation of path for aligning/removal of impacted canine.

REVIEW OF LITERATURE

Philipp R, Hurst R. (1978)[32] in their study found that elongation of image in the maxilla was more pronounced with the magnification ranging from 22.8% to 28% and the largest amount of distortion was found in the canine premolar region of both the arches.

Ames JR et al (1980)[2] has enunciated the advantages of computerized tomography are lack of image superimposition, preservation of detail of soft tissue, selective enlargement of areas of interest, tomographic capability, and the future possibility of the production of three-dimensional images.

Ericson S et al (1988)[16] in their study on clinical and radiographic examination on predisposing factors to analyze the resorption of maxillary incisors caused by ectopic eruption of maxillary canine and suggested a stepwise radiographic method to analyze the ectopic position of maxillary canine added as a supplement to clinical examination.

Traxler M et al (1989)[37] in his comparative study on impacted teeth with orthopantomogram and Computed Tomography ,the detection of displacement, contact and resorption, computed tomography was found to be superior to both clinical examination and orthopantomograms.

Becker et al (1995)[5] in their study have advanced the guidance theory of eruption which states that the maxillary canine is guided into position by the distal surface of the lateral incisor root. The factors in the impaction of maxillary canines can be due to deviations from the prototypical model, including the absence, aberrant morphology, or mistiming of the development of the lateral incisor are implicated.

Peck S et al (1995)[31] have looked for a genetic basis for impaction, noting the occurrence of other dental anomalies frequently found in conjunction with palatally displaced canines. Also cited as evidence by these researchers are the frequent occurrence of bilateral impactions, the tendency for impactions to be found in multiple members of the same family, and differences in frequency of impaction between genders and populations of various racial backgrounds.

Fox NA et al (1995)[19] In their study, the determination of localizing impacted maxillary canines with dental panoramic radiographs researchers were able to accurately predict the position of palatally displaced crowns only 80 percent of the time and image distortion present on these radiographs can only be used as a guide for position of crowns of impacted canine, further they are of no value for localization of roots of impacted maxillary canine.

P. Mozzo et al (1998)[30] in a study on new volumetric CT machine for dental imaging based on the cone-beam technique provides good performance in image quality and low radiation dose with a reduced scan timing.

Iramaneerat S et al (1998) [24] classified the initial position of palatally impacted canines on lateral cephalograms. The vertical distance from the cusp tip to the occlusal plane and the horizontal distance from the cusp tip to A-perpendicular (defined as a line passing through A point and perpendicular to the occlusal plane) as well as the angle between the long axis of the canine and A-perpendicular were measured. All of these values yielded weak, statistically insignificant correlations against treatment duration using lateral cephalograms.

Stella Chaushu et al (1999)[8] in his study found that in a total of 115 panoramic radiographs depicting 164 displaced maxillary canines evaluated, there was an overlap in the canine-incisor index ranges of the buccal (0.94-1.45) and palatal (1.15-1.29) canines in the apical zone seen on a panoramic radiograph with vertical restrictions.

Jacobs SG et al(1999)[25] from his study how to and when to localize impacted maxillary canine has used combination of radiographic methods to assess the impacted tooth less accurate localization and distortions in image obtained from single radiographic technique.

Schulze R et al (2000)[35] in his study on precision and accuracy of measurements in digital panoramic radiography made with a series of 70 digital panoramic radiographs on a dry skull in seven different positions with metallic pins and spheres found that vertical measurements were less reproducible than horizontal measurements. The most reliable measurements were obtained from linear objects in the horizontal plane.

Ericson S et al (2000)[17] in their study with Computed Tomography(CT) to analyze the extent and prevalence of maxillary incisor root resorption after ectopic eruption of maxillary canines and found that CT scanning shows increased detection of root resorption when compared to the low sensitivity in intraoral films.

Stivaros N et al (2000)[36] in his study of radiographic factors which were used to assess the localization of canines from a panoramic radiograph adapted similar assessment of Ericson and Kurol (1988) to evaluate the canine angulation to the midline, vertical height of the canine crown, antero-posterior position of the canine root apex, canine crown overlap of the adjacent incisor, root resorption of adjacent incisor, labio-palatal position of the canine crown, labio-palatal position of the canine apex.

Bodner L et al (2001)[6] compared the image accuracy of computed tomography (CT) with that of plain film radiography(PFR) and analyzed the 3 dimensional shape of impacted teeth which showed that CT was superior to plain film radiography and its usefulness in diagnosis and treatment planning.

Mckee I W et al(2001), (2002)[28,29] in his study_found that clinical assessment of mesiodistal tooth angulation with panoramic radiography needs extreme caution with an understanding of inherent image distortions, further head positioning can also potentially complicate image distortions attributing to its technique sensitivity of a panoramic radiography.

Ericson S et al (2002)[14] in their study on erupting maxillary canine and their relation to adjacent permanent incisor root resorption found the effective use of computed tomography in its evaluation.

Armstrong et al(2003)[4] has reported that a correct diagnosis (buccal or lingual) was made 88% of the time using the horizontal parallax method and 69% of the time using the vertical parallax method from his study concluding that horizontal plane is superior to vertical plane in diagnostic accuracy of radiographs and does not suggest dental panoramic radiographs.

Stella Chaushu et al (2004)[7] in their study with a sample of 20 patients recommended the routine adoption of digital volume tomography imaging for positional diagnosis of impacted teeth.

Cooke J, Wang H. (2006)[11] has observed visualization of the correct location and orientation is essential for determining the proper course of treatment, appropriate surgical strategies as well as the feasibility and mechanotherapy of orthodontic alignment.

Crescini et al (2007)[12] evaluated 168 cases of impaction, also using similar measurements to Ericson and Kurol[8], with a slight modification of the zones used to measure anteroposterior position. The average treatment time for all patients was 22.0 months and the time between the initiation of active traction on the canine and the emergence of the cusp tip averaged 8.0 months. The shorter overall treatment time was attributed by the authors to the exclusion of cases where direct traction of the canine was not possible due to transpositions or other obstacles in the path of forced eruption. The regression analysis showed that the time required for active traction was significantly affected by the angle between the long axis of the canine and the midline, the perpendicular distance between the occlusal plane and the cusp tip and the anteroposterior "sector" in which the cusp tip was found.

Garcia-Figueroa M et al (2008)[20] studied the effect of bucco lingual root angulation on mesiodistal angulation shown on a panoramic radiograph were the largest angular difference occurred in canine premolar region with discrepancies larger in maxillary arch than mandibular arch which indicates distortions in a panoramic radiograph on clinical assessment of root parallelism.

Liu et al (2008)[27] performed an analysis on a sample of 210 impacted maxillary canines and quantitatively described the canine position and the presence of root resorption on adjacent teeth with much accuracy and was able to classify them relating to treatment decisions. They concluded that localization of impacted canines in 3 planes varies greatly and can aid on treatment planning.

Padhraig S. Fleming et al (2009)[18] also used panoramic radiographs in an attempt to predict orthodontic treatment time adapting Stivaros and Mandall(2000) criteria , but found that in cases of palatally impacted maxillary canines, the treatment duration could not be related to the sagittal position of canine apex, horizontal position, or angulation of canine long axis to midline and further prospective research is needed for investigation to decide on treatment planning.

Kau et al (2009)[26] used constructed panoramic and axial views generated from the CBCT volume to establish a scale of difficulty designed to assess the probability of successful treatment.

Archna Nagpal (2009)[3] in their study on 68 impacted canines to evaluate a reliable method of localizing maxillary impacted canines and to assess and determine their validity and reproducibility of the method on panoramic radiographs showed that correct prediction of palatal canine impactions by differential magnification on panoramic radiographs was possible only in 77% of the cases. Horizontal and vertical restrictions have no value in recognition of the labiolingual position of impacted maxillary canines, Therefore panoramic radiograph cannot be used as an only radiographic method for reliable localization.

Alexander Dudic et al (2009)[1] Apical root resorption was underestimated when evaluated on OPT after orthodontic movement. Cone Beam Computed Tomography might be a useful complementary diagnostic method to conventional radiography, to be applied when a decision on continuation or modification of the orthodontic treatment is necessary because of orthodontically induced root resorption.

Schubert et al (2009)[34] in a recent study, found that significant results for all angular and linear measurements taken from a panoramic radiograph when a regression analysis was performed against treatment duration. They concluded that current 2D imaging diagnostics restrict the ability to predict the length of therapy at 40%. Individual bone density and metabolism has a role on treatment time and must be taken into account for a more exact prognosis.

Gary Orentlicher et.al (2010)[21] the use of 3-dimensional software programs and technologies to preoperatively evaluate impacted teeth which 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 which are difficult to assess with 2 Dimensional radiographs like orthopantomogram.

Susanna Botticelli et al (2010)[33] In their study of 60 consecutive patients, the diagnostic accuracy for the localization of impacted canines and detection of canine-induced root resorption of maxillary incisors and found that increased precision in the localization and arch space evaluation by 3 dimensional imaging comparing to 2D radiographs which had factors such as distortion, magnification and superimposition of anatomical structures situated in different planes of space.

MATERIALS AND METHODS

This prospective study was done with patients data referred to the Department of Oral Surgery from the Department of Orthodontics for opinion, between February 2010 and October 2012, at Ragas Dental College and Hospital, Chennai.

This study composed of a total of 4 patients aged 12 to 28 years of age and patients were informed about the need for further CT radiological assessment and consent was obtained

They were pre operatively assessed using, Conventional Digital Panoramic Radiographs with **Stivaros** and **Mandall (2000)** assessment criteria and 3 Dimensional Reconstructed Object from the Computed Tomographic data

Data Collection:

Digital Oral Pantomogram performed for 4 patients using

- Satellac digital dental orthopantomogram machine.
- 70kV without much magnification and masking.

Computed Tomogram performed for 4 patients with Helical/Spiral CT scan at 0.5mm slice thickness for bone window at 120kV and the data were collected in DICOM (Digital Imaging and Communications in Medicine) format with for further manipulation.

Methodology:

Conventional digital panoramic by **Stivaros** and **Mandall (2000)**[95] of Impacted Maxillary Canines adapted from Ericson and Kurol.

Radiographic Assessment Include:

1. **Ericson** and **Kurol**[8] most widely used method for objectively describing the location and angulation of an impacted canine as viewed on a panoramic radiograph was developed by two angular measurements were measured, relating the long axis of the canine to the vertical midline and the long axis of the lateral incisor. A linear measurement was made from the cusp tip to the occlusal plane at a 90 degree angle, and the anteroposterior position of the cusp tip was assessed and assigned to one of five zones (Figure 1).

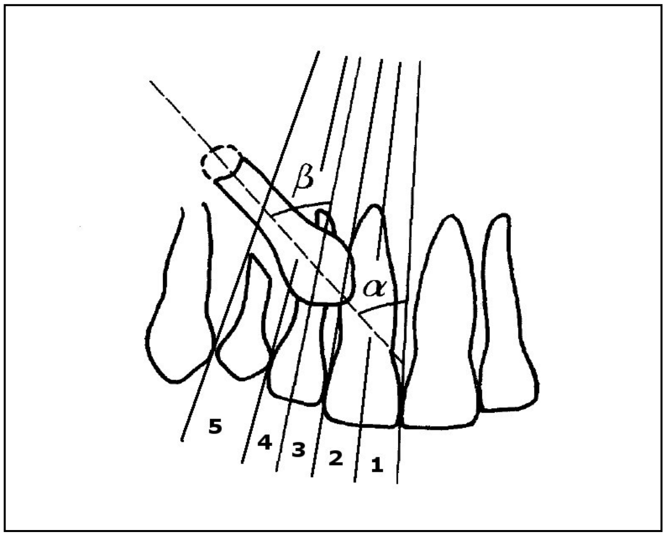

Figure 1: Ericson and Kurol's classification of canine position. Adapted from Ericson and Kurol[8]

The method of objectively classifying canines by their appearance on panoramic radiographs has been used in attempts to predict tooth position, root resorption, treatment planning, periodontal outcomes and treatment duration.

Stivaros and Mandall (2000)

Assessment of Angulation of the Canine Long Axis to the Upper Midline:

Canine Angulation to the Midline

A midline was constructed and a second midline drawn through the root apex and canine tip. The angle between the two lines gave the impacted canine angulation to the midline that was grouped as:

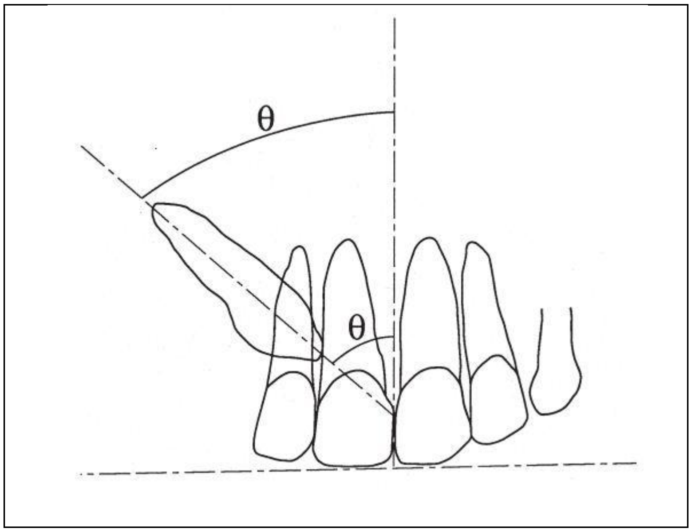

Figure 2: Adapted from Stivaros and Mandall (2000)

Grade 1	0-15˚
Grade 2	16˚-30˚
Grade 3	≥30˚

Assessment of Depth of Impaction of Canine Relative to the Root of Incisors:

Vertical Canine Crown Height

The crown height was graded relative to the adjacent upper incisor

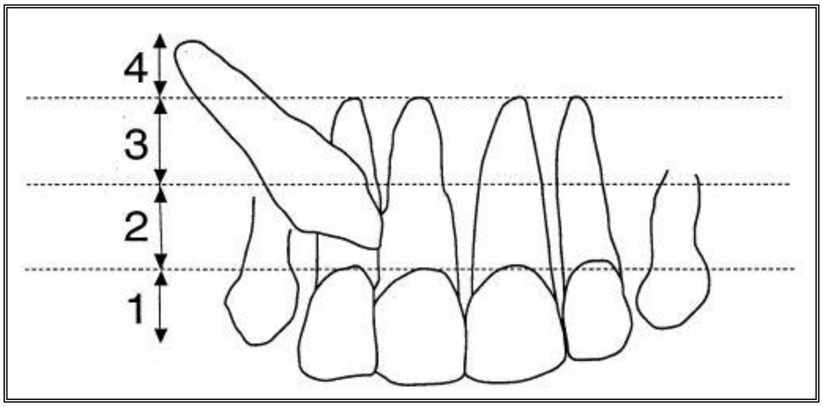

Figure 3: Adapted from Stivaros and Mandall (2000)

Grade 1	Below the level of the cement-enamel junction (CEJ).
Grade 2	Above the CEJ, but less than half way up the root.
Grade 3	More than half way up the root, but less than the full root length.
Grade 4	Above the full length of the root.

Assessment of Position of the Canine Apex Relative to the Adjacent Teeth:

Position of Canine Root Apex Antero-Posteriorlly

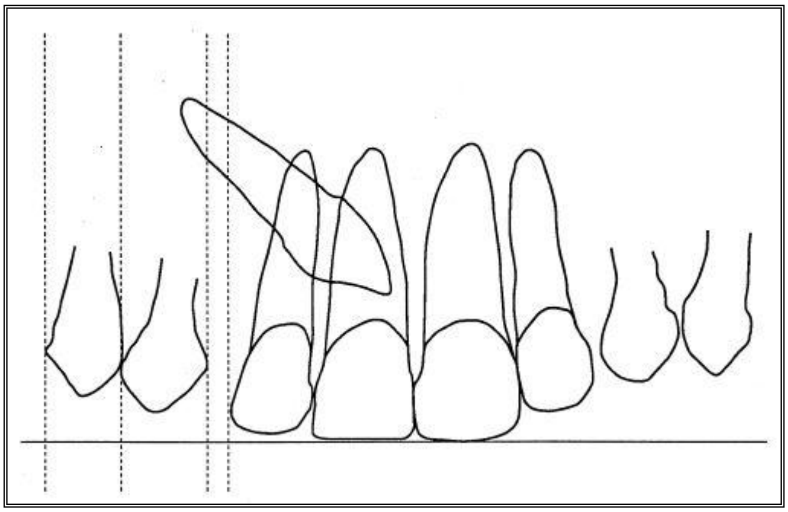

Figure 4: Adapted from Stivaros and Mandall (2000)

Grade 1	Above the region of the canine position.
Grade 2	Above the upper first premolar region.
Grade 3	Above the upper second premolar region.

Assessment of Mesiodistal Position of Canine Tip:

Canine Overlap of the Adjacent Incisor Root

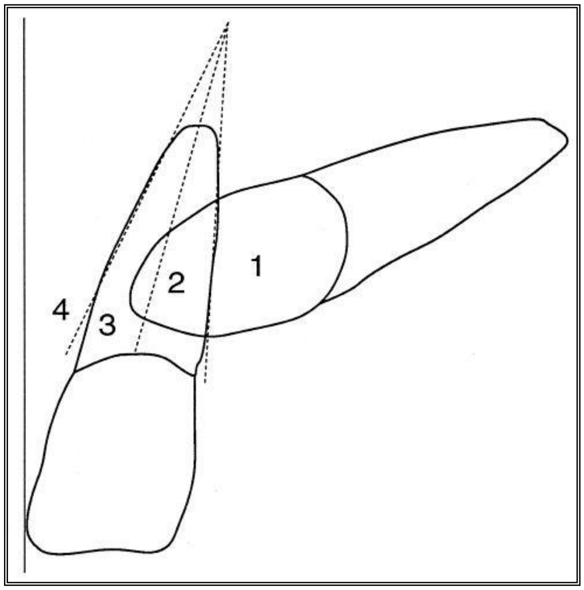

Figure 5: Adapted from Stivaros and Mandall (2000)

Grade 1	No horizontal overlap.
Grade 2	Less than half the root width.
Grade 3	More than half, but less than the whole root width.
Grade 4	Complete overlap of root width or more.

Evaluated for

1. Canine angulation to the midline
2. Vertical height of the canine crown
3. Antero-posterior position of the canine root apex
4. Canine crown overlap of the adjacent incisor
5. Root resorption of adjacent incisor

3D-OBJECT RECONSTRUCTION:

Computed Tomography data obtained in DICOM format were imported into MIMICS with thresholding technique bone and teeth were re constructed into 3D virtual objects for evaluation,

- Visualization of the impacted maxillary canine in transparency and opaque views.
- 3-Dimensional Object visualization with Rotation in all axis
- Transparency and separate view of different structuresVirtual Tooth sectioning and sectional view of the crown or root alone.Measuring the Distance from impacted maxillary canine to the occlusal plane and adjacent structures.
- Presence of cortication by accessing the bone density of the region.
- Simulation of Movement of Tooth on the path of elevation
- Assessment of surgical approach to the impacted tooth.

Added assessment with Stivaros and Mandall criteria:

- Inclination of impacted canine to the midline.
- Mesio-distal position of the apex.
- Vertical level of the clinical crown.
- Overlap with the lateral incisor.
- Labio-palatal position of the crown.
- Orientation of the impacted tooth to the nasal floor and palate.
- Root resorption of adjacent incisors.

RESULTS

RADIOGRAPHIC ASSESSMENT OF MAXILLARY IMPACTED CANINES WITH DIGITAL PANOROMIC RADIOGRAPHS

Patient 1

Miss Revathi 13years/ male

Digital Pantomogram

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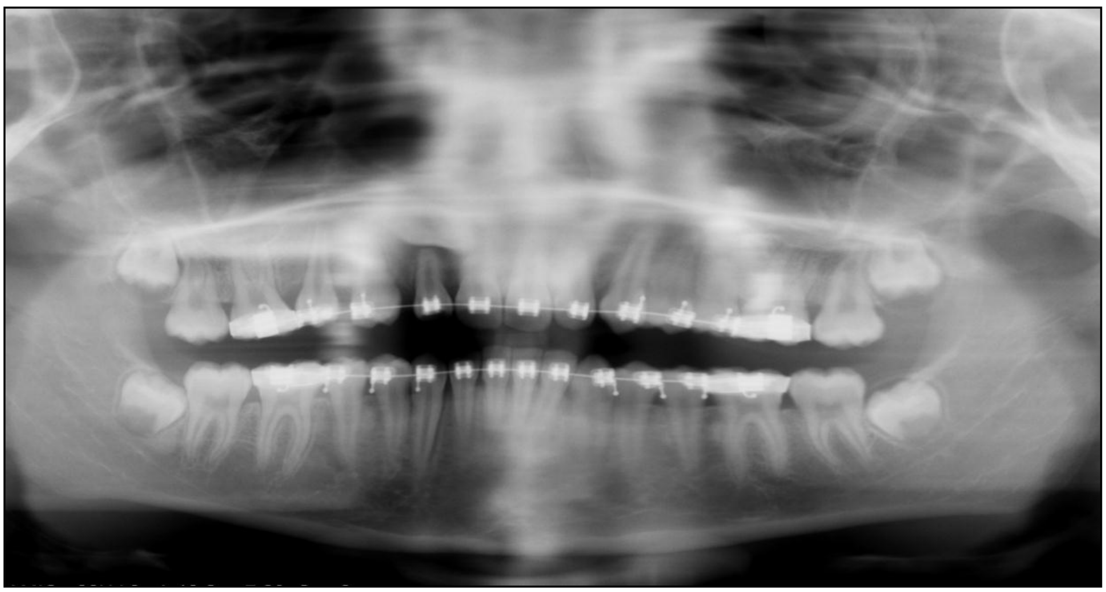
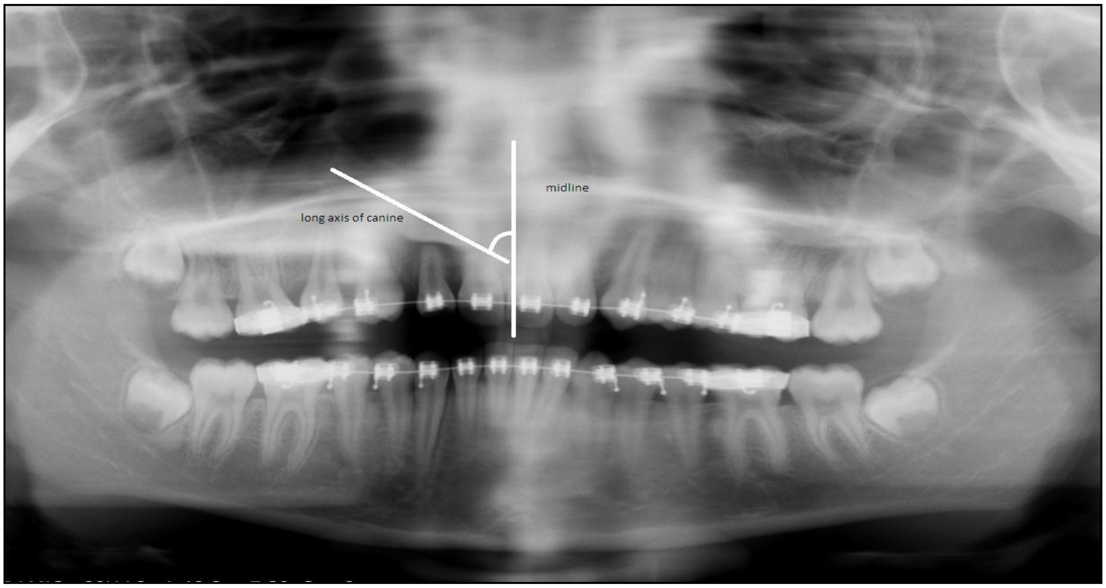
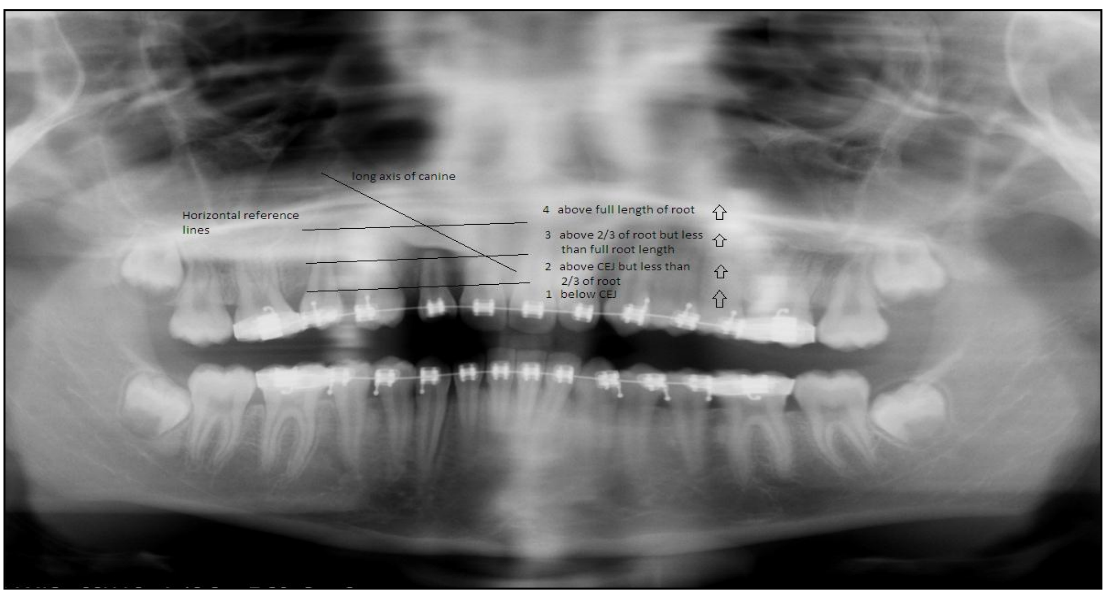


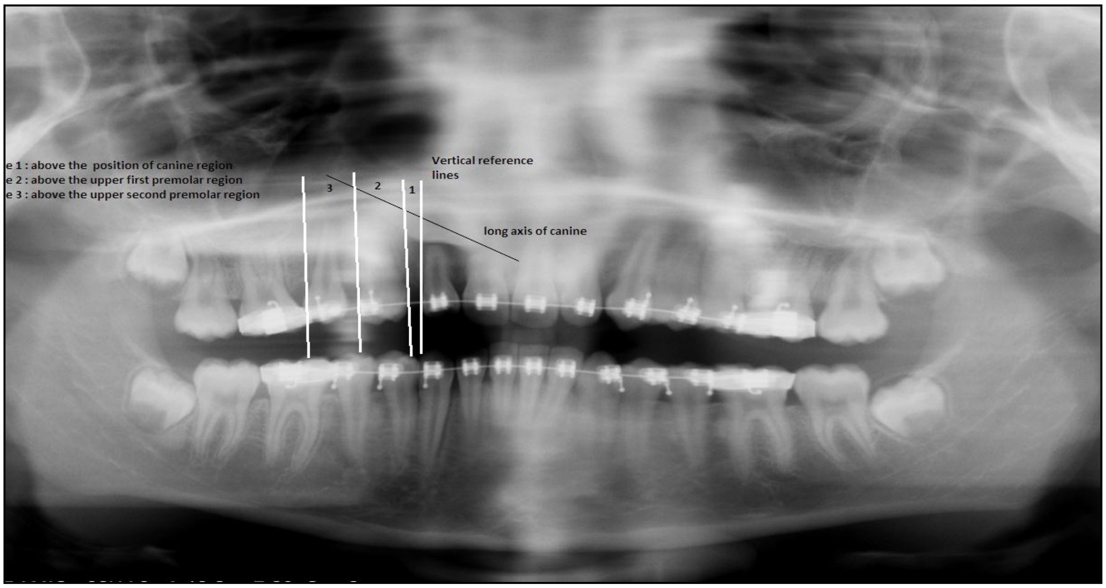
Angulation of the Canine Long Axis to the Upper Midline



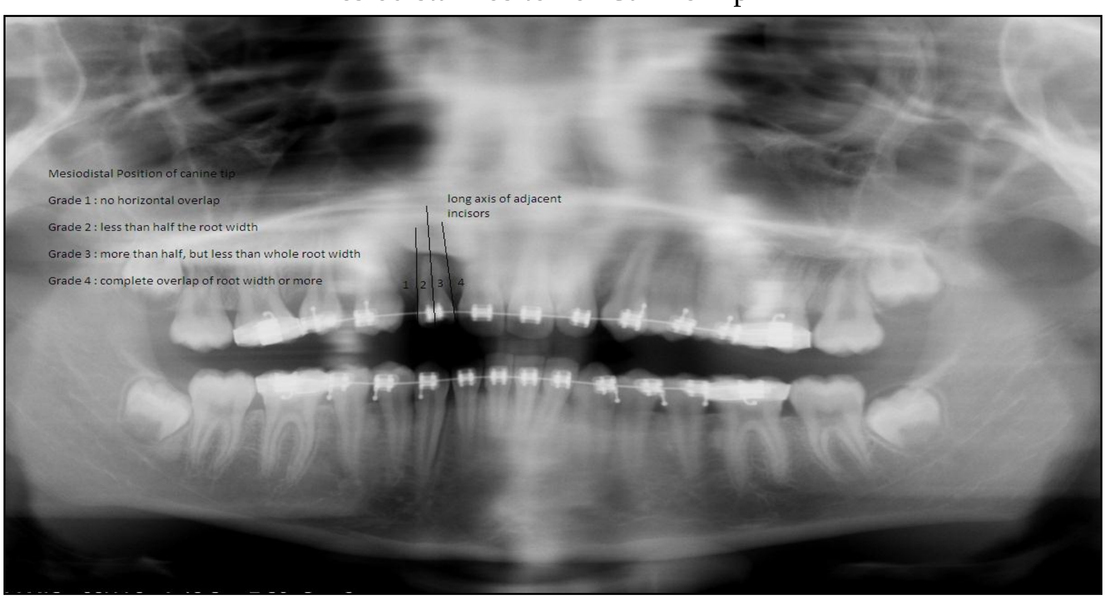
Depth of Impaction of Canine Relative to Root of Incisor



Position of Canine Apex Relative to the Adjacent Teeth



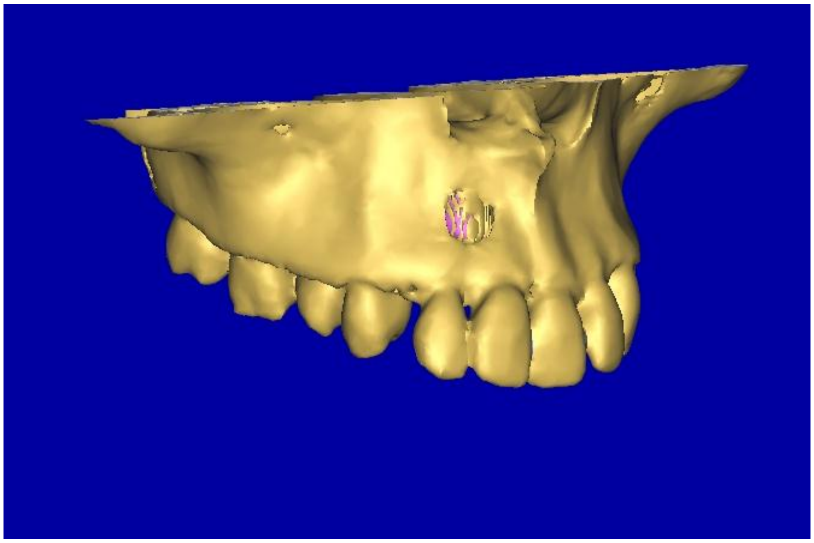
Mesiodistal Positon of Canine Tip



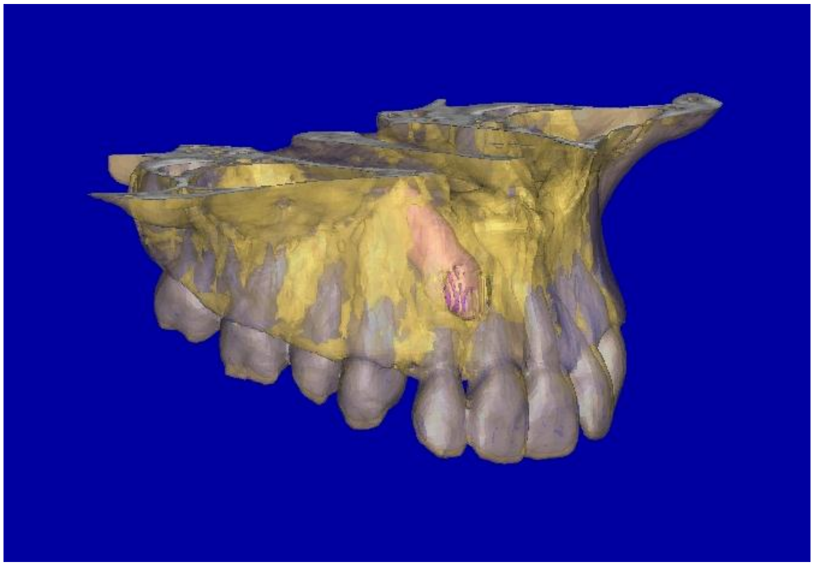
3 Dimensional Reconstructed CT Image

Patient 1

Opaque view



Transparent view

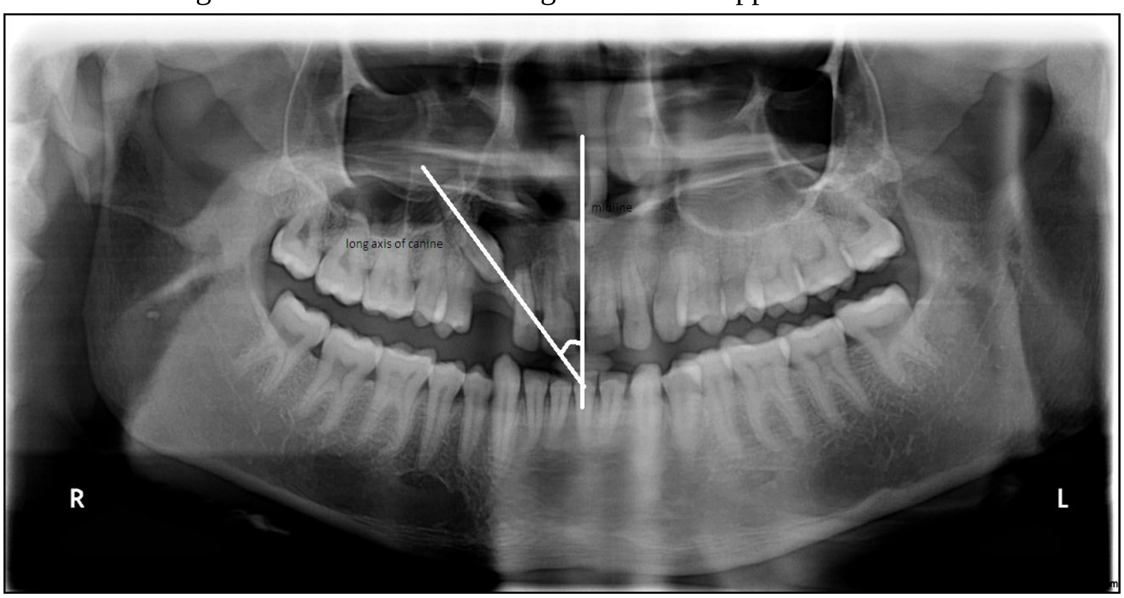


Patient 2

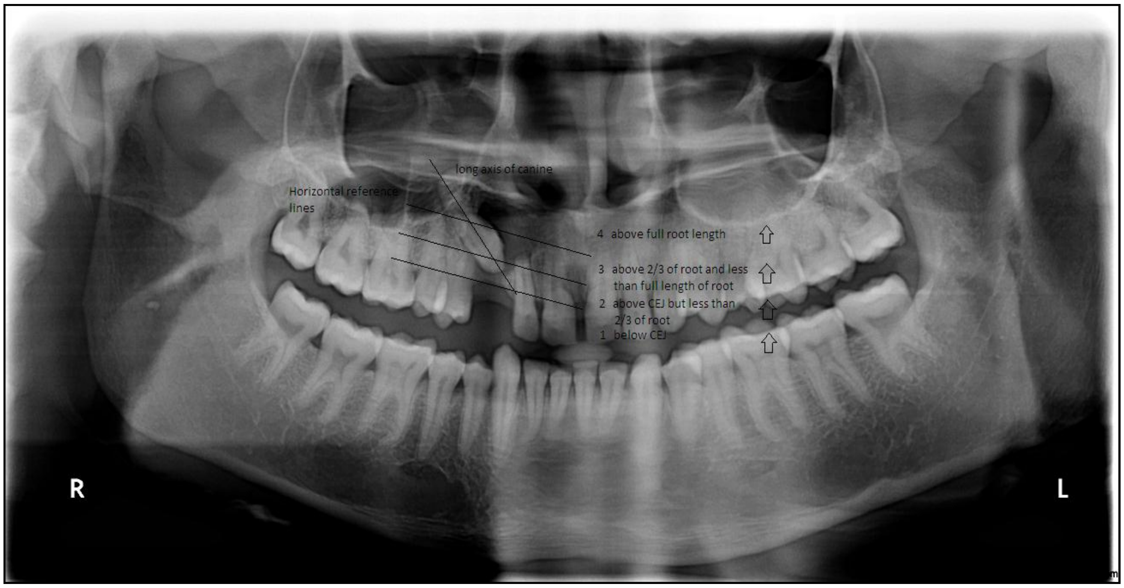
Mr. Prashant 25years /male

Digital Pantomogram

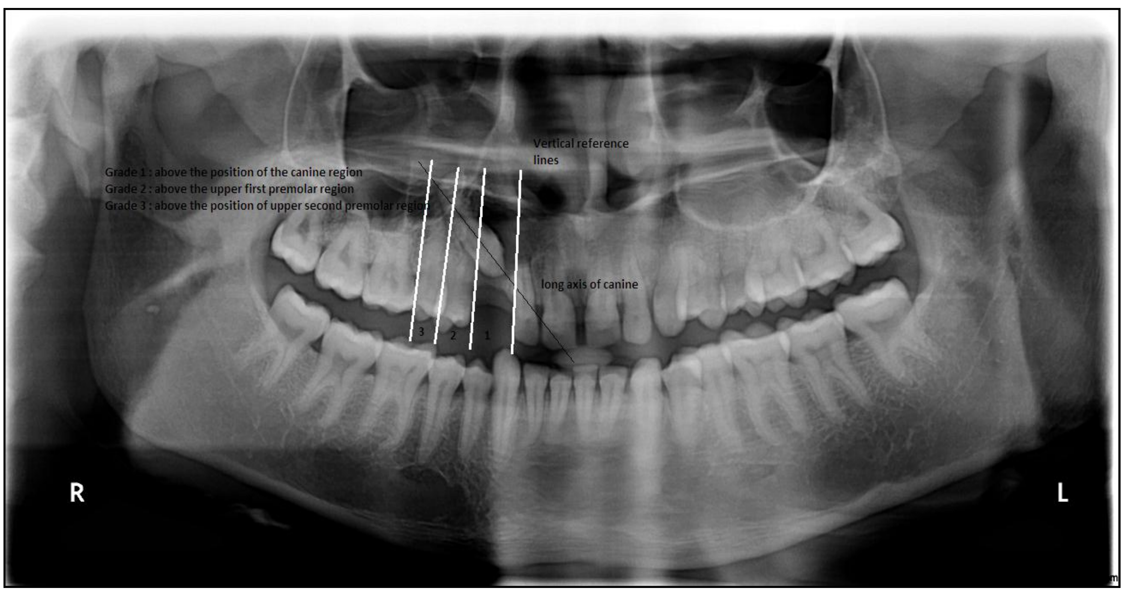
Angulation of the Canine Long Axis to the Upper Midline



Depth of Impaction of Canine Relative to Root of Incisor



Position of Canine Apex Relative to the Adjacent Teeth

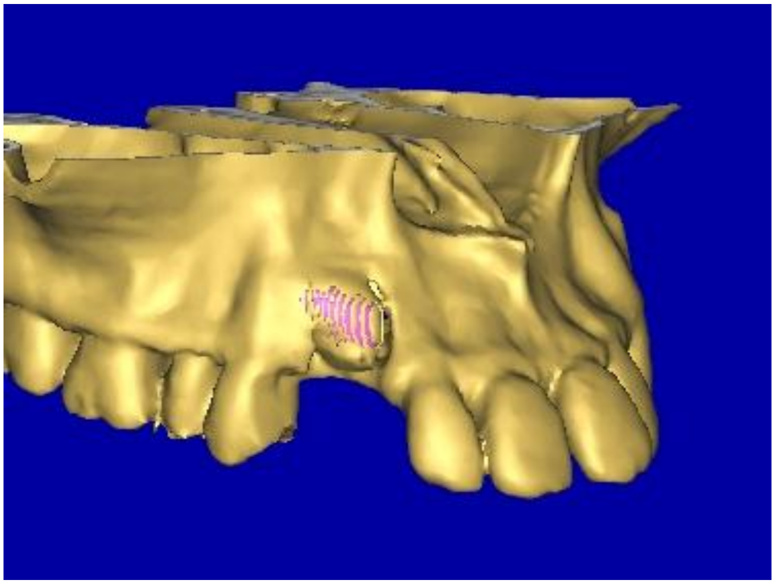


Mesiodistal Positon of Canine Tip

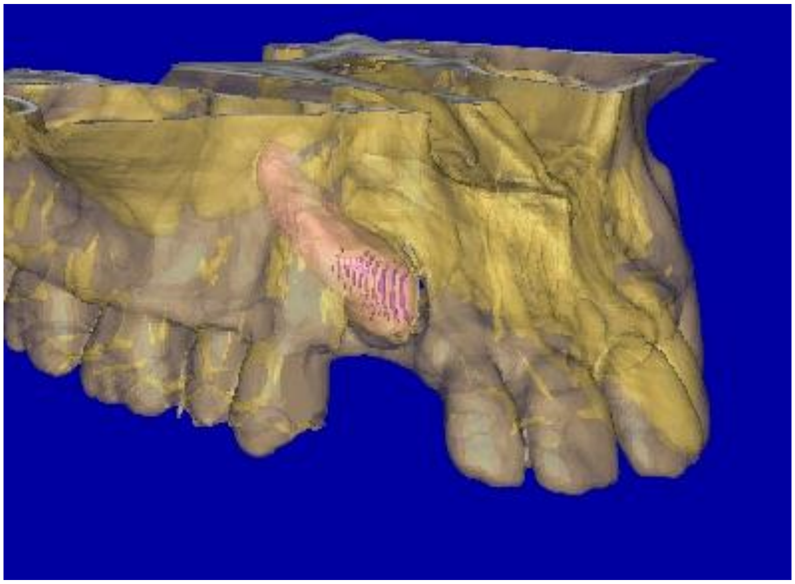
3 Dimensional Reconstructed CT Image

Patient 2

Opaque view



Transparent view

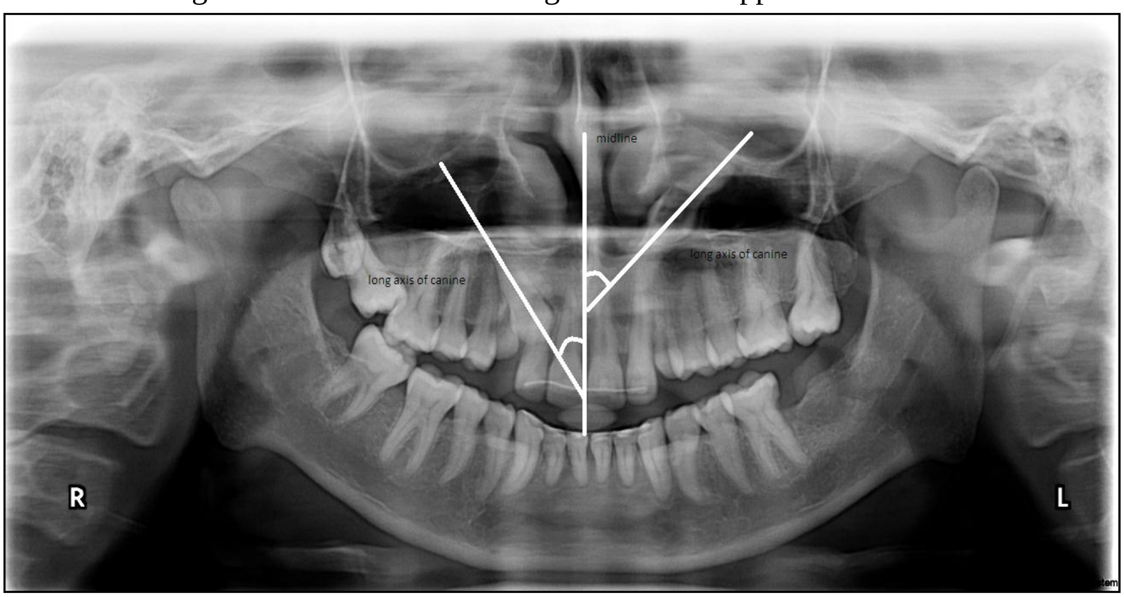


Patient 3

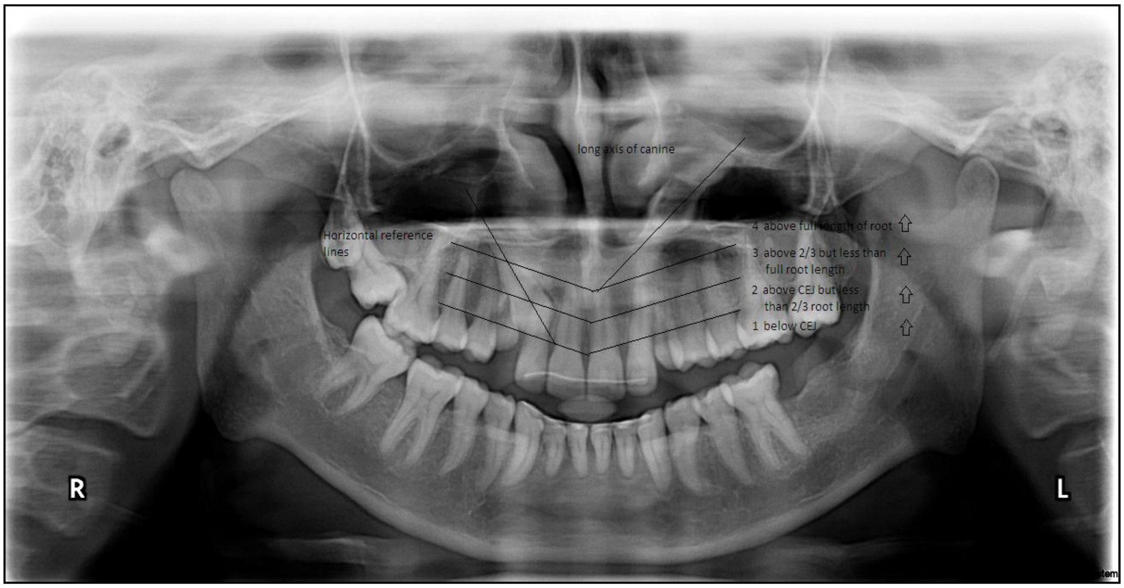
Mr. Harish Babu 27 years/ male

Digital Pantomogram

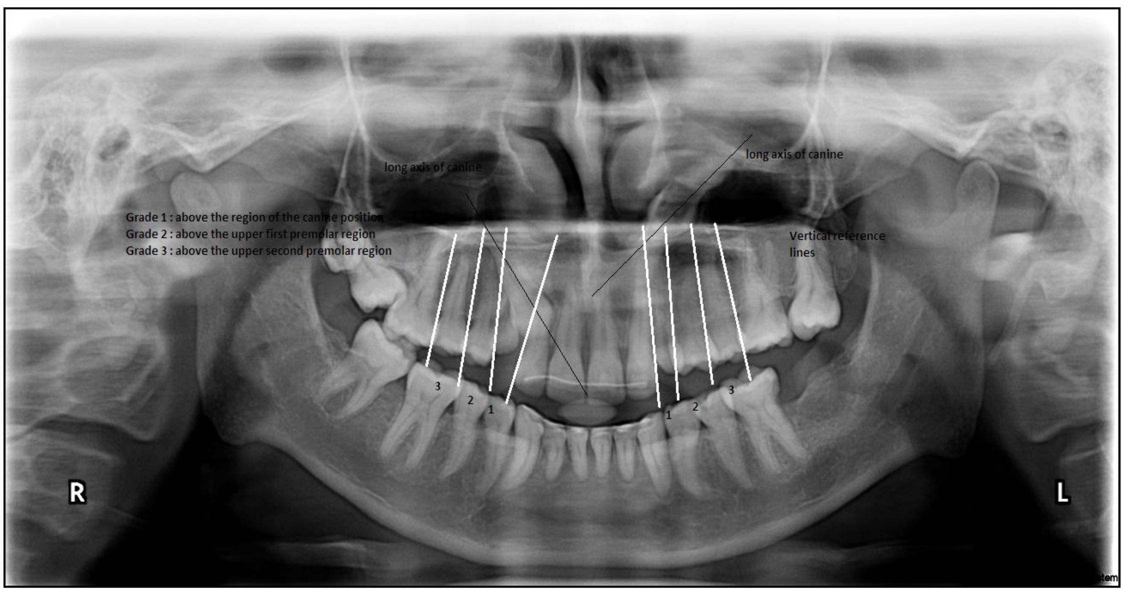
Angulation of the Canine Long Axis to the Upper Midline



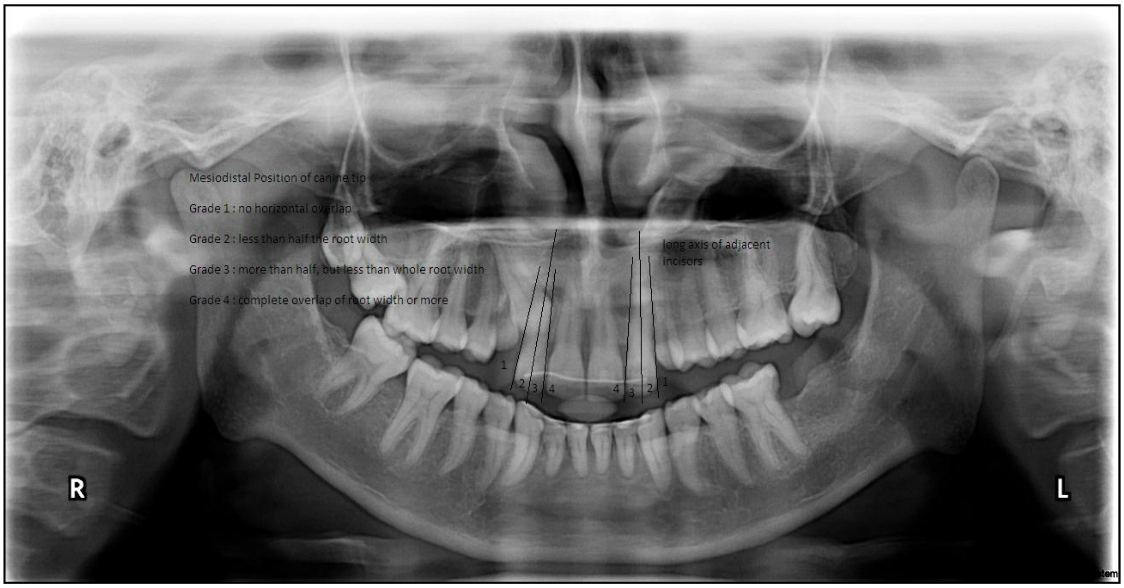
Depth of Impaction of Canine Relative to Root of Incisor



Position of Canine Apex Relative to the Adjacent Teeth



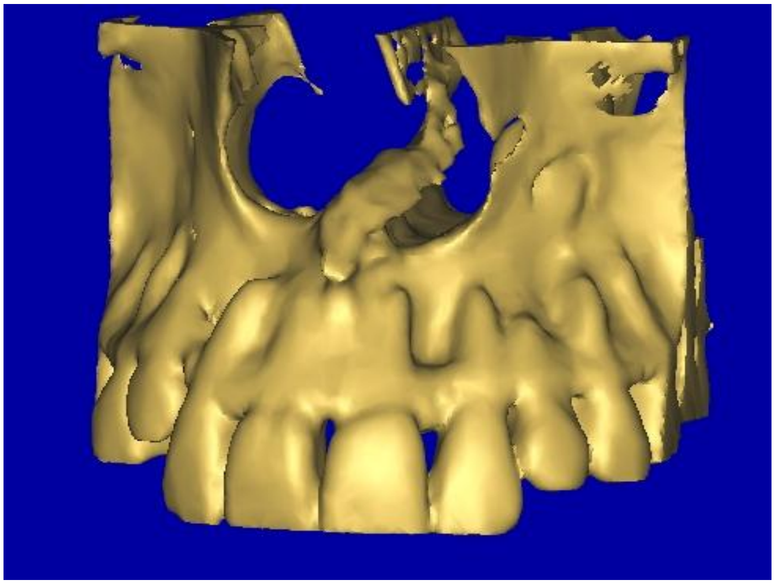
Mesiodistal Positon of Canine Tip



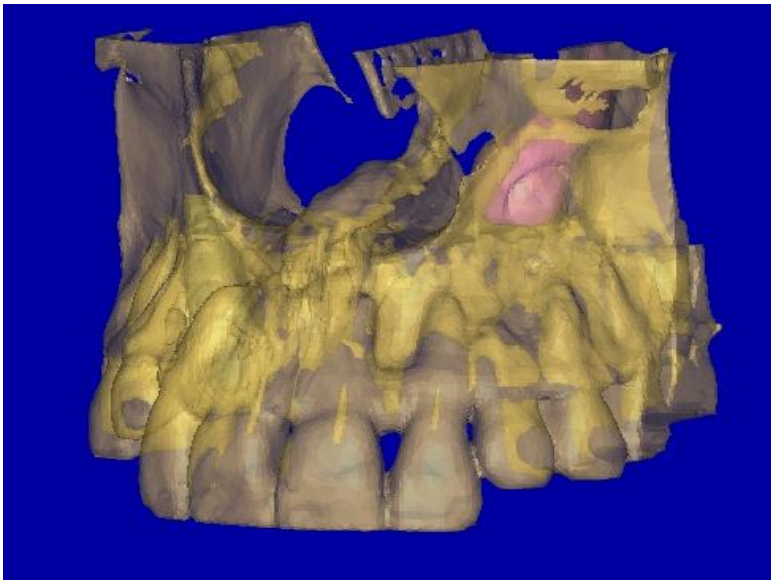
3 Dimensional Reconstructed CT Image

Patient 3

Opaque view



Transparent view

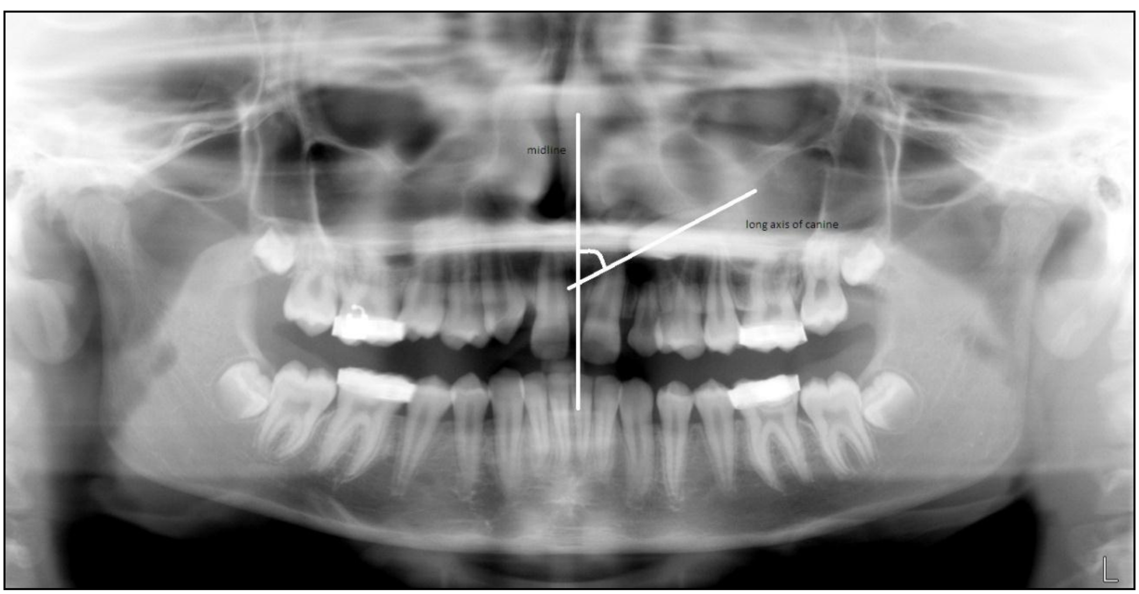


Patient 4

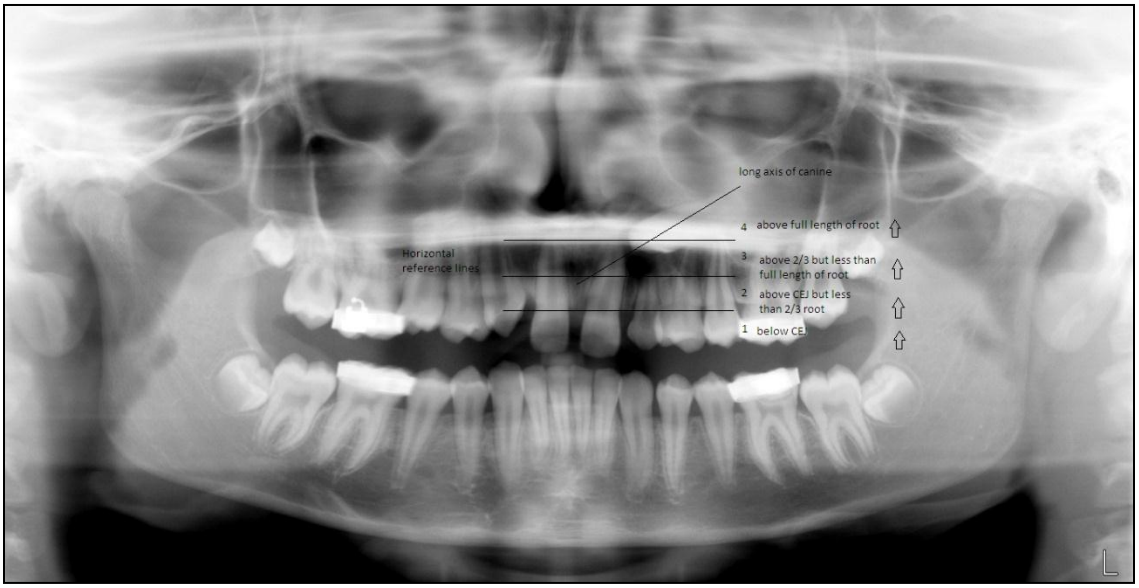
Master Alan   13years/male

Digital Pantomogram

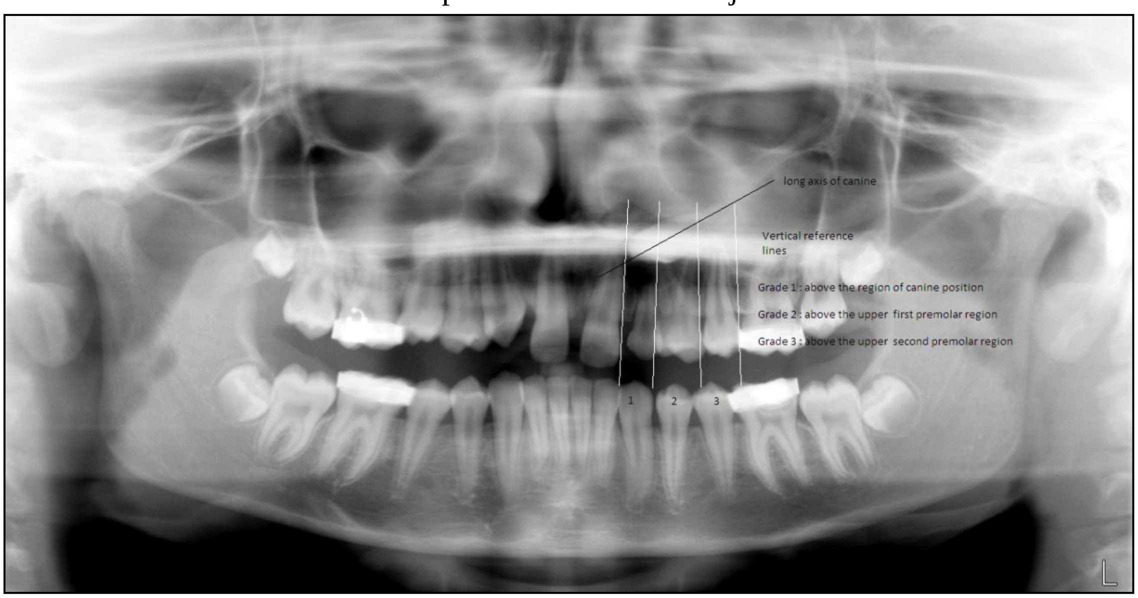
Angulation of the Canine Long Axis to the Upper Midline



Depth of Impaction of Canine Relative to Root of Incisor



Position of Canine Apex Relative to the Adjacent Teeth

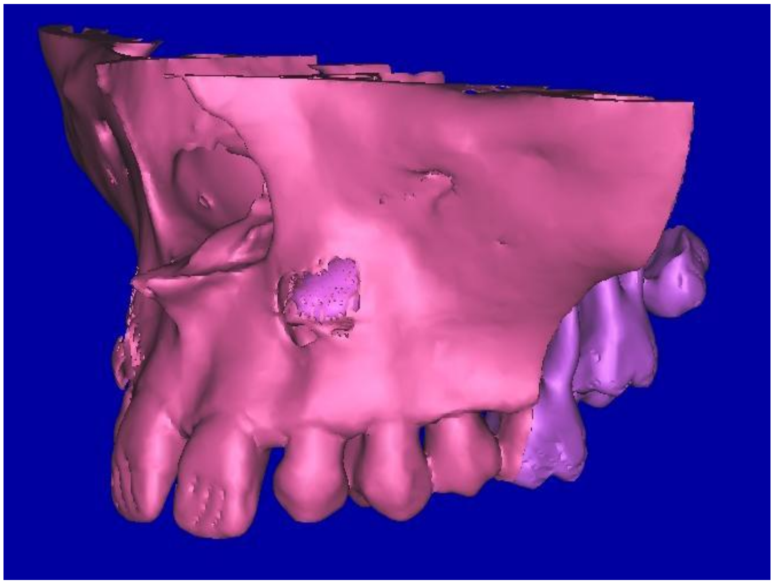


Mesiodistal Positon of Canine Tip

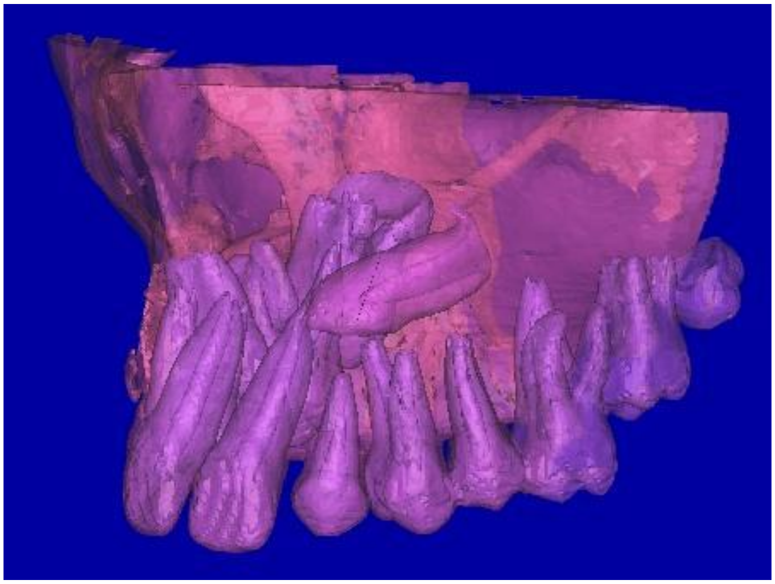
3 Dimensional Reconstructed CT Image

Patient 4

Opaque view



Transparent view

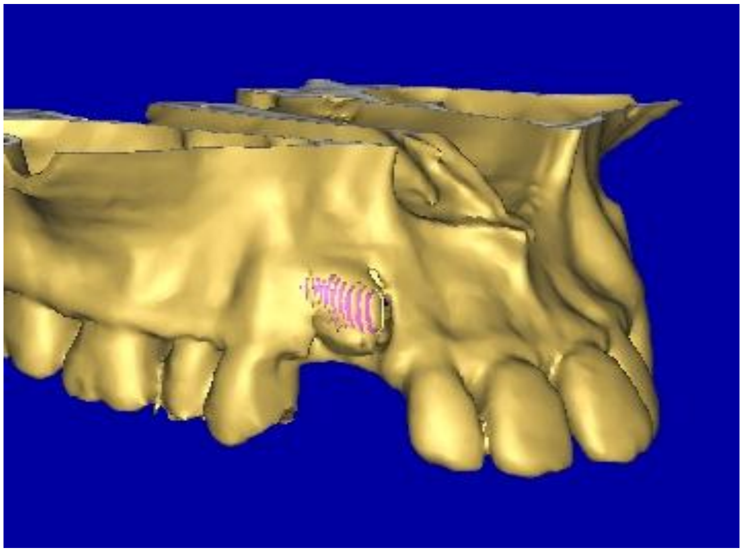


3D-OBJECT RECONSTRUCTION:

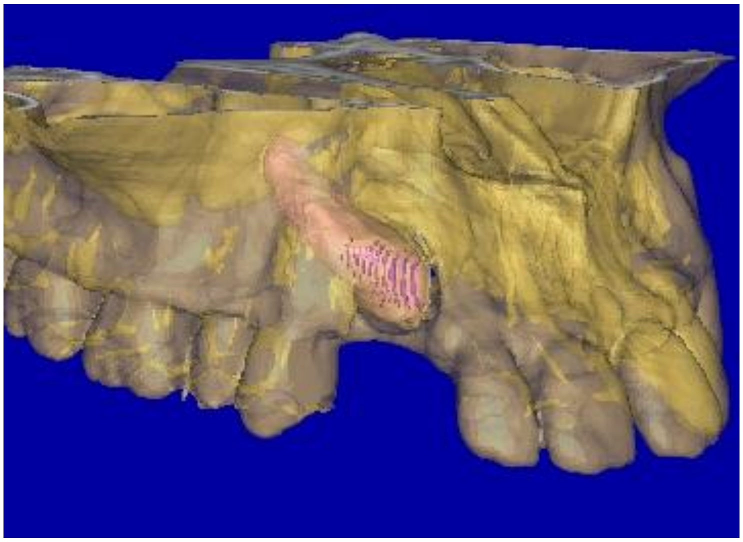
Evaluation of Impacted Maxillary Canine from 3 Dimensional Object Reconstruction

Visualization of impacted maxillary canine in transparency and opaque views

Opaque view

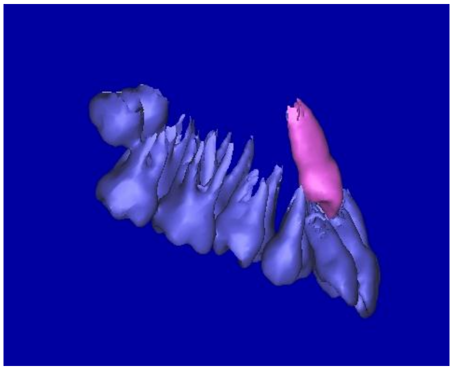


Transparent view

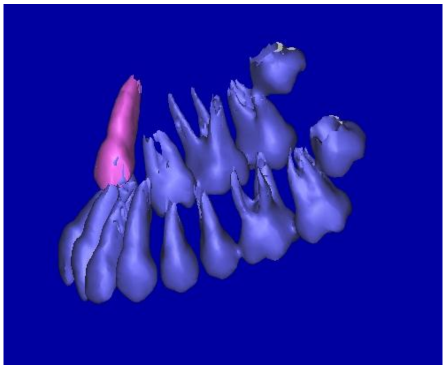


3Dimensional object visualization with rotation in all axis

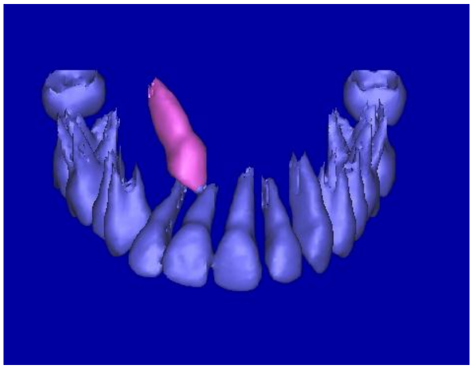
Right side



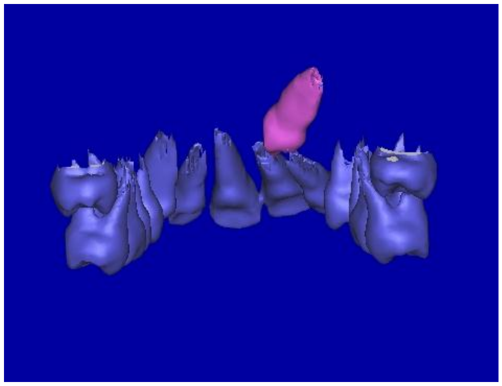
Left view



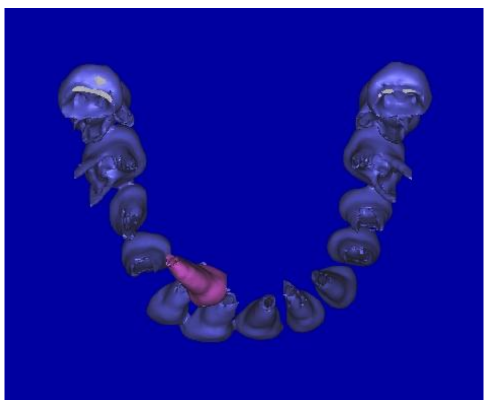
Front view



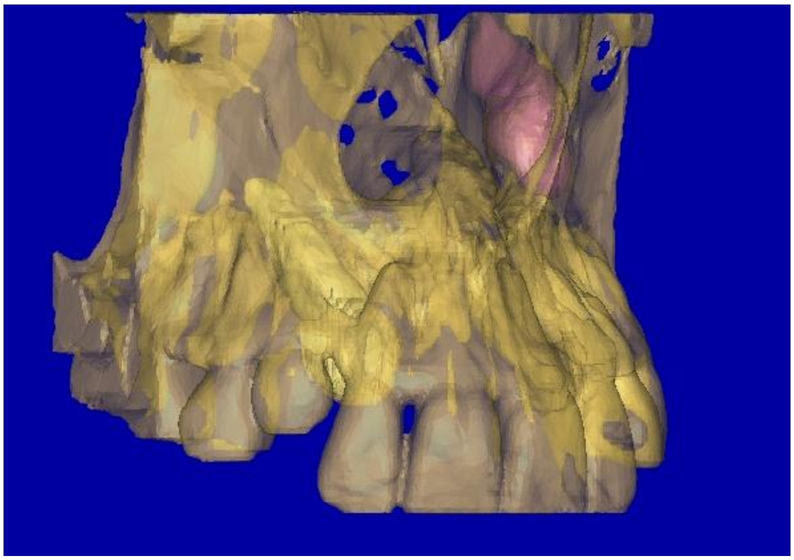
Posterior view

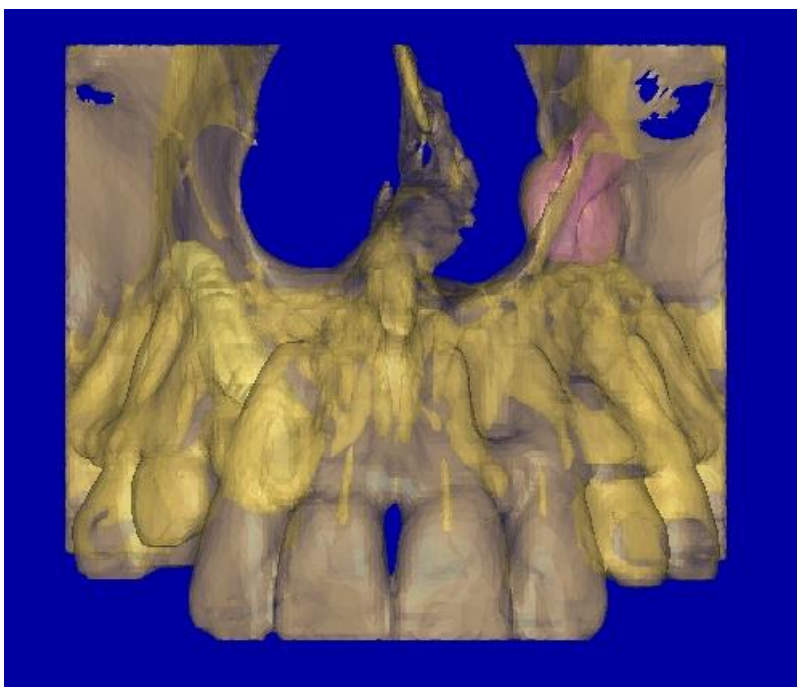


Superior view

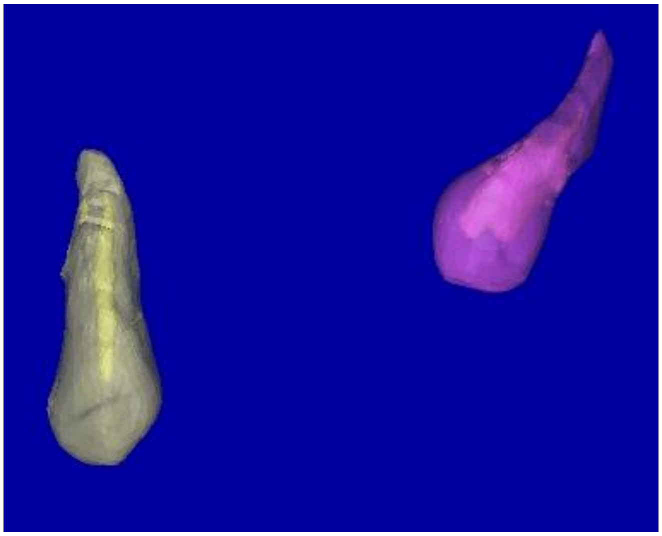


Transparency and separate views of different structures

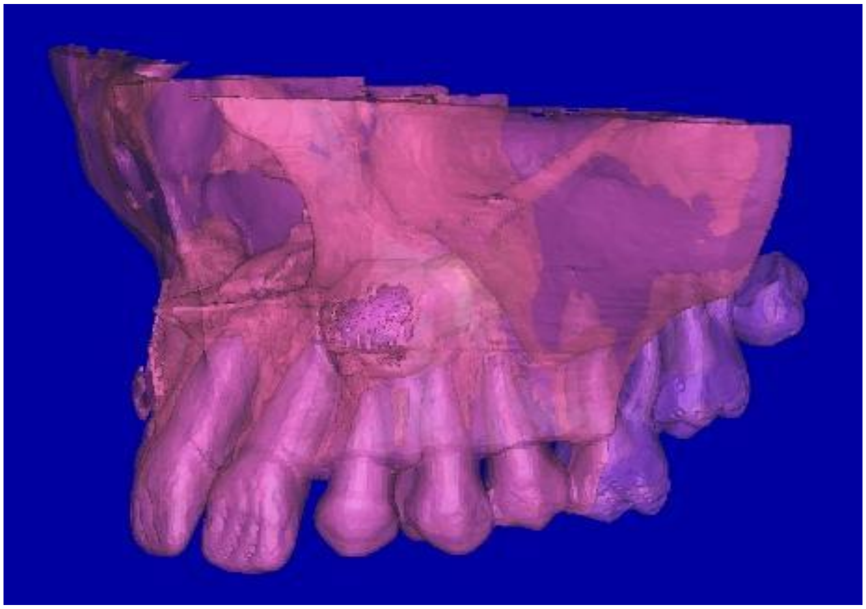


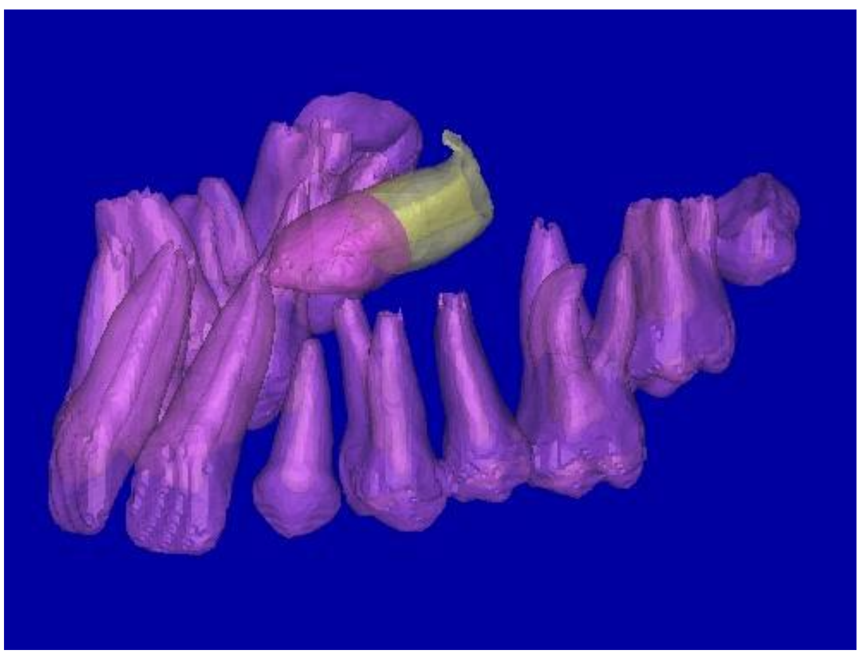


Tooth alone

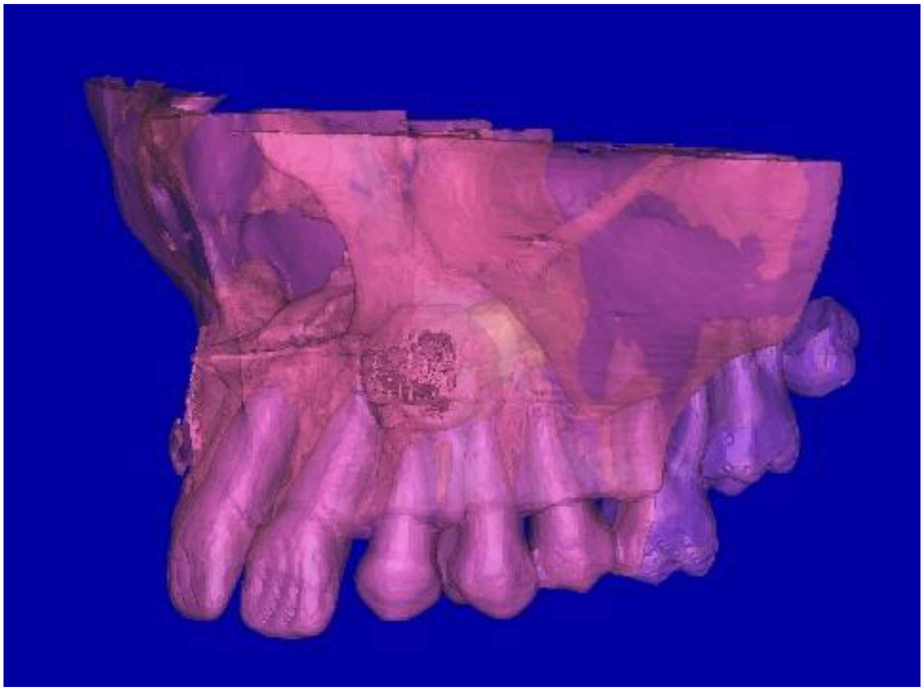


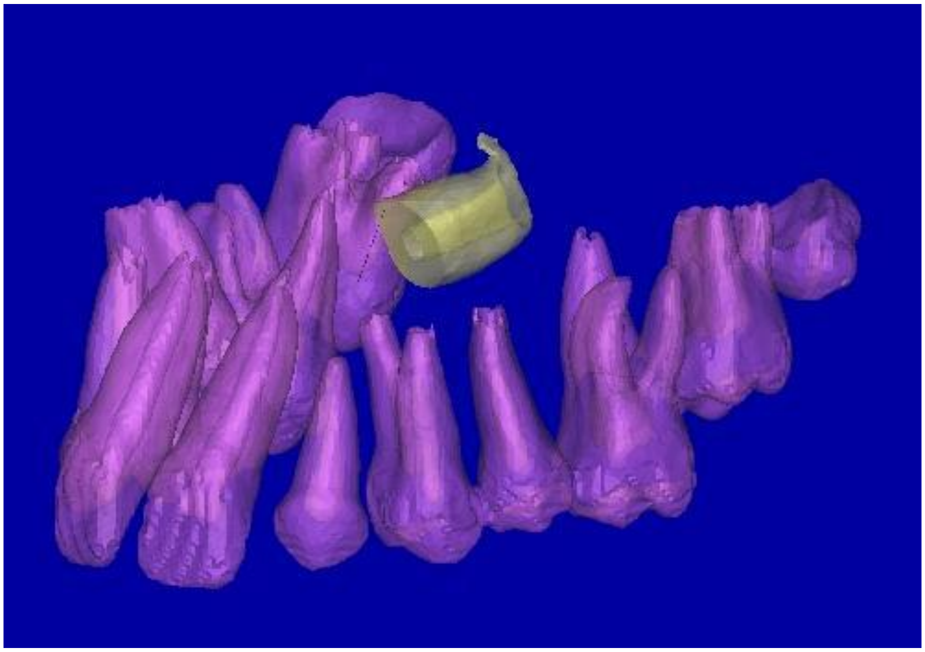
Virtual tooth Sectioning and sectional view of crown and root



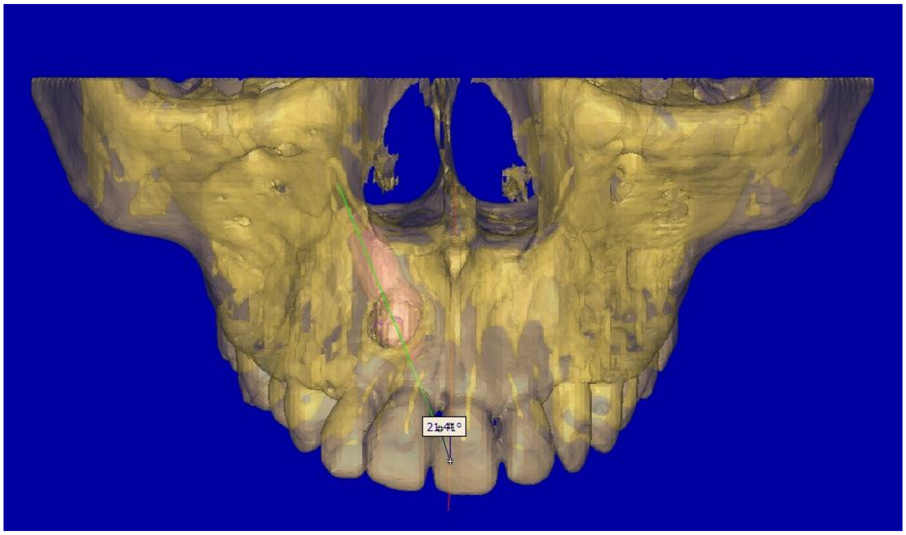


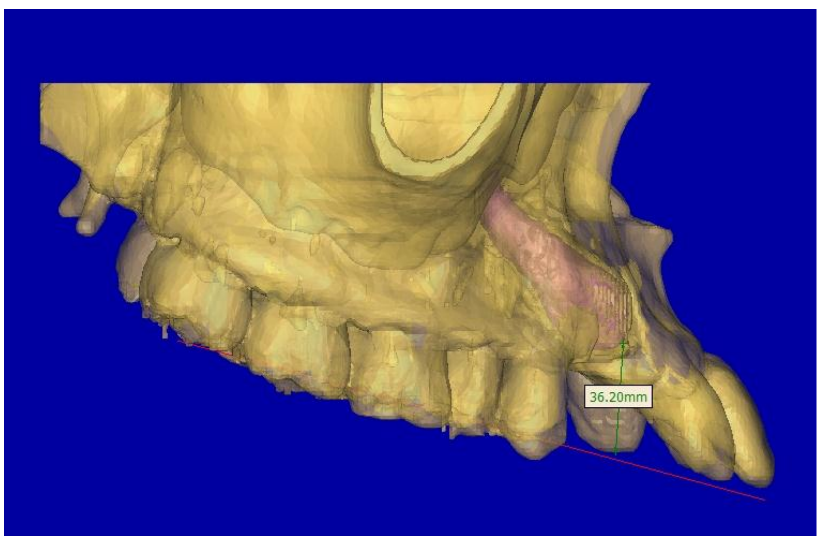
Crown sectioned



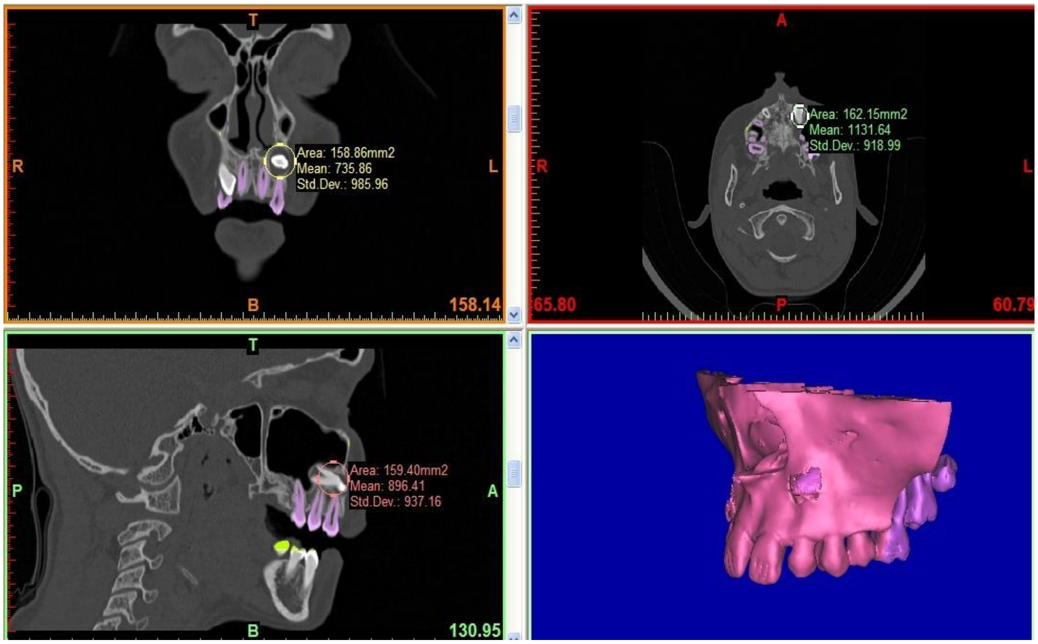


Measuring the distance and angulation

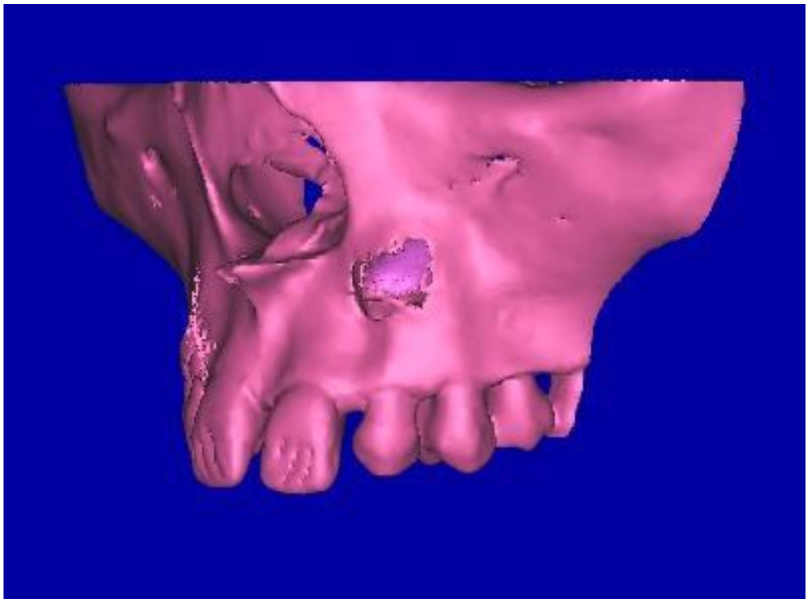


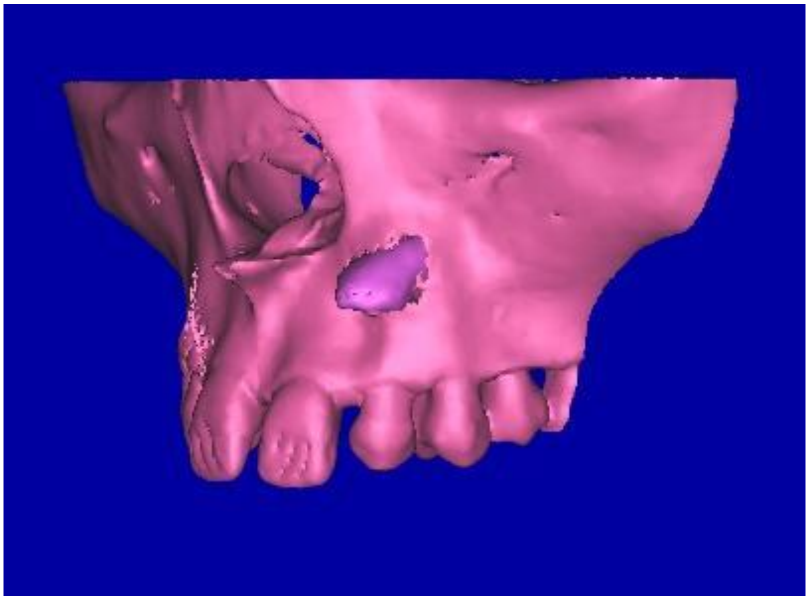


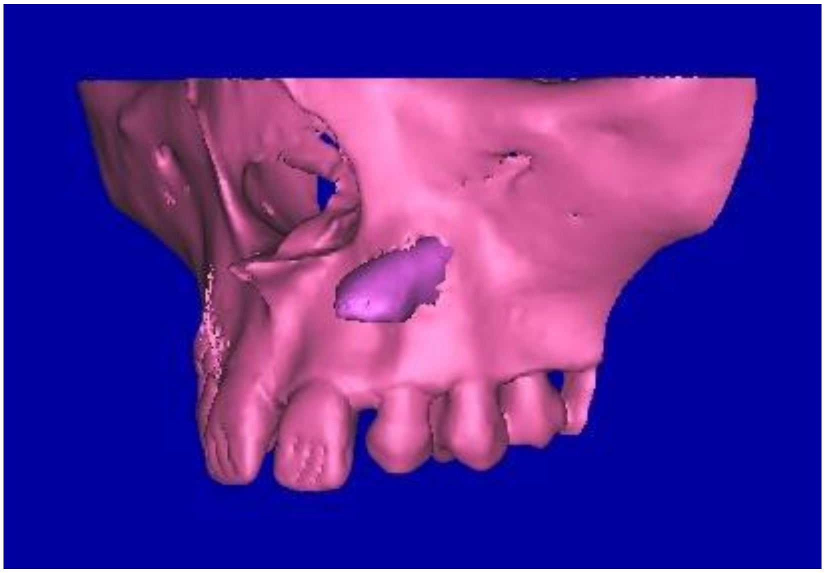
Presence of cortication by accessing the bone density

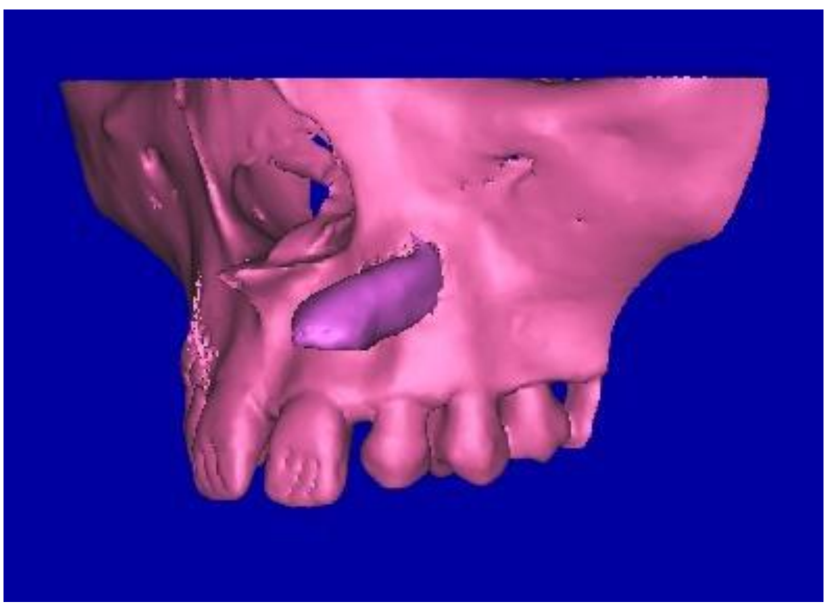


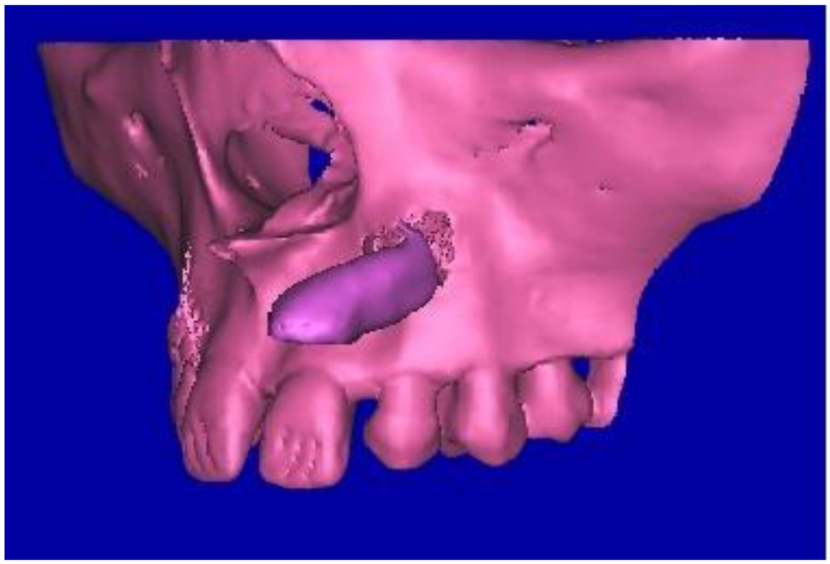
Simulation of tooth movement and path of elevation

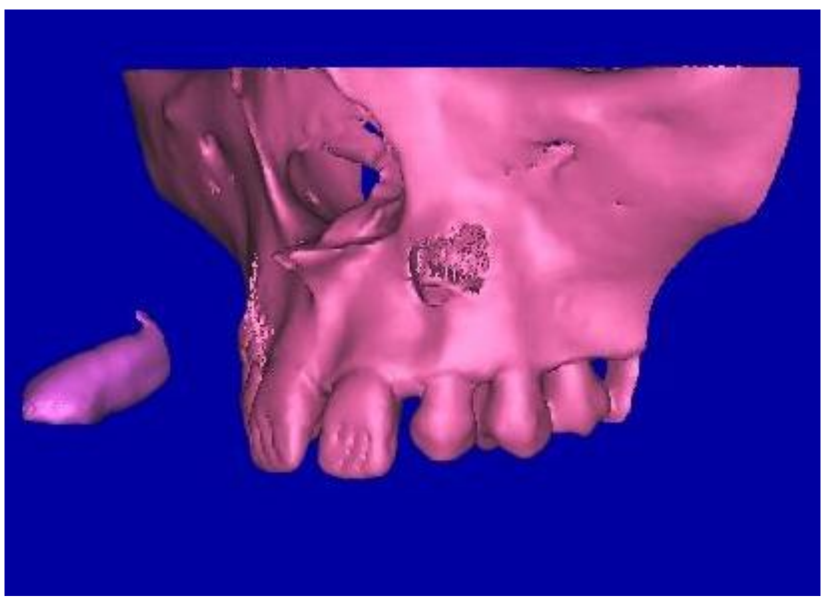






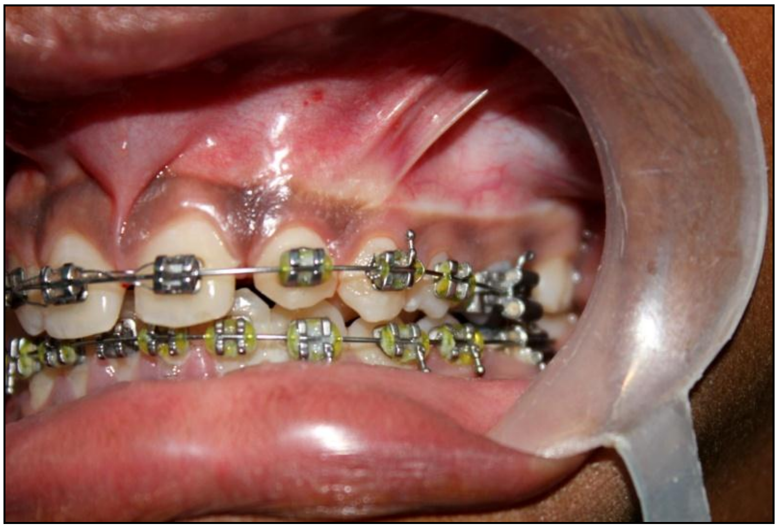




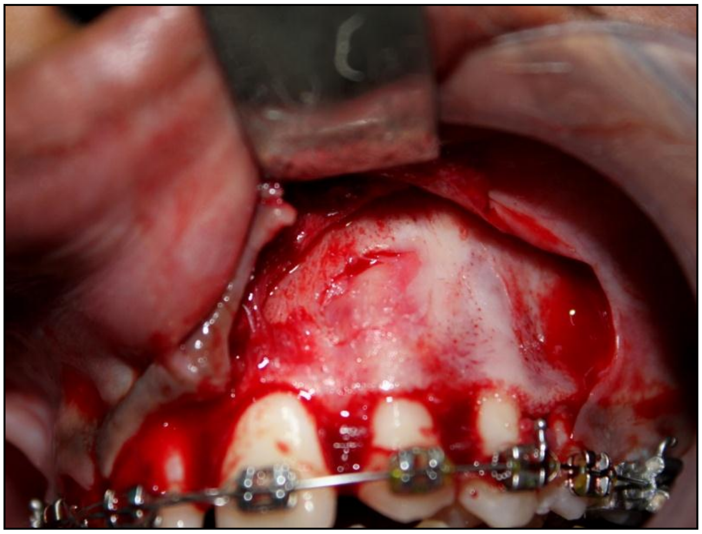


Patient Case –Surgical Extraction

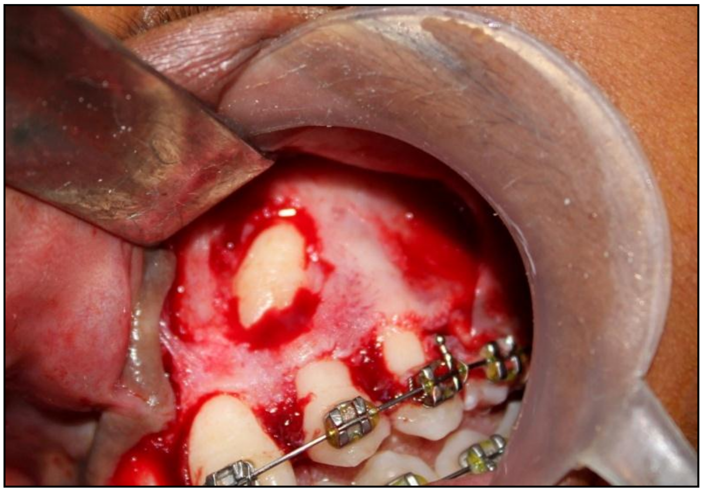
Pre-Surgical Photograph



Incision and Flap Elevation

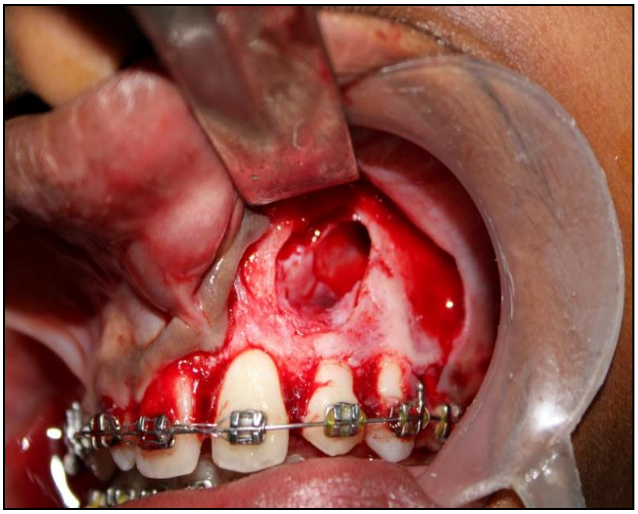


Tooth Exposure

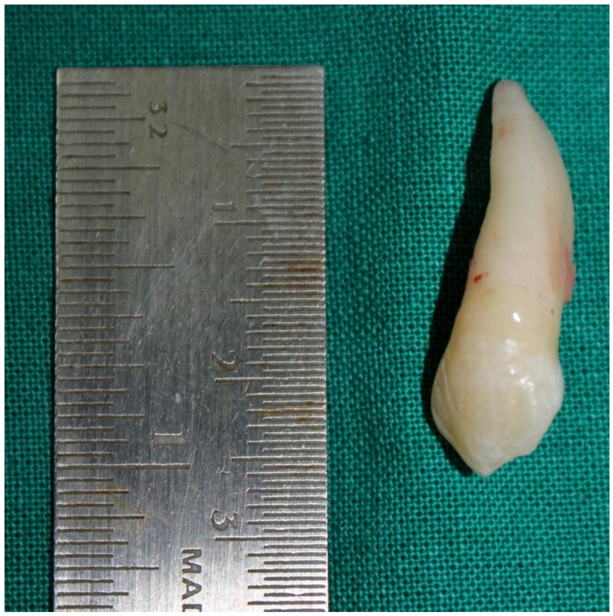


Tooth Elevation and Path of Removal

Extraction of canine with minimal bone removal



Extracted Tooth



Suturing done

DISCUSSION

The position of canine as the corner stone in occlusion and smile always stands as an enigma to the orthodontists and oral maxillofacial surgeons. After the third molars, the maxillary canines are the most commonly impacted permanent teeth. About one third of impacted maxillary canines are positioned labially or within the alveolus, and two thirds are located palatally.[23]

Although, the surgical management of completely impacted maxillary canine is a routine task for most oral surgeons either to expose or extract, certain impactions can be frustrating, with the position, inclination, adjacent tooth and anatomical structures.

Thus, preoperative radiographic assessment is necessary for surgeons to plan operative approaches and its difficulties.

There are several radiographic techniques available to localize impacted maxillary canines. Clark and colleagues popularized the buccal object rule to intra oral periapical dental radiographs to ascertain the position of tooth is buccal or palatel by changing the position of the X ray tube angle in a horizontal pattern.[9,10] Other authorsalso found occlusal radiographs were more reliable for localization of palatally displaced canines but still accuracy and exact relationship to adjacent structure was not well appreciated.[15,24] Lateral cepahalograms were used to analyze the position of palatally placed canines. The vertical distance from the cusp tip to the occlusal plane and the horizontal distance from the cusp tip to A-perpendicular (defined as a line passing through A point and perpendicular to the occlusal plane) as well as the angle between the long axis of the canine and A-perpendicular were measured. But all of these values yielded weak, statistically insignificant correlations.[24]

Conventional digital panoramic radiographs became more popular to determine the location of the impacted maxillary canine. Ericson and Kurol[15] constructed planes on oral pantomograms to localize the position of root and crown of impacted maxillary canines which were later modified and used by several authors, namely Stivaros and Mandal[36] adapted them to evaluate canine angulation to midline, mesio-distal position of the apex, vertical level of the clinical crown, overlapping with the lateral incisor, labio-palatal position of the crown, root resorption of adjacent incisor's. However, sufficient diagnostic information related to accurate anatomy is lacking with this method.[4, 19, 28, and 29]

Digital Panoramic radiograph is not an actual view. It is a projected view. It is a 2-dimensional view and does not show buccolingual direction of both tooth (i.e.; the depth of the radiographic structure in spacial relationships) and its adjacent anatomical structures, exact anatomy of the impacted maxillary canine (i.e., the exact angulation of the tooth and whether the tooth is palatally or buccally tilted) and the palatal side anatomy[19,35] (i.e., orientation and overlapping of maxillary canine with adjacent tooth structures ,if present), lastly the exact relationship between the impacted maxillary canine roots to the nasal floor and maxillary sinus cannot be predicted correctly, but can only be guessed by some predictable radiographic variables using digital pantomographs.[32]

Evaluation and assessment of surgical approach to the impacted maxillary canine tooth and the detailed shape of the tooth and its position might not be clearly evident on a digital panoramic radiograph; this imaging technique provides limited information because it gives only a 2-Dimensional image of an intricate 3-Dimensional anatomic relationship.[27, 33, and 38]

CT-generated images, demonstrated a difference with respect to localization of the canine apex mesio-distally and of both the apex and crown bucco-palatally, vertical localization of the crown, overlap with the lateral incisor, and perception of root resorption when comparing with other analog radiographs. [7] This might be explained by the horizontal distortion, which affects the image of objects located behind or in front of the focal trough on a digital pantomogram image.[39] Anatomical structures located within the focal trough of a panoramic radiograph would appear undistorted, while other objects located in front or behind the sharp line are blurred, magnified, or constricted and sometimes not clearly recognizable.[22]

Clinically, the difference between the two methods concerning the vertical level of the clinical crown would have an influence on the estimated outcome of treatment; the higher the canine position with respect to the occlusal plane, the longer and more difficult treatment. A more cranial localization was identified following 2D evaluation with respect to 3D. (This is in accordance with the findings of Chaushu et al.) (1999)[8] who reported that palatally located canines will be projected higher than labially located canines on a digital pantomogram as the central ray in panoramic radiography is directed from a slight negative angulation of −7 degrees.

The method of examination also influenced the estimation of overlap with the adjacent lateral incisor. A larger overlap was scored on the 3D images. This could be due to the horizontal deformation that affects the digital pantomogram, resulting in an increased dispersion of objects in the horizontal plane.[22] Clinically, in subjects where the overlap is larger, such as in upper anterior crowding, the overlap will appear less severe in two-dimensions.

But the 3D CT image allowed more precise localization with respect to the lateral incisor since axial sections were provided. Information on the exact position of the crown is relevant when performing surgical exposure, while the orthodontist needs to localize the apex to define the vector of traction.

The quality of the images was, as anticipated, assessed positively for the 3D image set. Further improvements in CT and CBCT are occurring both at the hard- and software level. It is however already possible to ameliorate the volumetric data exported in DICOM format by elaboration with other software dedicated to dento-maxillo-facial imaging.

3-Dimensional Object Reconstructions from CT data has opened up new avenues for the diagnosis, evaluation, visualization and treatment planning.[21] Although no dental image processing program has been designed specifically or primarily for use in the evaluation of impacted maxillary canine, 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 and simulation of path of tooth removal. The images are true representation of the jaws, allowing accurate measurements. In one of the patient case

The greatest strength of all these CAD based medical software programs is its ability to display 3-D reconstructed and simulated images; virtual replicas of the bone, teeth 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 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 to the 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.

In one of the patients case No: 4 planned for surgical extraction, localization of the canine was accurate with proper planning for type of incision and flap elevation with good visibility and minimal trauma to tissues and reduced bone removal and retrieval of the impacted tooth in its path of elevation completely with the help of 3 Dimensional object reconstructed data using CT data.

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 and position of the impacted maxillary canine.

SUMMARY AND CONCLUSION

In the case of the impacted maxillary canine, accurate localization of the impacted tooth is vital in diagnosis, treatment planning, and implementation of surgical and orthodontic treatment modalities. The initial position of an impacted canine can affect the duration of orthodontic and surgical treatment, knowledge of which is important to the practitioner and patient.

Conventional Panoramic Radiograph is a projected view, only shows limited information whereas 3-Dimensional Object Reconstruction shows all the information regarding impacted maxillary canine

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. The information given by the 3D reconstructed image from CT data, to mainly evaluate the position of the unerupted impacted canine and its relationship with neighboring structures, which has a strong clinical relevance to justify the risks of the radiation dose.

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