INFLUENCE OF DENTAL CHAIR BACKREST INCLINATION ON THE THREE DIMENSIONAL POSITIONING OF THE MANDIBLE – A CLINICAL TRIAL.

A Dissertation submitted

in partial fulfilment of the requirements

for the degree of

MASTER OF DENTAL SURGERY

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CERTIFICATE

This is to certify that **DR.S.ELAKKIYA**, Post Graduate student (2015-2018) in the Department of Prosthodontics, Adhiparasakthi Dental college and Hospital, Melmaruvathur-603319, has done this dissertation titled **"Influence of dental chair backrest inclination on the three dimensional positioning of the mandible – A Clinical Trial."** under our direct guidance and supervision in partial fulfilment of the regulations laid down by the Tamilnadu Dr. M.G.R medical university, Chennai-600032 for MDS; (Branch –I) Prosthodontics degree examination.

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DECLARATION

TITLE OF THE DISSERTATION	Influence of dental chair backrest inclination on the three dimensional positioning of the mandible – A Clinical Trial.
PLACE OF THE STUDY	Adhiparasakthi Dental College and Hospital, Melmaruvathur-603319.
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I hereby declare that no part of the dissertation will be utilized for gaining financial assistance or any promotion without obtaining prior permission of the Principal, Adhiparasakthi Dental college and Hospital, Melmaruvathur -603319. In addition, I declare that no part of this work will be published either in print or in electronic media without the guides knowledge who have been actively involved in dissertation. The author has the right to reserve for publish work solely with the permission of the principal, Adhiparasakthi Dental college and Hospital, Melmaruvathur-603319.

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ABSTRACT

BACKGROUND:

The maxillo-mandibular component of the craniofacial system consists of a group of organs and tissues that act harmoniously with interdependent mechanism. In conjunction with the neuromuscular system, the temporomandibular joint allows the mandible to perform various movements in the three dimensions. The mandibular position is influenced by various factors and functions like mouth opening, speech and chewing. Patient position and head orientation in the dental chair plays a major role in occlusal rehabilitation. So the head position of the patient plays a major role while recording centric relation and in prosthetic rehabilitation. Thus it is important to identify the influence of backrest inclination, on the registration of the mandibular position during dental treatment procedures.

Aim and Objective:

To study the influence of dental chair backrest inclinations on the 3-Dimentional positioning of the mandible.

Materials and Methods:

Total of 10 subjects with permanent dentition up to second molar with healthy periodontium and normal motor and temporomandibular functions to be selected. The chair was stabilized to check mandibular positions at 2 inclinations: 90°and 180°.To register the mandibular position, inter-occlusal records were made in centric relation for each subject at the said inclinations. Two CBCT were made for each subject with the inter-occlusal records registered at two different inclinations of the dental chair backrest respectively. The CBCT images were analyzed to study the 3-dimentional positioning of the mandible to the temporomandibular joint.

Result:

There was a significant retrusion of the mandible coupled with an upwards and forwards rotation of the mandible. The mandible is also superiorly positioned as seen by the reduction of the intra capsular space.

Conclusion:

It is essential to make registrations of the mandible with the patient seated erect and the chair at 90*, or else a change in mandibular position will complicate rehabilitation.

Key words: Mandibular position, centric relation, Inter-Occlusal record, Dental chair, CBCT, Chair inclination.

CONTENTS

LIST OF PICTURES

LIST OF TABLES

LIST OF CHARTS

INTRODUCTION

The maxillomandibular component of the cranio-maxillary system consists of a group of organs and tissues that act harmoniously with interdependent mechanism. Temporomandibular joint is the only movable joint in the head. In conjunction with the neuromuscular system, the temporomandibular joint allows mandible to perform various movements 3-dimensionally[1,2]. Among the various mandibular positions, the centric relation position, is where there is a state of near physiologic rest as dictated by mandible and the temporomandibular joint and it is determined the ligaments and muscles of mastication[3,4,5]. The mandibular position is influenced by various factors and functions like mouth opening, speech and chewing. The position of the body and head, quality of sleep, psychological factors that alter muscle tone, proprioception, occlusal changes, muscle spasms, and temporomandibular joint dysfunction have all been reported to influence mandibular postural position. Functional and static occlusion can be analysed with casts mounted in articulator. Semi-adjustable articulators, although somewhat limited, are capable of reproducing maxillomandibular relations and are important for diagnosing and planning prosthetic treatment [3].

The great variety of treatments used in modern dentistry makes it necessary for dental chairs to be adjustable so that the dentist can position the patient in the most convenient and comfortable position for each particular treatment. Particular adjustment features should include provision for adjusting the elevation of the chair above the floor, the orientation of the chair, and the inclinations of the seat and backrest portions of the chair. The elevation adjustment mechanism should be as compact as possible without sacrificing strength and safety, so that the dentist's knees can extend under the seat when he is working close to the patient in a seated position. The adjustment mechanism for the seat and backrest inclinations should be interrelated, so that the seat and backrest are always automatically held in the best relative orientation for patient comfort. All adjustment mechanisms should be easy to use and should be as mechanically simple as possible so as to reduce manufacturing and maintenance costs. Finally, the dental chair should be comfortable and should be designed so that it is as easy as possible for the patient to get on and off the chair[6,7,8,9].

Patient position and head orientation in the dental chair plays a major role in occlusal rehabilitation[10,11,12]. In literatures, it has been mentioned that the Frankfort Horizontal plane of the patient should be parallel to the floor while making the occlusal records, which will result in a most reproducible occlusal rehabilitation, as they are made under patient`s physiological rest position of the temporomandibular joints. When there is an alteration between the FH plane and floor parallelism due to change in the back rest angulation of the dental chair, which might influence the temporomandibular joint and thereby the occlusal rehabilitation[13,14].So the head position of the patient plays a major role while recording centric relation and in prosthetic rehabilitation.

IMAGING:

Imaging is an important diagnostic adjunct to the clinical assessment of the dental patient. The introduction of panoramic radiography in the 1960s and its widespread adoption throughout the 1970s and 1980s made major progress in dental radiology, providing clinicians with a single comprehensive image of jaws and maxillofacial structures. However, intraoral and extra oral procedures, used individually or in combination, suffer from the same inherent limitations of all planar two-dimensional (2D) projections: magnification, distortion, superimposition, and misrepresentation of structures. Numerous efforts have been made toward three-dimensional (3D) radiographic imaging (eg, stereoscopy, tuned aperture CT) and although CT has been available, its application in dentistry has been limited because of cost, access, and dose considerations. The introduction of cone-beam computed tomography (CBCT) specifically dedicated to imaging the maxillofacial region heralds a true paradigm shift from a 2D to a 3D approach to data acquisition and image reconstruction. Interest in CBCT from all fields of dentistry is evident because it has created a revolution in maxillofacial imaging, facilitating the transition of dental diagnosis from 2D to 3D images. CBCT is a recent technology. Imaging is accomplished by using a rotating gantry to which an x-ray source and detector are fixed. A divergent pyramidal- or cone-shaped source of ionizing radiation is directed through the middle of the area of interest onto an area x-ray detect or on the opposite side. The x-ray source and detector, rotate around a rotation fulcrum fixed within the centre of the region of interest. During the rotation, multiple (from 150 to more than 600) sequential planar projection images of the field of view (FOV) are acquired in a complete, or sometimes partial, arc. This procedure varies from a traditional medical CT, which uses a fan-shaped x-ray beam in a helical progression to acquire individual image slices of the FOV and then stacks the slices to obtain a 3D representation. Each slice requires a separate scan and separate 2D reconstruction. Because CBCT exposure incorporates the entire FOV, only one rotational sequence of the gantry is necessary to acquire enough data for image reconstruction[15,16,17].

AIMS AND OBJECTIVES

For comfort sake, in 4 handed dentistry, the patient is usually put in supine position to work with. But when jaw relation records are made in this position they might be erraneous. To check the dental chair backrest angulation and its influence on the mandibular position various 2-Dimensional studies have been conducted and the studies concluded that the mandibular position is influenced by the dental chair back rest angulations to certain extent. For further clarification, a 3-Dimentional study of the mandibular position under different dental chair backrest angulations was done. On the basis of clinical observations, it has been hypothesized that the change in the inclination of the chair could lead to a different head inclination and consequently a different mandible position. The purpose of this study was to examine the extent of influence of different chair inclinations (90 degrees and 180 degrees) 3-Dimentionally on the registration of mandibular positions.

GENERAL REVIEW

The rationale of recording Centric Relation records is to establish guidelines as starting point to develop occlusion with artificial teeth in harmony with the various structures of masticatory apparatus including TMJ. It aids to maintain physiologic as well as anatomic health of tissues. When maximum intercuspation is coinciding with centric position, it provides stability to the prosthesis thereby preserving the health of remaining tissues (edentulous foundation, remaining natural teeth, musculature and TMJ)[18,19,20]. An occlusal analysis in relation to the TMJ radiographs will reveal factors that should be added to the purely clinical definition of centric relation. It has been previously established that bilateral asymmetric TMJ spaces and condylar retrusion or protrusion are most often associated with disc derangement and/or palpable muscle spasm. Conversely, bilateral TMJ space symmetry and condylar concentricity (condyle centred in the superior portion of the glenoid fossa) are associated with joint and muscle health. All TMJ radiographs are obtained with the teeth in the acquired centric occlusion[21,22,23,24].Centric relation is considered functional, when the magnitude and direction of the centric relation deflective slide to the acquired centric occlusion correlate with the condylar displacement observed on the TMJ radiographs. For example, if the patient has a 2 mm. deflective slide straight forward, the centric relation is considered functional when the TMJ radiographs reveal equal condylar protrusion proportional to the mandibular deflection. In the judgment of the dentist, the occlusal correction of the deflective contacts will result in bilateral condylar concentricity. Conversely, centric relation is dysfunctional when the magnitude and direction of the centric relation deflective slide to the acquired centric occlusion do not correlate with condylar position in the TMJ radiographs. When no deflective slide is present, both condyles should be concentrically located in each fossa with bilateral symmetrical joint spaces in order for centric relation to be considered functional. Dysfunctional centric relation is often associated with disc derangement and/or palpable muscle spasm. When the centric relation is functional, the most retruded jaw position should be used. If the centric relation is dysfunctional, a therapeutic or treatment centric occlusion must be established by the dentist, utilizing the TMJ radiographs as a guide[25,26,27,28].Centric occlusion is the occlusion of opposing teeth when the mandible is in centric relation. Centric occlusion is the first tooth contact and may or may not coincide with maximum intercuspation. It is also referred to as a person's habitual bite, bite of convenience, or intercuspation position. Centric relation is currently understood as the maxillomandibular relation in which the condyles articulate with the thinner and avascular portion of their respective discs; this set occupies an antero-superior position, against the posterior inclination of the articular eminence. It is considered a position that does not depend on any dental contact and is clinically discernible when the mandible is positioned supero-anteriorly and is restricted to a rotation movement around a transverse horizontal axis[29,30,31].To register these maxillomandibular relations, some techniques use intraoral devices that deprogram muscles to facilitate moving the mandible into various positions according to the planned treatment[32,33].

REVIEW OF LITERATURE

1. Atwood DA. (1966) did a critique of research of the rest position of the mandible and stated that the postural position of the mandible is not a single absolute position, but a range of positions; that the width of the range will vary from individual to individual and within the same individual at different times.J Prosthet Dent 1966; 16:848-54.
2. Weinberg LA. (1983) did a review on the role of stress, occlusion, and condyle position in TMJ dysfunction pain. J Prosthet Dent 1983;49:532-45.
3. Ayub E, Glasheen-Wray M, Kraus S. (1984) did a study on head posture and its effect on the rest position of the mandible and stated that correction of a forward head posture may effect the resting vertical dimension of the mandible. Manual physical therapy techniques were successful in assisting a patient to obtain a desired head to thorax posture as described in the standard posture. J Orthop Sports Phys Ther 1984; 5:179-83.
4. Utt TW et al., (1995) did a three dimensional comparison of condylar position changes between centric relation and centric occlusion using the mandibular position indicator and stated that condylar position is influenced by centric occlusion than centric relation which is statistically significant. Am J OrthodDentofacialOrthop 1995; 107:298-308.
5. Fantini SM, Paiva JB, RinoNeto J, Dominguez GC, Abrão J, Vigoritto JW. (2005) did a study on increase of condylar

displacement between centric relation and maximal habitual intercuspation after occlusal splint therapy and stated that use of occlusal splints results in greater mean condylar displacement values, especially vertically, between CR and MHI positions, which contributed to a more accurate orthodontic diagnosis. Braz Oral Res 2005; 19:176-82.

6. Cordray FE (2006) did a prospective study on three-dimensional analysis of models articulated in the seated condylar position from a deprogrammed asymptomatic population and stated that the neuromuscular deprogramming, registering the SCP/CR and mounting orthodontic study casts in the SCP/CR on a semi adjustable articulator enhance the diagnosis by yielding information that is not available from intraoral visual estimation. Am J OrthodDentofacialOrthop 2006; 129:619-30.

7. Weffort SYK et al., (2010) did a study on condylar displacement between centric relation and maximum intercuspation in symptomatic and asymptomatic individuals and stated that statistically significant differences between CR and MIC were quantifiable at the condylar level in asymptomatic and symptomatic individuals. Angle Orthod 2010; 80:835-42.

8. Okeson JP, de Leeuw R. (2011) did a differential diagnosis of temporomandibular disorders and other orofacial pain disorders and concluded that there are many types of pain conditions that produce orofacial pain. The most common are dental and periodontal pains, some of the other common pain disorders are

musculoskeletal, which in the orofacial structures are called TMD. These disorders need to be identified by the dentist and can be managed by relatively simple strategies. Dental Clin North Am 2011; 55:105-20.

9. Etz E, Hellmann D, Giannakopoulos NN, Schmitter M, RammelsbergP,Schindler HJ. (2012) did a study on the variability of centric jaw relations in the process chain of prosthetic restorations and their neuromuscular effects and stated that the presence of prosthesis in a patients mouth had an effect on the accuracy of the jaw relation records made. J CraniomandFunc 2012:141-56.

10. Fleigel JD et al., (2013) did a study on reliable and repeatable centric relation adjustment of maxillary occlusal device and stated that the occlusal device is now suitable for extended use due to stable centric occlusal tooth contacts and comfortable disclusive angles. Journal of Prosthodontics 2013; 22:233-36.

11. Gomes Lde C, Horta KO, Goncalves JR, Santos-Pinto AD. (2014) did a systematic review on craniocervical posture and craniofacial morphology and concluded that there is signifcant associations were found between variables concerning head posture and craniofacial morphology. Eur J Orthod 2014; 36:55-66.

12. Wiens JP, Priebe JW. (2014) gave a brief description about Occlusal stability in various prosthetic restorations. Dental Clin North Am 2014;58:19-43.

13. Mariana Freire Coelho *et al.*, (2015) did a study on influence of dental chair backrest inclination on the registration of the mandibular position and stated that mandibular position is influenced by increasing inclination, and this influence was statistically significant at a 180 degree incline. Journal Prosthetic Dentistry, November 2015; 114:693-695.

14. Okeson JP. (2013) gave a brief description about the management of temporomandibular disorders and occlusion. 7th edition. St Louis: Mosby; 2013.

15. Dawson PE.(1995) gave a new definition for relating occlusion to varying conditions of the temporomandibular joint. J Prosthet Dent 1995;74:619-27.

16. Sanjay Bansal. (2008) did a review on Critical evaluation of various methods of recording centric jaw relation and concluded that there are many opinions and much confusion concerning Centric Relation records. A certain technique might be required for an unusual situation or a problempatient. In the final analysis, the skill of the dentist and the cooperation of the patient are probably the most important factors in securing an accurate CentricRelation record.The Journal of Indian Prosthodontic Society. December 2008; Vol 8, Issue 4.

17. In-Young Park. (2015) did a study on Three-dimensional cone-beam computed tomography based comparison of condylar position and morphology according to the vertical skeletal pattern and stated thatCondylar position and morphology vary according

to vertical facial morphology. This relationship should be considered for predicting and establishing a proper treatment plan for temporomandibular diseases during orthodontic treatment.Korean J Orthod. 2015 Mar;45(2):66-73.

18. Scarfe, W. C., & Farman, A. G. (2008) gave a brief description about what is cone-beam CT and how does it work? Dental Clinics of North America, *52*(4), 707-730.

MATERIALS AND METHODS

Selection of subjects:

Total of 10 subjects with permanent dentition up to second molar with or without third molar with healthy periodontium and normal motor and temporomandibular functions were selected.

Periodontal health status is evaluated using Russell's periodontal index.

Tooth mobility, motor and temporomandibular functions are evaluated by clinical examination.

Clinical examination of the subjects:

Russell's periodontal index:[34] [picture 1]

Russell developed an index for measuring periodontal disease which can be based solely upon the clinical examination or, it can make use of radiograph.

The subjects teeth were examined clinically using CPITN probe and Russell's periodontal index scores were recorded. The subjects with a score of 0 and 1 were considered to have healthy periodontium and were included in the study.

Checking for Tooth Mobility:[35,36] [picture 2]

Mobility is graded clinically by applying pressure with the ends of 2 metal instruments (e.g. dental mirrors) and trying to rock a tooth gently in a bucco-lingual direction (towards the tongue and outwards again). Using the fingers is not reliable as they are too compressible and will not detect small increases in movement.Normal, physiologic tooth mobility of about 0.25 mm is present in health.

Grace &Smales Mobility Index is the method followed for checking tooth mobility in which index are scored from Grade 0 to 3.

The subjects were examined clinically for teeth mobility and scored using Grace & Smales Mobility Index. The subjects with Grade 0 mobility where only included in the study.

Checking for TMJ function:

INSPECTION [picture 3 & 4]

Facial asymmetry, swelling, masseter or temporalis muscle hypertrophy muscle Assessment of range of mandibular movements: maximum mouth opening, lateral movement , deviation while opening , protrusive movement The maximum opening distance between the incisal edges of upper and lower incisor is measured using scale. Normal opening – 40 to 55 mm. Normal opening can also be estimated by patient’s own finger. Normal: three finger end on end ,Two finger opening reveals reduction in opening but not necessarily reduction in function, One finger opening indicates reduced function[37,38].

LATERAL RANGE OF MOVEMENT

Normal lateral range of movement is >7mm Measurements are made with teeth slightly separated, measuring the displacement of lower midline from maxillary midline.[39]

PALPATION: [picture 5]

The lateral aspect of TMJ Palpate directly over the joint while the patient opens and the mandible, and the extent of mandibular condylar movement can be assessed. Normally, condylar movement is easily felt. Have the patient close slowly, and you will feel the condyle move posteriorly against your finger. Opening involves two motions. First, the mandibular condyle rotates anteriorly on the disk. Second, the condyle and the disk both glide anteriorly and inferiorly over the articular tubercle of the temporal bone.[40]

AUSCULTATION:

JOINT SOUNDS:

There are 2 types of joint sound to look out for: Clicks - single explosive noise of short duration. Crepitus - continuous 'grating' noise.

CLICKS: A joint click probably represents the sudden distraction of 2 wet surfaces, symptomatic of some kind of disc displacement. The timing of a click is also significant: a click heard later in the opening cycle may represent a greater degree of disc displacement. Clicks may frequently be felt as well as heard, though they are not normally painful.

CREPITUS: Crepitus is the continuous noise during movement of the joint, caused by the articulatory surfaces of the joint being worn. This occurs most commonly in patients with degenerative joint disease. The joint sounds should be listened to with a stethoscope.[41]

Inclusion Criteria:

I. Both male and female subjects aged between 18 to 25 years with complete permanent dentition up to second molars.

II. Subject with normal motor and temporomandibular functions.

III. Subject with healthy periodontium.

Exclusion Criteria:

I. Subjects below 18 and above 30 years of age

II. Subject with edentulous space.

III. Subject with compromised motor functions

IV. Subject with tooth mobility, and

V. Subject with temporomandibular disorders.

Methodology:

Positioning of the chair:

1. Dental chair with a fixed headrest accompanied with the inclination of the backrest. To standardize the angles to be used in the study, a protractor was adapted and positioned on the axis connecting the chair’s backrest to its seat.
2. The chair was stabilized to check mandibular positions at 2 inclinations: 90° and 180°.

To register the occlusal contacts, inter-occlusal records were made in centric relation for each subject at various inclinations as mentioned above. [picture 6&7]

Making of Deprogramming device:

Method followed for making inter-occlusal records:

Maxillary impression were made with alginate and cast is poured using dental stone. The deprogrammer was made using clear self-cure acrylic material in the upper central incisors of the cast and it is finished and polished. The deprogramming device should be trimmed in such a way that it separates the maxillary and mandibular teeth from occlusion by about 4 to 5mm. The lower slopes of the deprogrammer should be trimmed to 45 angulation to that of the mandibular incisors. So that, it guides the mandible in a backwards and posteriorly direction. [picture 8] The subjects were instructed to wear the deprogrammer for 10 minutes. Which will prevent the maxillary and mandibular teeth from contact and thereby the engram is lost. Now the temporomandibular joint was guided to centric relation for obtaining occlusal record by the operator.

Positioning the jaw in centric relation: [picture 9]

The operator guided the mandible into a posterior position, applying slight pressure. Using three fingers of one hand, moderate, inclined pressure was applied to the chin. During this procedure, the test subjects were asked to place the tongue in the dorsal direction against the palate as far as possible.

The AlphaBite Bite registration material was the material used for making inter-occlusal records.

AlphaBite Bite registration material:[42] [picture 10]

Danville Materials offers AlphaBite™, a bite registration material made with the highest quality fillers and silicones. AlphaBite is nonsticky, highly stable, and accurate. AlphaBite's working time is 30 seconds, with a total set time of 90 seconds. The material comes in 50ml cartridges in two-packs and four-packs.

After deprogramming, the subjects were asked to sit in the dental chair in upright position and relax. Now the dental chair backrest was adjusted to 90 degree angulation and the subjects Frankfort horizontal plane is made parallel with the floor and AlphaBite™ bite registration material was injected over the entire occlusal and incisal surface of the mandible and the mandible was guided to centric relation position by the operator and the subject was instructed to bite on the bite registration material in the retruded mandibular position until it sets completely. Now the dental chair backrest was adjusted to 180 and the bite registration was done in centric same as in 90 angulation position.

Making of the jaw relation record: [picture 11a & 11b]

Procedure of making the Centric jaw relation:

The subject was asked to sit straight and relaxed. In this position, the occlusal records were made using AlphaBite Bite registration material. The material was injected over the mandibular occlusal and incisal surface and the mandible was guided to centric relation and the subject was asked to bite with the bite registration material in place. The thickness of the bite registration material was restricted to 4 ± 2 mm for all the samples.

Making of the CBCT images: [picture 12]

Two CBCT was made for each subject.

1. First CBCT was made with the inter-occlusal record made at 90. The subject was instructed to bite on the occlusal record in position and a CBCT was made.
2. Second CBCT was made with the inter-occlusal record made at 180. The subject was instructed to bite on the occlusal record in position and a CBCT was made.

Cone beam computed tomography (CBCT) has been widely accepted for clinical application in dentistry. But, the radiation dose of CBCT to patient has also caused broad concern. According to the literature, the effective radiation doses of CBCTs in market fall into a wide range that is from 19 μSv to 1073 μSv [19]. [picture 13 & 14]

Considering the radiation exposure to the patient, the following steps can be implicated

- To reduce the patient dose to the greatest possible extent, the chosen CBCT scanning protocol should be in accordance with the diagnostic task at hand;
- A thyroid collar should be used for CBCT scanning; wearing leaded glasses is recommended when it does not detract from imaging quality.

Studying the CBCT images:

The CBCT images was analyzed to study the 3-dimentional positioning of the mandible to the temporomandibular joint.

The following points were marked in the CBCT:

1. Sella

2. Nasion
3. Gonion
4. Gnathion
5. Porion
6. MB cusp of mandibular 1st molar.

Brief description about each point[43]:

Sella – it is the point in the midpoint of Pituitary Fossa.

Nasion- it is the anterior most point on frontonasal suture.

Gonion-Most posterior inferior point on angle of mandible.Can also be constructed by bisecting the angle formed by intersection of mandibular plane and posterior border of ramus of mandible.

Gnathion-Point located perpendicular on mandibular symphysis midway between pogonion and menton.

Porion-Most superior point of outline of external auditory meatus.

Planes to be studied:

1. Sella-Nasion (SN) Plane.
2. Gonion-Gnathion (Go-Gn) Plane.
3. FH plane. (Po-Po)
4. Inter molar plane.

Brief description about each angle[44,45]:

Sella-Nasion (SN) Plane- This plane is represents the anterior cranial base and is formed by connecting Sella to Nasion.

Gonion-Gnathion (Go-Gn) Plane- This plane represents the mandibular base and is formed by connecting gonion and gnathion.

FH plane (Po-Po)-This plane represents the habitual postural position of the head. This is formed by connecting the porion on either side of the skull.

Inter molar plane- this is formed by connecting the intra-arch mesio-buccal cusp tip of the mandibular 1^{st} molars.

Angles to be read:

The angle formed between SN plane and Go-Gn planes.

The angle formed between FH plane (Po-Po) to Inter Molar plane.

The following measurements are made in the two different CBCT for each subject and compared

1. The mandibular plane angle as measured by SN-Go-Gn angle.
2. Roll as measured by FH plane (Po-Po) to Inter Molar plane.

Joint space Measurement in centric relation:

Measurements were made in the anterior, superior and posterior joint space between the condylar head and glenoid fossa. Anterior, Superior and Posterior joint spacewere measured in sagittal plane.The measured values were tabulated for each subject to know the difference in mandibular position at 90 and 180 inclinations of the dental chair backrest.

Overjet Measurement: [picture 15]

The amount of overjet between the maxillary central incisor and mandibular central incisor in centric relation was measured using a scale at 90^0 and 180^0dental chair backrest angulation.

RESULT

CBCT analysis was done using "CareStream 3D Imaging software" for the following planes and the data obtained were charted. The values obtained from the CBCT analysis were shown in table 1.

Rotation of the Mandible: [picture 16]

The mandibular plane angle was measured between two planes, SN and Go-Gn planes. These two planes intersect to form the mandibular plane angle. This analysis was done for all the 20 CBCT and the values were entered as Table 2. The mean and SD for subjects at 90 angulation was found to be 32.700 and 1.8886 respectively and the mean and SD for subjects at 180 angulation was found to be 31.800 and 1.6193 respectively.

Roll of the Mandible: [picture 17]

The relationship between the Occlusal plane and the base of the skull is measured using the angle formed between the two plane FH Plane (Po-Po) and the inter-molar plane (mesio-buccal cusp tip of mandible molar on 1 quadrant to the mesio-buccal cusp tip of mandibular molar on the other quadrant). After marking these two planes in the CBCT the angle between them is measured. The values obtained were entered as shown in Table 3. The mean and SD for all 10 subjects at 90 angulation was found to be 2.100 and 0.9944 respectively and the mean and SD for all the 10 subjects at 180 angulation was found to be 2.800 and 1.1353 respectively.

Change in Intra Capsular Space: [picture 18]

The space between the condylar head and glenoid fossa was measured using CareStream3D Imaging software and the anterior, superior and posterior joint space were measured and charted separately. The Table 4 [a,b,c], shows the anterior, middle and posterior joint space measurements between the glenoid fossa and the condylar head.

Anterior Space:

The anterior joint space measurement is charted in Table 4a. The mean and SD for subjects at 90 angulation was found to be 2.590 and 0.8020 respectively and the mean and SD for subjects at 180 angulation was found to be 2.000 and 0.7601 respectively.

Mid-Capsular Space:

The superior or middle joint space measurement is entered in Table 4b. The mean and SD for subjects at 90 angulation was found to be 3.980 and 0.7406 respectively and the mean and SD for subjects at 180 angulation was found to be 3.640 and 0.8140 respectively.

Posterior Joint Space:

The posterior joint space measurement is entered in Table 4c. The mean and SD for subjects at 90 angulation was found to be 3.440 and 1.3826 respectively and the mean and SD for subjects at 180 angulation was found to be 2.940 and 1.2429 respectively.

Overjet:

Amount of overjet at 90 and 180 angulation was recorded in Table 5. The mean and SD for subjects at 90 angulation was found to be 3.3 and 1.4944 respectively and the mean and SD for subjects at 180 angulation was found to be 5.6 and 2.0111 respectively.

Statistical Analysis:

Statistical analysis was done using SPSS 17 software. The values obtained where checked for normality and it followed a normal curve distribution. So, paired samples T-Test was used to compare the values between 90° and 180°.

According to Table 2, the mean and SD for all 10 subjects at 90 angulation was found to be 32.700 and 1.8886 respectively and the mean and SD for all the 10 subjects at 180 angulation was found to be 31.800 and 1.6193 respectively. These values were compared using paired t-test and the paired difference between 90 and 180 angulation was analysed. The calculated Mean and SD is 0.9000 and 0.9944 respectively with 95% confidence interval (table 6). So it can be said that the mean will fall in-between 0.1886 to 1.6114 for all the pairs. The P-Value was found to be 0.019 which is statistically significant.

According to Table 3, the mean and SD for all 10 subjects at 90 angulation was found to be 2.100 and 0.9944 respectively and the mean and SD for all the 10 subjects at 180 angulation was found to be 2.800 and 1.1353 respectively. These values were compared using paired t-test and the paired difference between 90 and 180 angulation was analysed. The calculated Mean and SD is -0.7000 and 0.6749 respectively with 95% confidence interval (table 6). So it can be said that the mean will fall in-between -1.1828 to -0.2172 for all the pairs. The P-Value was found to be 0.010 which is statistically significant.

According to Table4a, the mean and SD for all 10 subjects at 90 angulation was found to be 2.590 and 0.8020 respectively and the mean and SD for all the 10 subjects at 180 angulation was found to be 2.000 and 0.7601 respectively. These values were compared using paired t-test and the paired difference between 90 and 180 angulation was analysed. The calculated Mean and SD is 0.5900 and 0.2807 respectively with 95% confidence interval (table 6). So it can be said that the mean will fall in-between 0.3892 to 0.7908 for all the pairs. The P-Value was found to be <0.001 which is statistically significant.

According to Table4b, the mean and SD for all 10 subjects at 90 angulation was found to be 3.980 and 0.7406 respectively and the mean and SD for all the 10 subjects at 180 angulation was found to be 3.640 and 0.8140 respectively. These values were compared using paired t-test and the paired difference between 90 and 180 angulation was analysed. The calculated Mean and SD is 0.3400 and 0.2271 respectively with 95% confidence interval (table 6). So it can be said that the mean will fall in-between 0.1776 to 0.5024 for all the pairs. The P-Value was found to be 0.001 which is statistically significant.

According to Table 4c, the mean and SD for all 10 subjects at 90 angulation was found to be 3.440 and 1.3826 respectively and the mean and SD for all the 10 subjects at 180 angulation was found to be 2.940 and 1.2429 respectively. These values were compared using paired t-test and the paired difference between 90 and 180 angulation was analysed. The calculated Mean and SD is 0.5000 and 0.2789 respectively with 95% confidence interval (table 6). So it can be said that the mean will fall in-between 0.3005 to 0.6995 for all the pairs. The P-Value was found to be <0.001 which is statistically significant.

According to Table5, the mean and SD for all 10 subjects at 90 angulation was found to be 3.3 and 1.4944 respectively and the mean and SD for all the 10 subjects at 180 angulation was found to be 5.6 and 2.0111 respectively. These values were compared using paired t-test and the paired difference between 90 and 180 angulation was analysed. The calculated Mean and SD is -2.30 and 0.335 respectively with 95% confidence interval (table 6). So it can be said that the mean will fall in-between -3.06 to -1.54 for all the pairs. The P-Value was found to be 0.001 which is statistically significant.

DISCUSSION

Maintaining balance in the stomatognathic system is important during occlusal rehabilitation, and a correct centric relation register is a prerequisite for long-term success of the prosthesis.[46,47] There are various techniques available to record accurate centric relation, typically, centric relation is recorded with bimanual manipulation, pushing the condyles up into the fossa (4 fingers underneath the mandibular angle) (functional techniques).In dentistry, centric relation is the mandibular jaw position in which the head of the condyle is situated anteriorly and superiorly within the mandibular fossa/glenoid fossa(muscle and ligament).The reason that centric relation is so important is because it is the repeatable possible position of the condyle- disc assemblies that is achieved by coordinated muscle activity when the jaw is closed.[48,49] Occlusion in Centric is the occlusion of opposing teeth when the mandible is in centric relation. Occlusion in Centric is the first tooth contact and may or may not coincide with maximum intercuspation. Maximum intercuspation is also referred to as a person's habitual bite, bite of convenience, or intercuspation position (ICP).The retruded contact position (RCP) is a relatively reproducible maxillomandibular relationship. It is used as a reference point for mounting casts on an articulator. Occlusion has a biological adaptability and is not constant. Mandibular guidance from the operator has been shown to give more consistent RCP recordings.[50]

This position of condyle in the mandibular fossa is called centric relation. Centric relation can be influenced by various mandibular positions and head position. These variations can be studies clinically for achieving accurate prosthetic rehabilitation. There are various methods available to study the temporomandibular joint position and head position.(Mandibular Position Indicator)[51]

In recent years, cone beam computed tomography is used widely in dentistry which will give a 3-Dimentional analysis.[52]

Technological advances, such as digital imaging systems, have significantly increased the level of detailed information available to the practitioners while mitigating the level of patient radiation exposure. While oral health professionals have long relied on 2-D imaging for diagnosis and treatment planning, this technology typically requires multiple exposures, and with them, multiple doses of radiation.

Today, with a properly prescribed 3-D scan, practitioners have gained the ability to collect much more data – often with a single scan and potentially with a lower effective patient dose. With cone beam computed tomography, oral health professionals gain a highly accurate 3-D image of the patient’s anatomy from a single scan. These 3-D images allow the practitioner to better diagnose and understand the true extent of dental disease, and they can provide for more appropriate treatment for patients. CBCT should not be used as a substitute for conventional 2-D examinations; rather 3-D should be used as a supplemental exam when it is expected that the 3-D scan will provide additional information, with the potential to enhance the diagnosis or treatment plan. Cone beam computed tomography (or CBCT, also referred to as C-arm CT, cone beam volume CT, or flat panel CT) is a medical imaging technique consisting of X-ray computed tomography where the X-rays are divergent, forming a cone. The average effective dose from background radiation is about 3 mSv per year. The adult effective dose from a CT exam of the abdomen is roughly equivalent to the adult effective dose from roughly 400 chest X-rays.[53,54]

In this study the influence of dental chair backrest angulation on the mandibular position is studied 3-Dimentionally using cone beam computed tomography.

In this study, total of 10 subjects with permanent dentition up to second molar with or without third molar with healthy periodontium and normal motor and temporomandibular functions were selected. Periodontal health status is evaluated using Russell's periodontal index. Tooth mobility, motor and temporomandibular functions are evaluated by clinical examination.

Dental chair with a fixed headrest accompanied with the inclination of the backrest. To standardize the angles to be used in the study, a protractor was adapted and positioned on the axis connecting the chair's backrest to its seat. The chair was stabilized to check mandibular positions at 2 inclinations: 90° and 180°.To register the occlusal contacts, inter-occlusal records were made in centric relation for each subject at various inclinations as mentioned above.

Deprogramming was done before making an inter-occlusal records. There are variations between individuals regarding the way their muscles respond and because the same individuals may respond differently on different days. The engram (the masticatory "muscle memory") is shown to be a conditionable reflex whose muscle conditioning lasts less than two minutes, far shorter than previously thought.[55] This reflex, reinforced and stored in the masticatory muscles at every swallow, adjusts masticatory muscle activity to guide the lower arch unerringly into its ICP (inter-cuspal position). These muscle adjustments compensate for the continually changing internal and external factors that affect the mandible's entry into the ICP. Deprogramming devices are used to eliminate muscle engrams. The muscle that frequently prevents condylar seating is the lateral pterygoid – which is programmed to position the mandible to avoid pain and posterior interferences in the arc of closure. Deprogramming generally is done by placing something in the anterior that eliminates posterior occlusal contact. In this study, Lucia jig was used as a deprogrammer. The subjects were instructed to bite on the Lucia jig for 10 minutes before proceeding with the inter-occlusal records.

After deprogramming, the subjects were asked to sit in the dental chair in upright position and relax. Now the dental chair backrest was adjusted to 90 degree angulation and the subjects Frankfort horizontal plane is made parallel with the floor and AlphaBite™ bite registration material was injected over the entire occlusal and incisal surface of the mandible and the mandible was guided to centric relation position by the operator and the subject was instructed to bite on the bite registration material in the retruded mandibular position until it sets completely.

Now the dental chair backrest was adjusted to 180 and the bite registration was done in centric same as in 90 angulation position.

CBCT was made with the patient biting on the inter-occlusal records made at 90* and 180*. Before taking a CBCT the subject was instructed to bite on the inter-occlusal record properly. The subject should bite on it completely without any discrepancy between the occlusal surface of the teeth and the inter-occlusal record. 1st the subject was asked to bite on the 90 inter-occlusal record and a CBCT was made and 2nd CBCT was made by asking the subject to bite on the 180 inter-occlusal record.

The two CBCT obtained for each subject was analysed using CareStream 3D imaging software.

The CBCT was analysed for the following:

1. The mandibular plane angle as measured by SN-Go-Gn angle.
2. Roll as measured by FH plane (Po-Po) to Inter Molar plane.
3. The space between the condylar head and glenoid fossa. (Anterior, superior and posterior joint space measurements)

These values were tabulated and compared among each subjects. That is the analysis made with 90 and 180 angulation CBCT for each subjects were compared and the final result was tabulated and charted.

From the charts we can interpret that,

SN and Go-Gn planes.

As seen in chart1, we can observe a mean angle of 32.7* at 90* angulation of the chair and a mean angle of 31.8* at 180* angulation of the chair. This shows that there is a change in 0.9*. On statistical analysis this change was found to be significant.

FH Plane (Po-Po) and the inter-molar plane:

As seen in chart2, we can observe a change from a mean of 2.1* at 90* angulation of chair and 2.8* at 180* angulation. This shows a change of cant of the occlusal plane of 0.7* which is statistically significant.

Anterior, Middle and Posterior joint space.

Chart 3 [a,b,c], show the change from mean of 2.59 mm at 90* chair angulation to 2 mm at 180* chair angulation was seen in Anterior Joint space. A change from mean of 3.98 mm at 90* chair angulation to 3.64 mm at 180* chair angulation was seen in Middle Joint space. A change from mean of 3.44 mm at 90* chair angulation to 2.94 mm at 180* chair angulation was seen in Posterior Joint space. On observation of the results it can be seen that there is a definite reduction in the joint space. On statistical analysis this change was found to be significant.

Overjet:

Chart 4 shows the change from mean of 3.3 mm at 90* chair angulation to 5.6 mm at 180* chair angulation was seen in Overjet. On statistical analysis this change was found to be significant.

On analysing the changes found in the position of the mandible, it can be seen that, there is a significant retrusion with a upward and forward rotation of the mandible which also has reduced the joint space significantly. Furthermore, a definite cant of the occlusal plane was also observed.

If the jaw relation records were made at 180* for any oral rehabilitation procedures, the change in orientation of the jaw will have a significant deleterious effect on the prognosis. This is due to the reduction in vertical dimension anteriorly and opening of the space in the posteriors [Christinson phenomenon]. So restoration with this record will lead to premature contact in the posterior and open bite in the anteriors. Hence it is imperative that, jaw relation records need to be made with the patient in upright position.

SUMMARY

The analysis and values obtained from the CBCT analysis and clinical study can result in the following findings;

Rotation of mandible: a difference of + 0.9* was observed

Roll of the mandible: a difference of + 0.7* was observed

Joint space analysis:

The anterior joint space measurement: a difference of - 0.59 mm was observed

The superior or middle joint space measurement: a difference of - 0.34 mm was observed

Posterior joint space: a difference of - 0.5 mm was observed

Overjet: a difference of + 2.3mm was observed

CONCLUSION

Even though preparation of teeth / implants may be made with the patient in supine position, jaw relation records need to be made with the patient in upright position. If not there will be an upward and backward positioning of the mandible. This will bring about a major difference in occlusal scheme, which will prove deleterious to the prognosis of the restoration. This means that with a upward and backward rotation of the mandible there is a deepening of the overbite and increase space in the posterior quadrants. An occlusal scheme made in this position will have a posterior cant, which will lead to premature posterior contact.

REFERENCES

1. Atwood DA. A critique of research of the rest position of the mandible.J Prosthet Dent 1966;16:848-54.
2. Fantini SM, Paiva JB, RinoNeto J, Dominguez GC, Abrão J, VigorittoJW.Increase of condylar displacement between centric relation and maximalhabitual intercuspation after occlusal splint therapy. Braz Oral Res 2005;19:176-82.
3. Utt TW, Meyers CE Jr, Wierzba TF, Hondrum SO. A three-dimensionalcomparison of condylar position changes between centric relation and centricocclusion using the mandibular position indicator. Am J Orthod Dentofacial Orthop 1995;107:298-308.
4. Cordray FE. Three-dimensional analysis of models articulated in the seatedcondylar position from a deprogrammed asymptomatic population: aprospective study. Part 1. Am J Orthod Dentofacial Orthop 2006; 129:619-30.
5. Weffort SYK, Fantini SM. Condylar displacement between centric relationand maximum intercuspation in symptomatic and asymptomatic individuals.Angle Orthod 2010;80:835-42.
6. Gomes Lde C, Horta KO, Gonçalves JR, Santos-Pinto AD. Systematic review:craniocervical posture and craniofacial morphology. Eur J Orthod 2014;36:55-66.

7. Okeson JP, de Leeuw R. Differential diagnosis of temporomandibular disordersand other orofacial pain disorders. Dental Clin North Am 2011;55:105-20.

8. Ayub E, Glasheen-Wray M, Kraus S. Head posture: a case study of the effectson the rest position of the mandible. J Orthop Sports Phys Ther 1984;5:179-83.

9. Weinberg LA. The role of stress, occlusion, and condyle position in TMJdysfunction pain. J Prosthet Dent 1983; 49:532-45.

10. Fleigel JD 3rd, Sutton AJ. Reliable and repeatable centric relation adjustmentof the maxillary occlusal device. J Prosthodont 2013;22:233-6.

11. Etz E, Hellmann D, Giannakopoulos NN, Schmitter M, Rammelsberg P,Schindler HJ. The variability of centric jaw relations in the process chain ofprosthetic restorations and their neuromuscular effects. J Craniomand Func 2012:141-56.

12. Wiens JP, Priebe JW. Occlusal stability. Dental Clin North Am 2014;58:19-43.

13. Okeson JP. Management of temporomandibular disorders and occlusion. 7thed. St Louis: Mosby; 2013.

14. Dawson PE. New definition for relating occlusion to varying conditions of thetemporomandibular joint. J Prosthet Dent 1995;74:619-27.

15. Machen DE. Uptake on TMJ litigation-part 1. Am J Orthod Dentofac Orthop 1989;96:448-9.

16. Ricketts RM. Variations of the temporomandibular joint asrevealed by cephalometric laminography. Am J Orthod Dentofac Orthop 1950;36:877-98.

17. Madsen B. Normal variations in anatomy, condylar movements, and arthrosis frequency of the temporo mandibular joints. ActaRadiolDiag 1966;4:273-88:

18. Weinberg LA. An evaluation of duplicability of temporo mandibular joint radiographs. J Prosthet Dent 1970;24: 512-41.

19. Weinberg LA. Technique for temporomandibular joint radiographs. J Prosthet Dent 1972;28:284-308.

20. Williamson EH, Wilson CW. Use of a submental vertexanalysis for producing TMJ laminograpbs. Am J Orthod 1976;70:200-7.

21. Weinberg LA. Role of condylar position in TMJ dysfunction-pain syndrome. J Prosthet Dent 1979;41:636-43.

22. Mikhail MG, Rosen H. The validity of temporomandibularjoint radiographs using the head positioner. J Prosthet Dent1979;42:44t-6.

23. Blaschke DD, Blaschke TJ. Normal TMJ bony relationshipsin centric occlusion. J Dent Res 1980;60:98-104.

24. Ismail YH, Rokni A. Radiographic study of condylar positionin centric relation and centric occlusion. J ProsthetDent 1980;43:327-30.

25. Mongini F. The importance of radiography in the diagnosisof TMJ dysfunctions. A comparative evaluation of transcranialradiographs and serial tomography. J Prosthet Dent!981;45:186-98.

26. Williams BH. Oriented lateral temporomandibular jointlaminographs. Angle Orthod 1983;53:228-33.
27. Hatcher DC, Blom RJ, Baker CG. Temporomandibularjoint spatial relationships: osseous and soft tissues. J ProsDent 1986;56:344-53.
28. Weinberg LA, Chastain JK. New TMJ clinical data and theimportance on diagnosis and treatment. J Am Dent Assoc1990;120:305-11.
29. Aquilino SA, Matteson SR, Holland GA, Phillips C. Evaluationof condylar position from temporomandibular jointradiographs. J Prosthet Dent 1985;53:88-97.
30. Pullinger AG, Hollender L, Solberg WK, Petersson A. Atomographic study of mandibular position in an asymptomaticpopulation. J Prosthet Dent 1985;53:706-12.
31. Pullinger AG, Hollender L. Variation in condyle-fossa reiationshipsaccording to different methods of evaluation intomograms. Oral Surg Oral Med Oral Pathol 1986;62:710-27.
32. 1K Pullinger AG, Hollender L, Solberg WK, Guichet D. Tomographicanalysis of mandibular position in diagnosticsubgroups of temporomandibular disorders. J Prosthet Dent1986;55:723-9.
33. Girardot RA. The nature of condylar displacement in patientswith temporomandibular pain-dysfunction. OrthodRev 1987;1:16-23.

34. Griffiths RH. Report on the president's conference on theexamination, diagnosis, and management of temporomandibulardisorders. J Am Dent Assoc 1983;106:75-7.

35. American Dental Association. Recommendations in radiographicpractices, 1984 Council on Dental Materials, Instrumentsand Equipment. J Am Dent Assoc 1984;109:764-5.

36. American Academy of Craniomandibular Disorders. Craniomandibulardisorders: guide-lines for evaluation, diagnosis,and management. Chicago: Quintessence, 1990:25-33.

37. Hellsing G, L'Estange R Holmlund A. Temporo mandibular joint disorders: a diagnostic challenge. J Prosthet Dent 1986;56:600-5.

38. Kirk W. Diagnosing disk dysfunction and tissue changes inthe temporomandibular joint with magnetic resonance imaging.J Am Dent Assoc 1989;119:527-30.

39. Buttram JR, Farole A. Arthroscopy of the temporomandibularjoint. CompendContinEduc Dent 1989;10:652-6.

40. Sears VH. Mandibular condyle migration as influenced bytooth occlusion. J Am Dent Assoc 1952;45:179-92.

41. Posselt U. An analyzer for mandibular positions. J ProsthetDent 1957;7:365-74.

42. Long JH. Location of terminal hinge axis by intraoralmeans. J Prosthet Dent 1970;23:11-24.

43. Hoffman P J, Silverman SI, Garfinkel L. Comparison ofcondylar position in centric relation and in centric occlusionin dentulous patients. J Prosthet Dent 1973;30:582-8.

44. Williamson EH, Steinke RM, Morse PK, Swift TR. Centricrelation: a comparison of muscle-determined position andoperator guidance. AM J ORTHOD DENTOFAC ORTHOP1980;77:133-45.

45. Shafagh I, Amirloo R. Replicability of chin point-guidanceand anterior deprogrammer for recording centric relation.J Prosthet Dent 1979;42:402-4.

46. Rosner D, Goldberg G. Condylar retruded contact positionand intercuspal position correlation in dentulous patientspart 1: three-dimensional analysis of condylar registrations.J Prosthet Dent 1986;56:230-7.

47. Slavicek R. Part 4 instrumental analysis of mandibular castsusing the mandibular position indicator. J ClinOrthod1988;22:566-75.

48. S.A.M.M.P.I. 200 Mandibular Position Indicator. (instructionmanual) Tonawanda, New York: Great Lakes Orthodontics, Ltd.

49. Dawson PE. Evaluation, diagnosis, and treatment of occlusalproblems. St Louis: CV Mosby 1989:29, 130.

50. Okeson JP. Management of temporomandibular disordersand occlusion. St Louis: CV Mosby 1989:109, 453-78: Pullinger AG, Solberg WK, Hotiender L, Petersson A.

51. Relationship of mandibular condylar position to dentalocclusion factors in an asymptomatic population. Am J Orthod Dentofac Orthop 1987;91:200-6.
52. Butler JG. Patterns of change in human mandibular archwidth during jaw excursions. Arch Oral Biol 1972;17:623-31.
53. Rosner D, Goldberg GF. Condylar retruded contact positionand intercuspal position in dentulous patients, part II:patients classified by anamnestic questionnaire. J ProsthetDent 1986;56:359-68.
54. Parker WS. Centric relation and centric occlusion-an orthodonticresponsibility. Am J Orthod 1978;74:481-500.
55. Lerman MD. The muscle engram: the reflex that limits conventional occlusal treatment. Cranio®. 2011 Oct 1;29(4):297-303.

TABLE 1: CBCT ANALYSIS

SAMPLE NO.	90` ANGULATION						180` ANGULATION					
	Mandibular plane - SN-Go-Gn plane angle	FH plane (Po-Po) to Inter Molar plane angles	Overjet between upper and lower anterior	Space between glenoid fossa and condylar head			Mandibular plane - SN-Go-Gn plane angle	FH plane (Po-Po) to Inter Molar plane angles	Overjet between upper and lower anterior	Space between glenoid fossa and condylar head		
				Anterior	Middle	Posterior				Anterior	Middle	Posterior
Sample 1	36°	3°	5mm	3.2mm	4.6mm	6.7mm	33°	3°	8mm	2.3mm	4.3mm	5.9mm
Sample 2	31°	1°	0mm	1.8mm	4.3mm	2.4mm	30°	3°	2mm	1.4mm	4.3mm	2.1mm
Sample 3	34°	2°	4mm	3.3mm	2.5mm	3.1mm	34°	2°	8mm	3.1mm	2.2mm	2.3mm
Sample 4	30°	2°	3mm	3.4mm	4.2mm	1.6mm	30°	3°	7mm	2.7mm	3.8mm	1.6mm
Sample 5	33°	4°	4mm	1.5mm	4.3mm	4.3mm	33°	5°	6mm	1.1 mm	4.2mm	3.7mm
Sample 6	31	2	3mm	3.0mm	4.1mm	2.8mm	30	3	5mm	2.3mm	3.9mm	2.1mm
Sample 7	33	1	4mm	2.1mm	3.9mm	2.9mm	31	1	5mm	1.8mm	3.1mm	2.2mm
Sample 8	32	1	2mm	1.6mm	4.7mm	3.4mm	32	2	3mm	1.1mm	4.2mm	3.2mm
Sample 9	35	3	5mm	3.6mm	2.8mm	3.1mm	34	4	7mm	2.9mm	2.3mm	2.8mm
Sample 10	32	2	3mm	2.4mm	4.4mm	4.1mm	31	2	5mm	1.3mm	4.1mm	3.5mm

TABLE 2:

	Mandibular plane - SN-Go-Gn plane angle	N	Mean	Std. Dev
Pair 1	90° Angulation	10	32.700	1.8886
	180° Angulation	10	31.800	1.6193

TABLE 3:

	FH plane (Po-Po) to Inter Molar plane angles:	N	Mean	Std. Dev
Pair 2	90° Angulation	10	2.100	0.9944
	180° Angulation	10	2.800	1.1353

TABLE 4a:

	Space between glenoid fossa and condylar head - Anterior (mm)	N	Mean	Std. Dev
Pair 3	90° Angulation	10	2.590	0.8020
	180° Angulation	10	2.000	0.7601

TABLE 4b:

	Space between glenoid fossa and condylar head - Middle (mm)	N	Mean	Std. Dev
Pair 4	90° Angulation	10	3.980	0.7406
	180° Angulation	10	3.640	0.8140

TABLE 4c:

	Space between glenoid fossa and condylar head - Posterior (mm)	N	Mean	Std. Dev
Pair 5	90° Angulation	10	3.440	1.3826
	180° Angulation	10	2.940	1.2429

TABLE 5:

	Overjet	N	Mean	Std. Dev
Pair 6	90° Angulation	10	3.3	1.4944
	180° Angulation	10	5.6	2.0111

TABLE 6:

PAIRED DIFFERENCES

		Mean	Std. Dev	95% CI for Difference		P-Value
				Lower	Upper	
Pair 1	Mandibular plane - SN-Go-Gn plane angle	0.9000	0.9944	0.1886	1.6114	0.019
Pair 2	FH plane (Po-Po) to Inter Molar plane angles	-0.7000	0.6749	-1.1828	-.2172	0.010
Pair 3	Space between glenoid fossa and condylar head - Anterior (mm)	0.5900	0.2807	0.3892	0.7908	<0.001
Pair 4	Space between glenoid fossa and condylar head - Middle (mm)	0.3400	0.2271	0.1776	0.5024	0.001
Pair 5	Space between glenoid fossa and condylar head - Posterior (mm)	0.5000	0.2789	0.3005	0.6995	<0.001
Pair 6	Overjet	-2.30	0.335	-3.06	-1.54	0.001

CHART 1

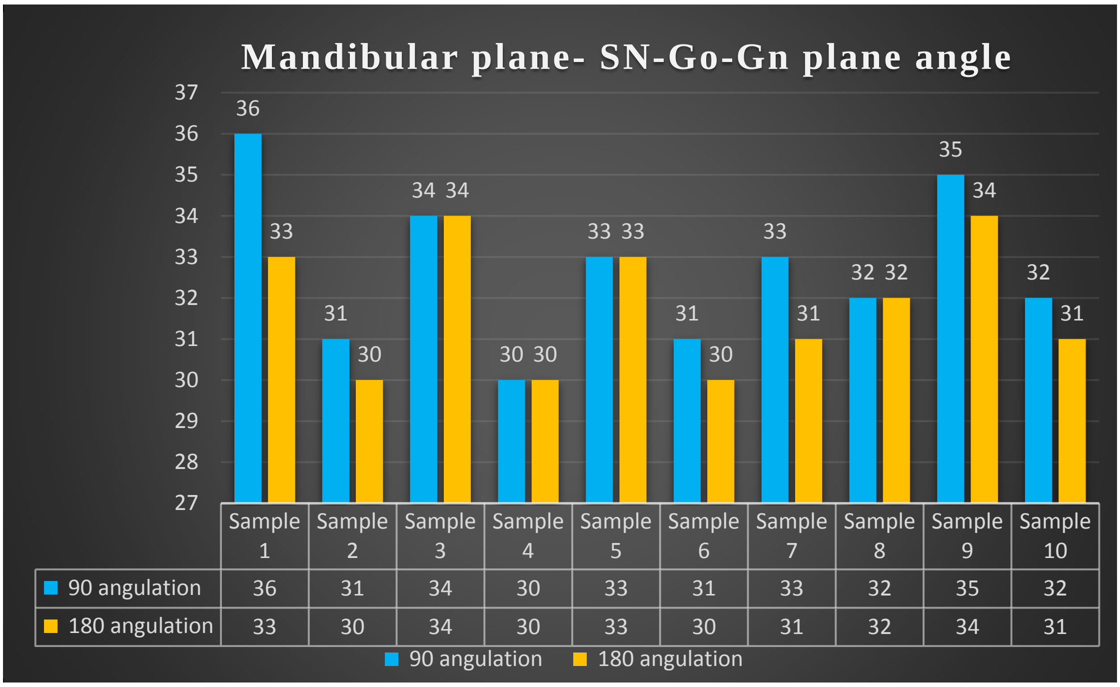
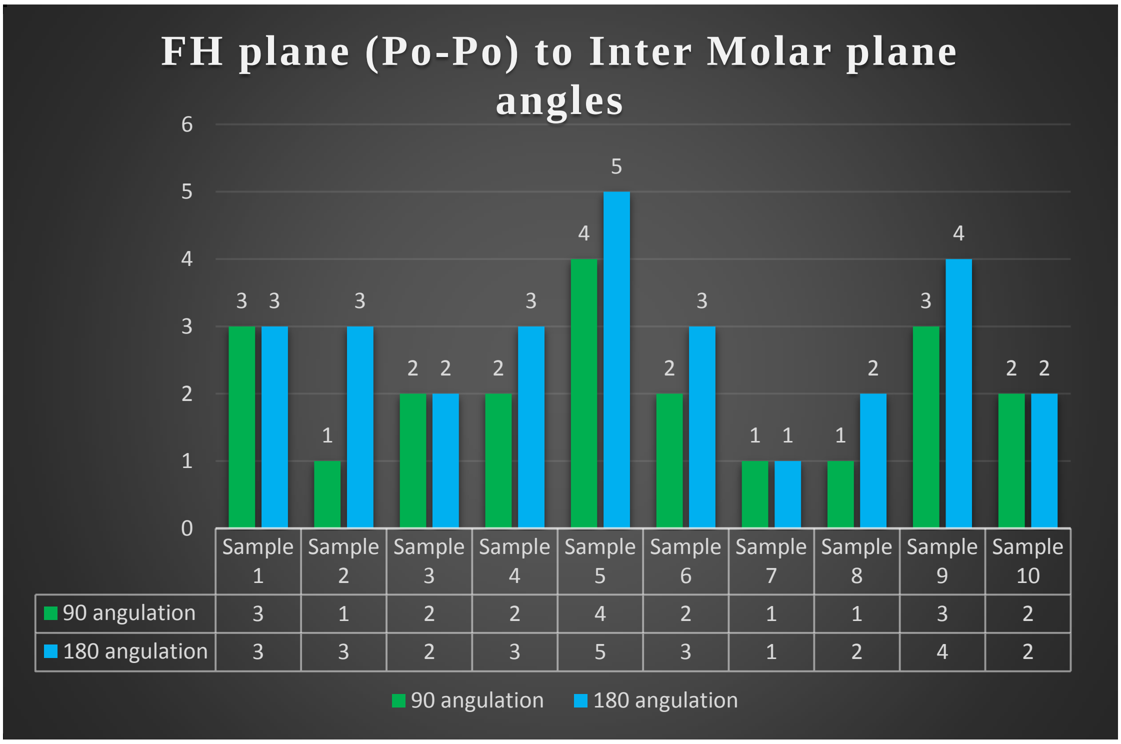


CHART 2



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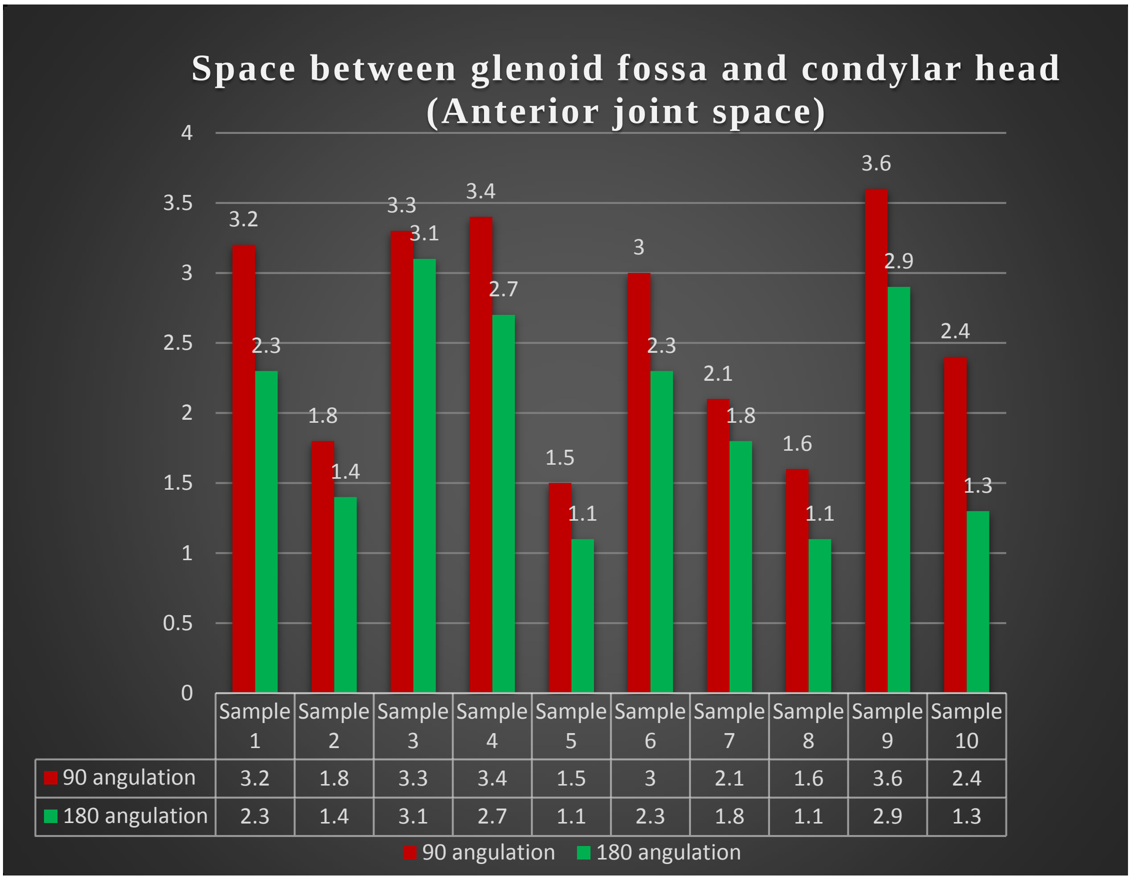


CHART 3 b:

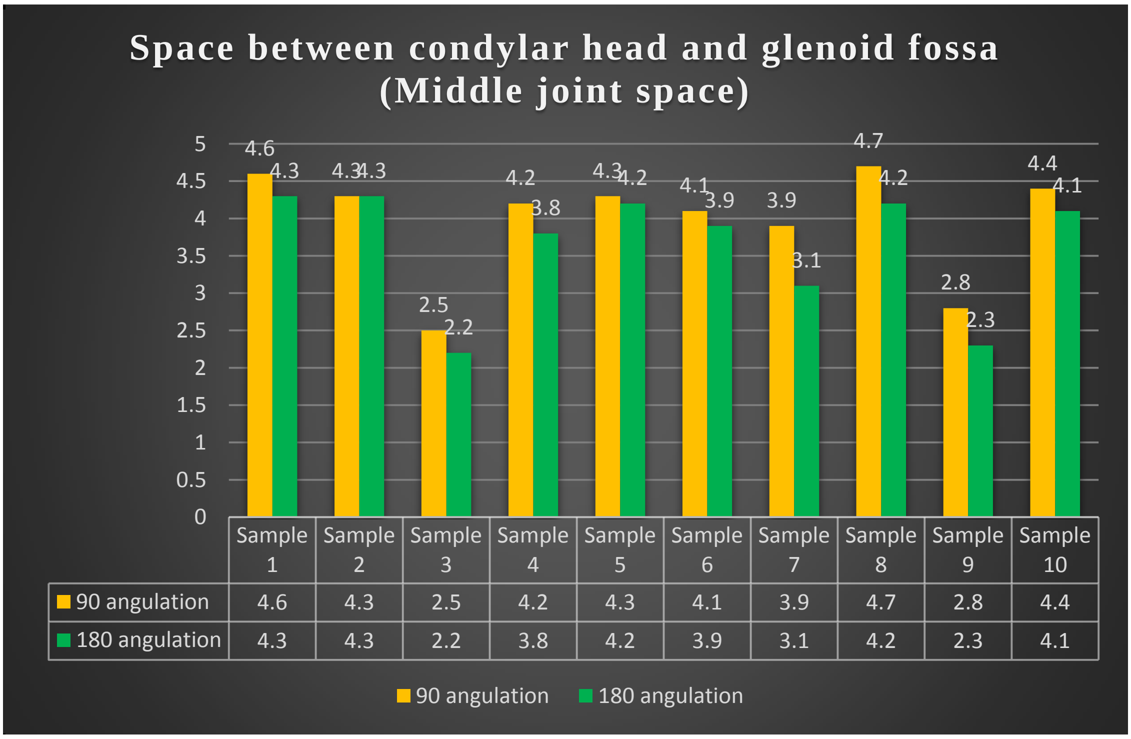
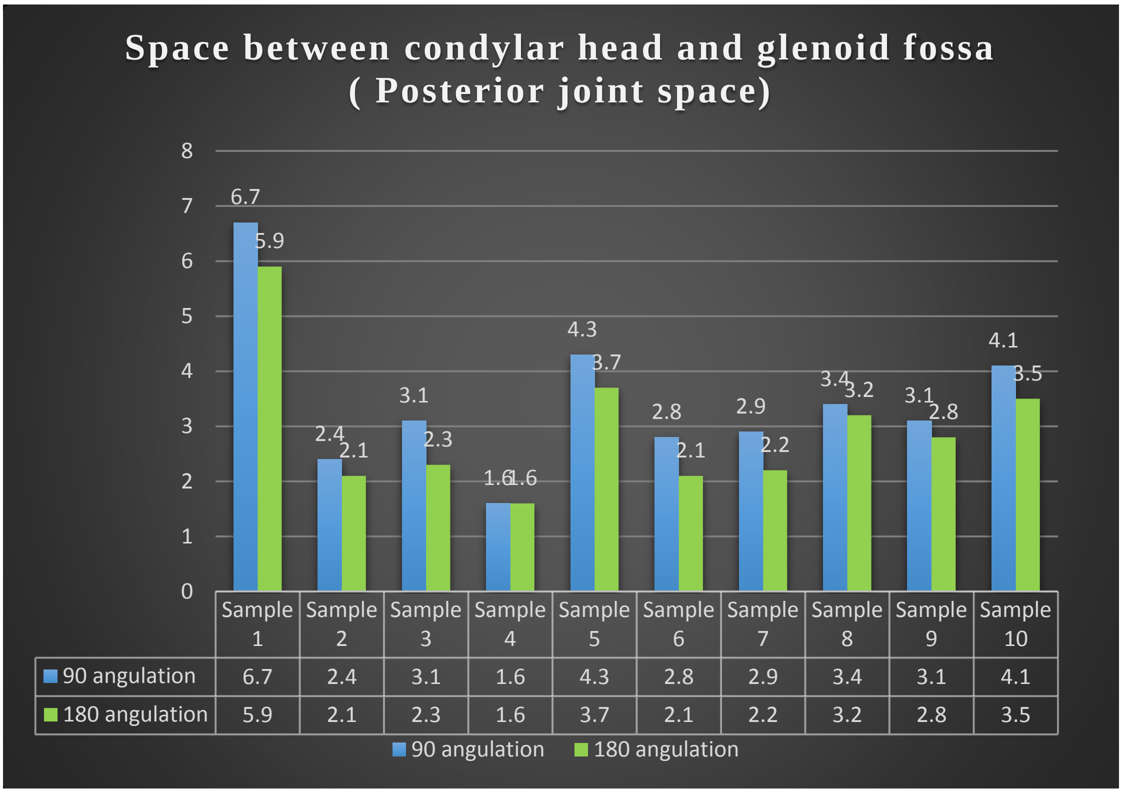
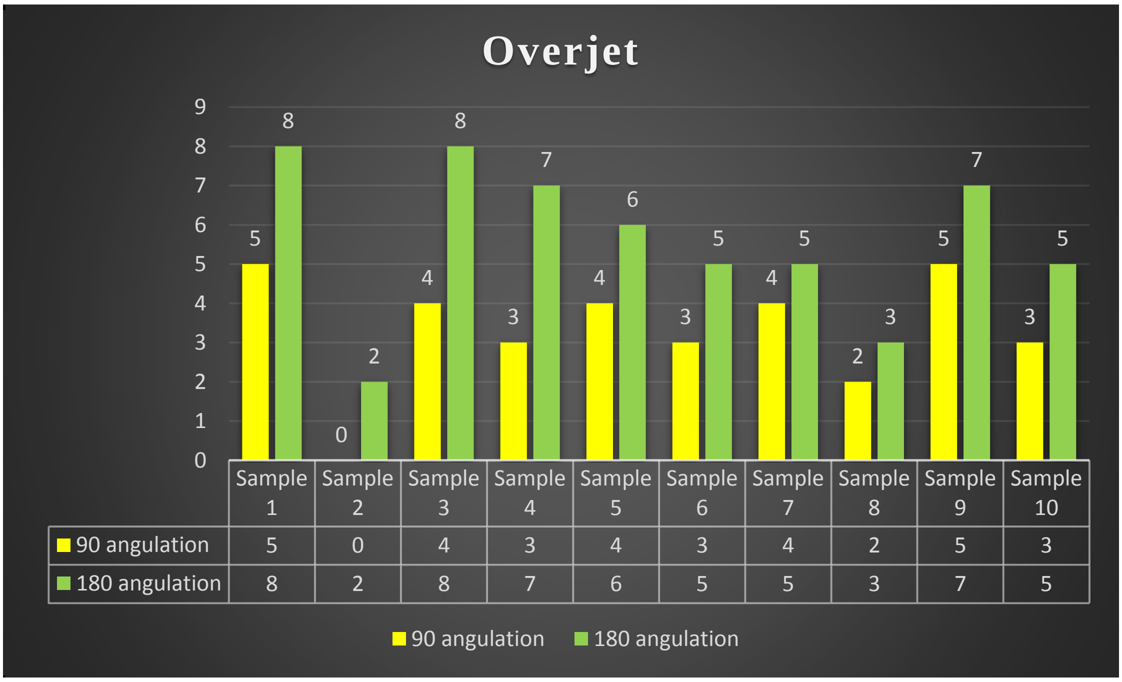


CHART 3 c:



	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
90 angulation	6.7	2.4	3.1	1.6	4.3	2.8	2.9	3.4	3.1	4.1
180 angulation	5.9	2.1	2.3	1.6	3.7	2.1	2.2	3.2	2.8	3.5

CHART 4:



	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
90 angulation	5	0	4	3	4	3	4	2	5	3
180 angulation	8	2	8	7	6	5	5	3	7	5

CHART 5:

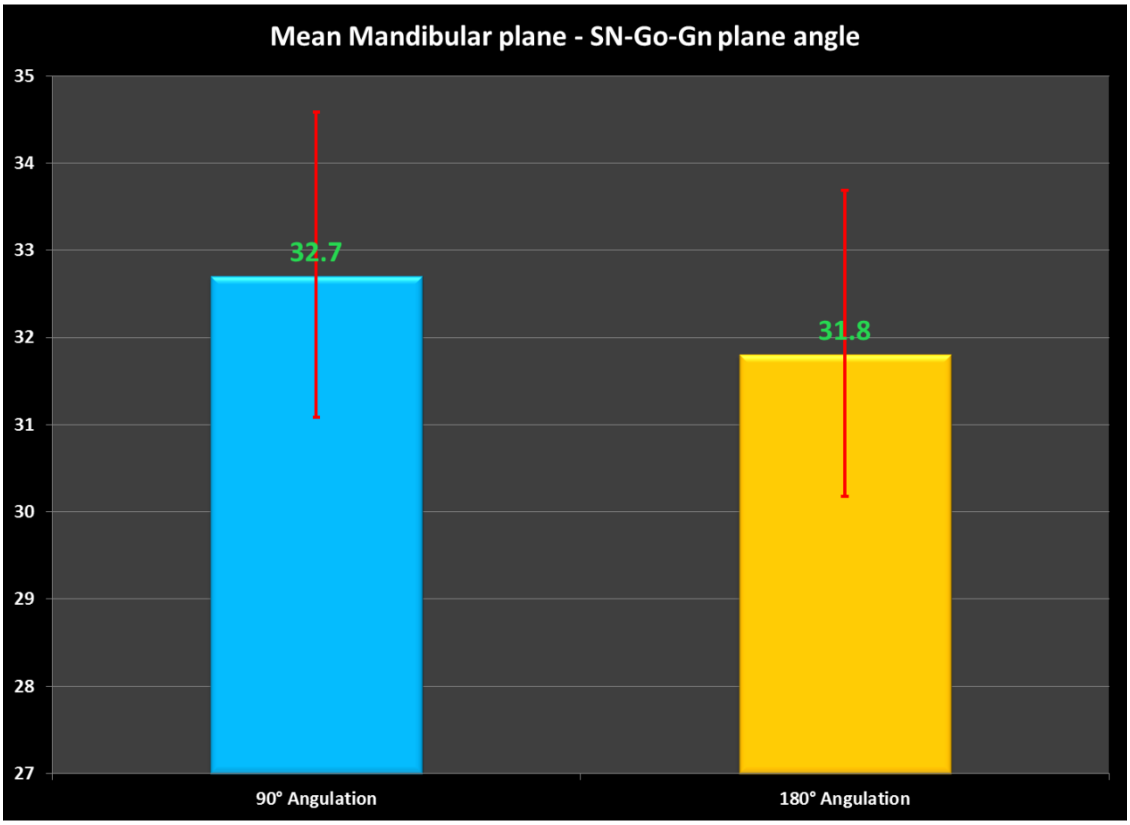


CHART 6:

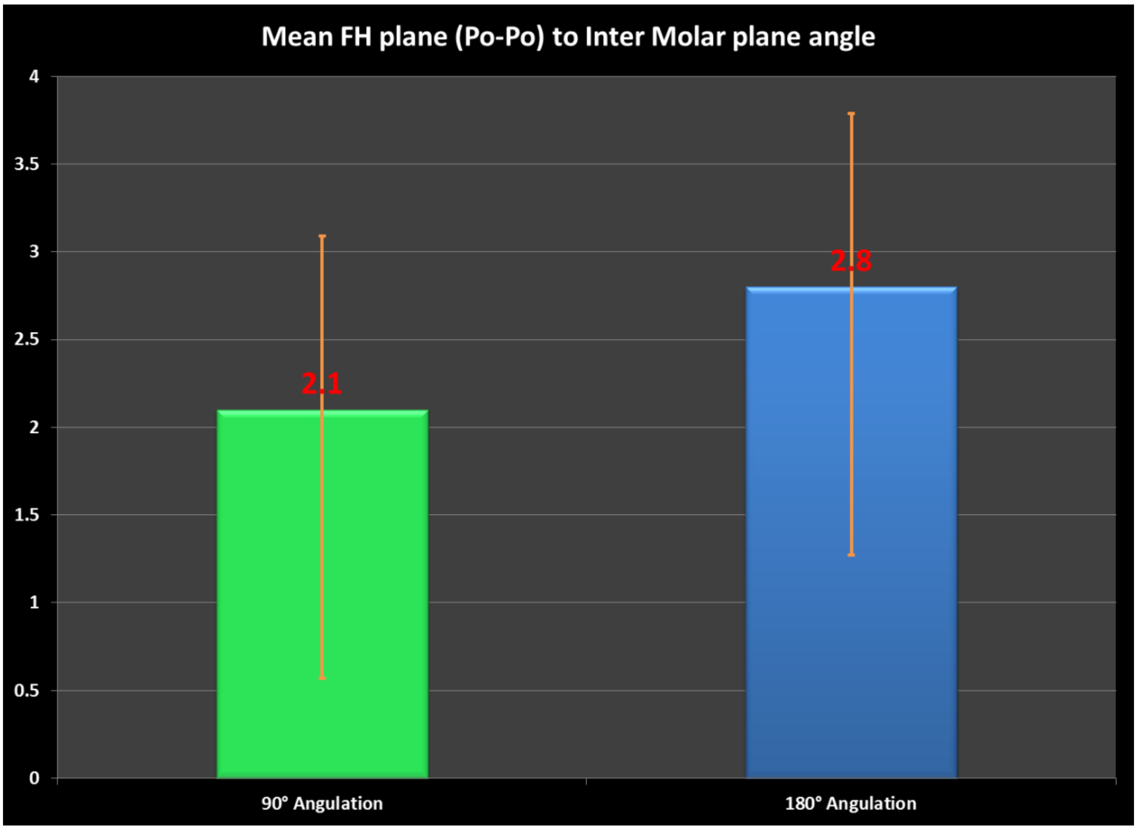


CHART 7:

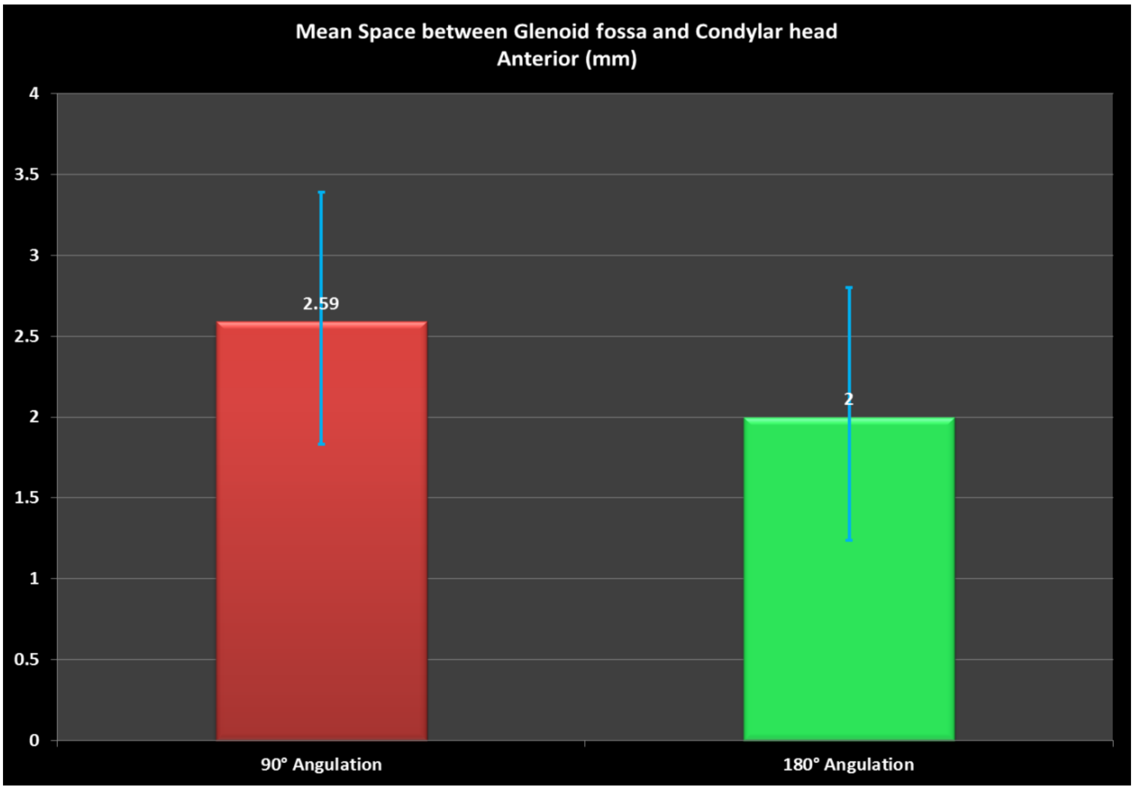


CHART 8:

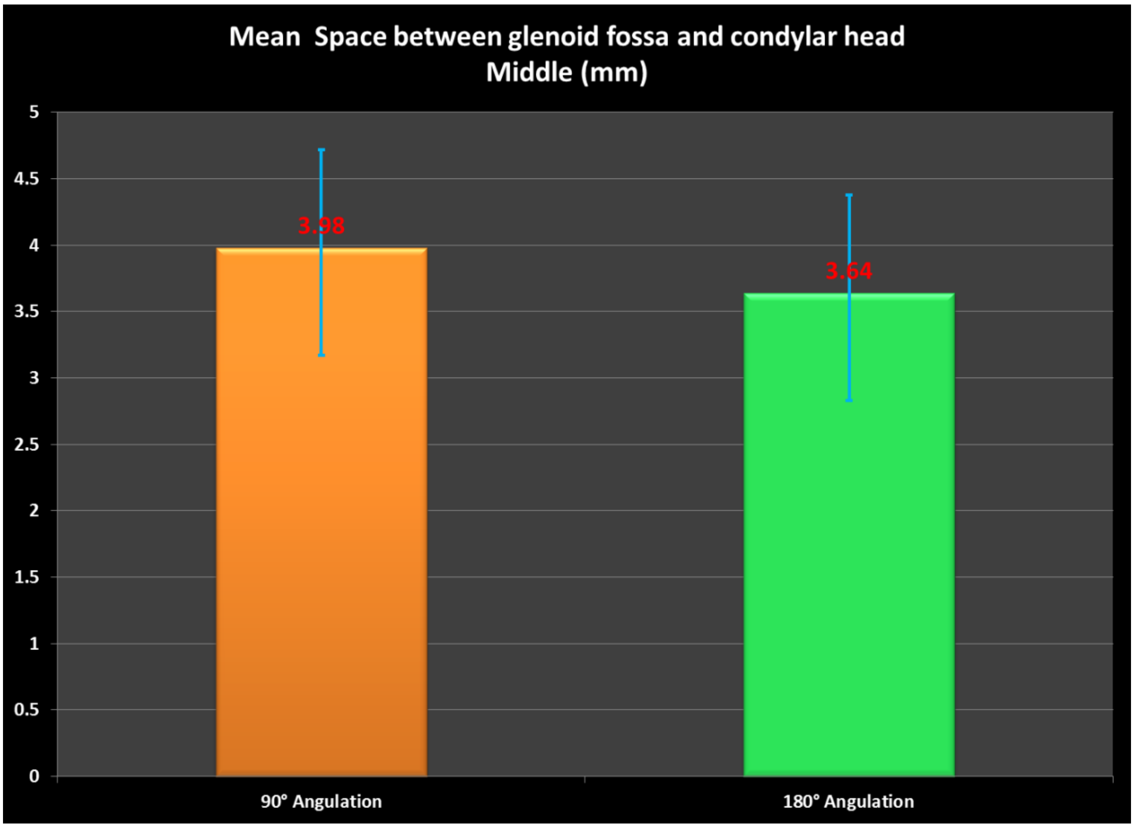


CHART 9:

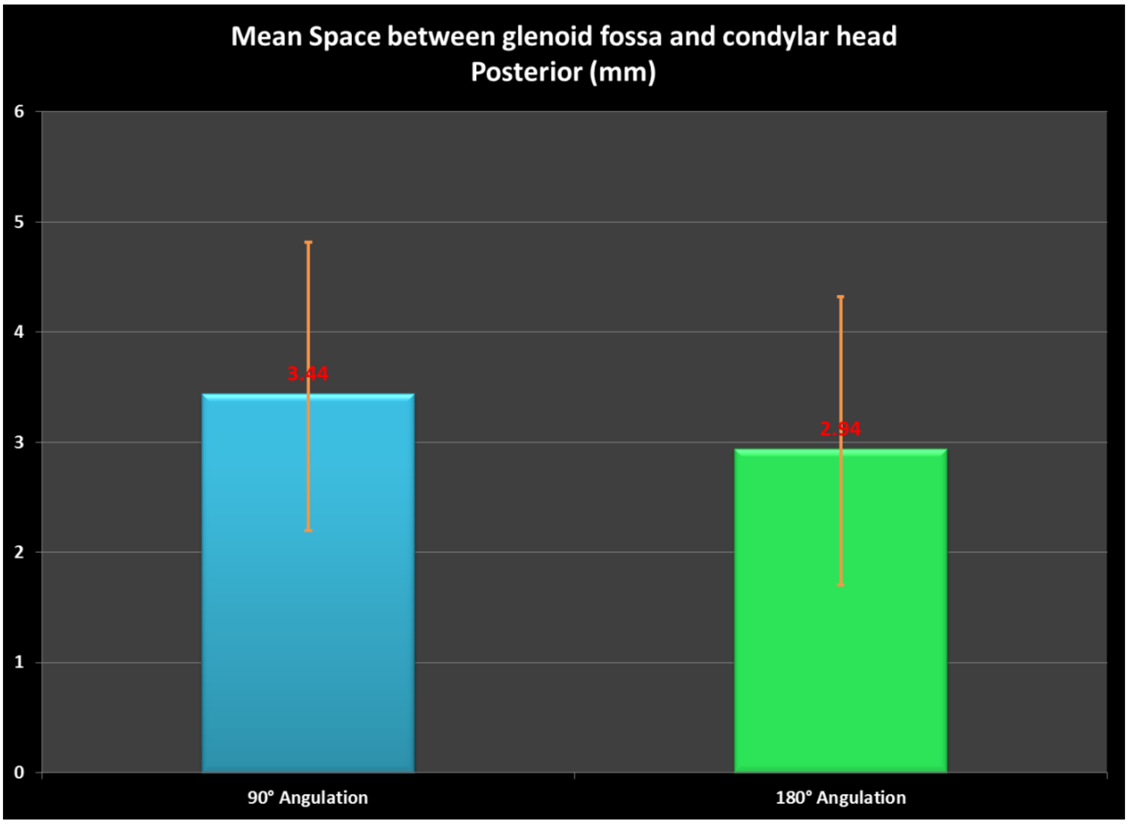
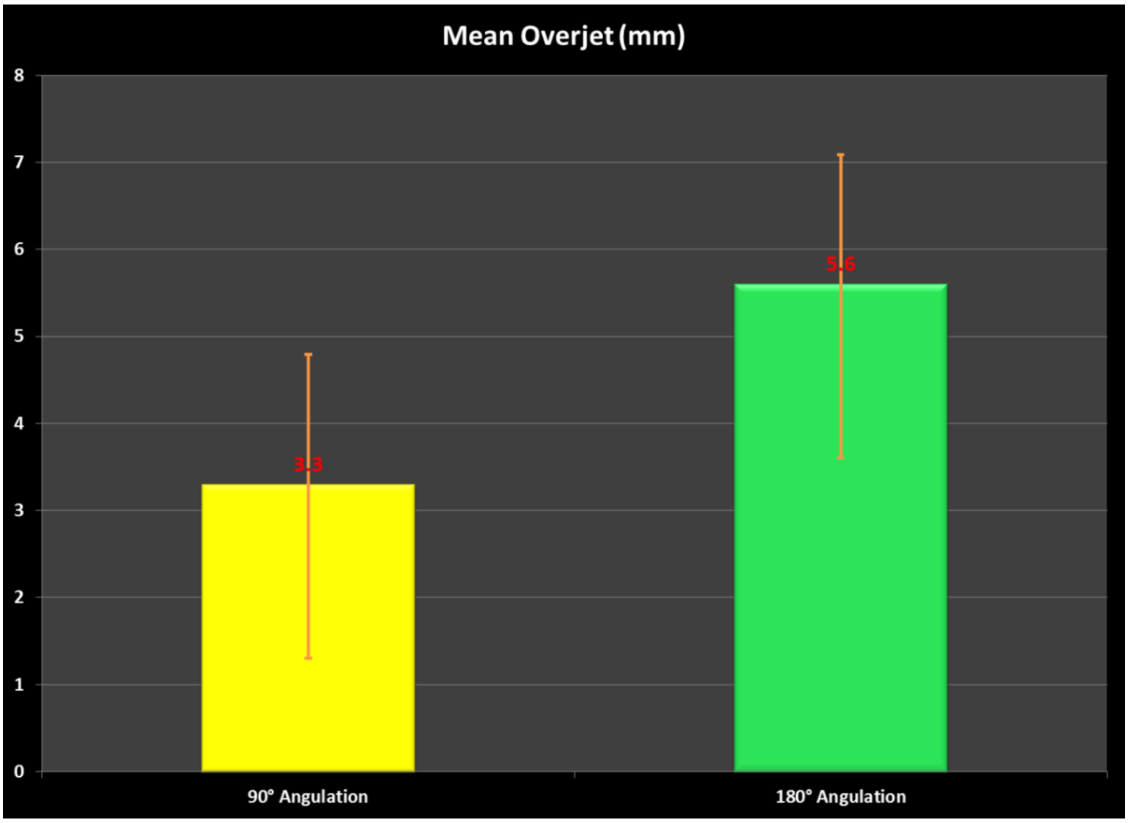
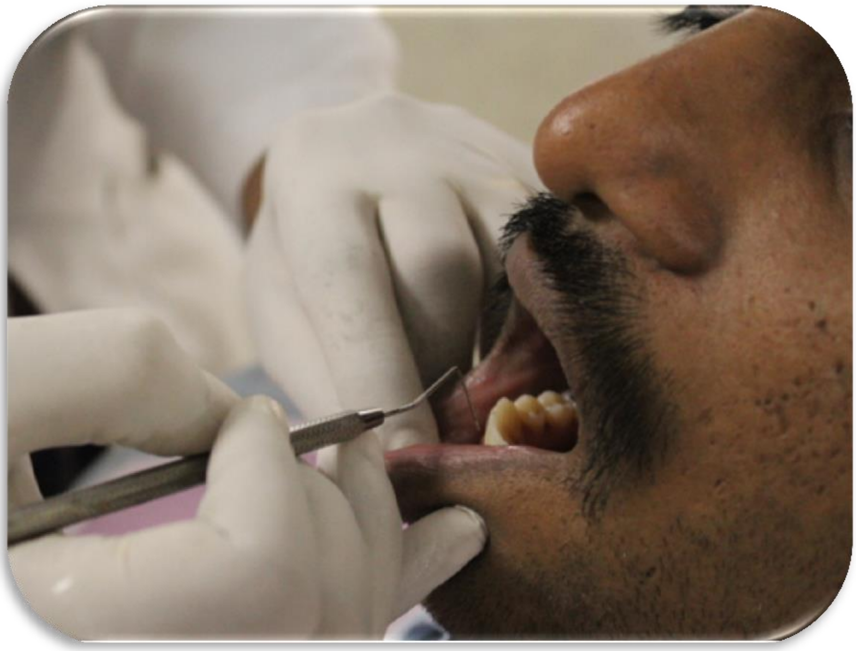


CHART 10:

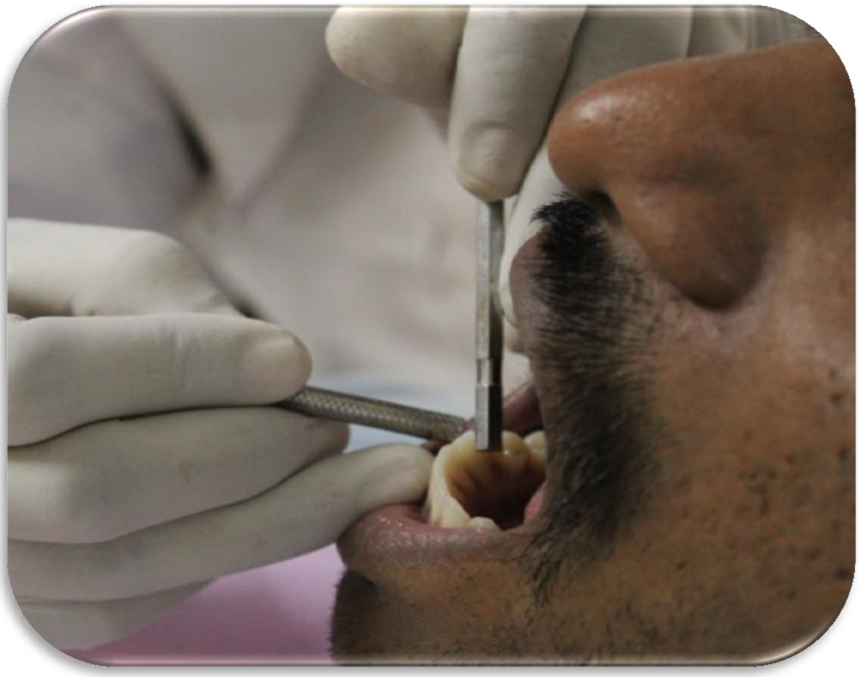


PICTURE 1



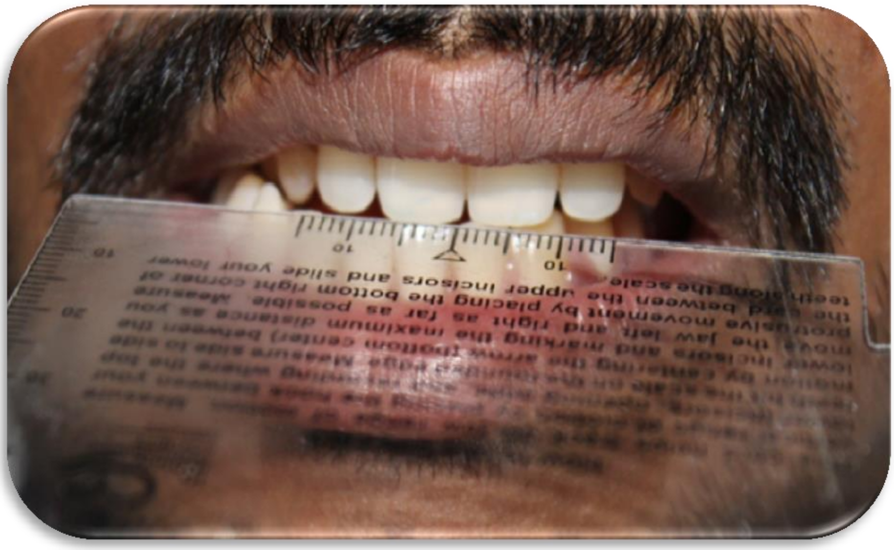
Russell's periodontal index

PICTURE 2



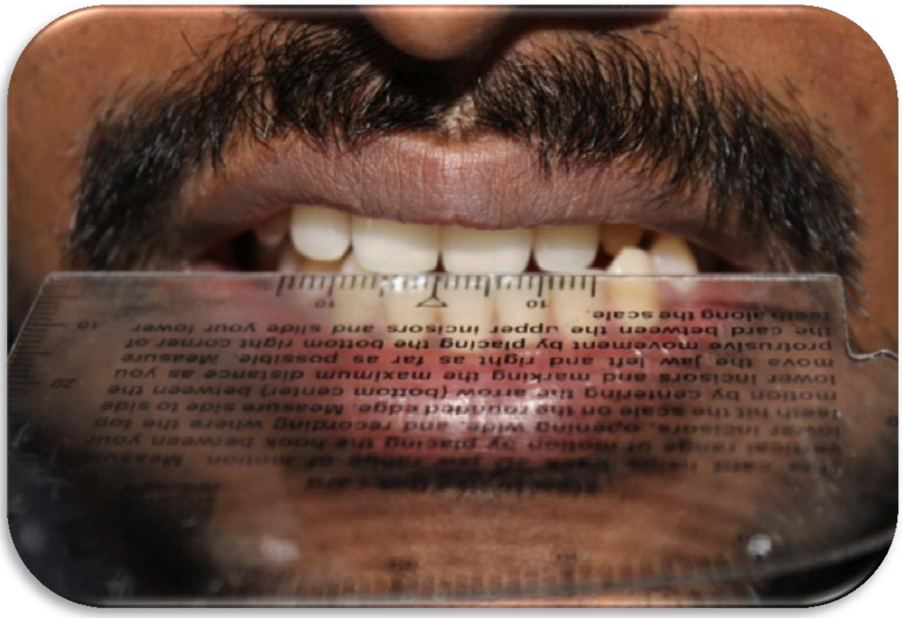
Checking for Tooth Mobility

PICTURE 3



TMJ-Lateral Range of Movement

PICTURE 4



TMJ-Lateral Range of Movement

PICTURE 5

TMJ- Palpation

PICTURE 6

Dental Chair Backrest at 90^{O} Angulation

PICTURE 7

Dental Chair Backrest at 180^{O} Angulation

PICTURE 8

Deprogramming Device

PICTURE 9

Positioning the jaw in centric relation

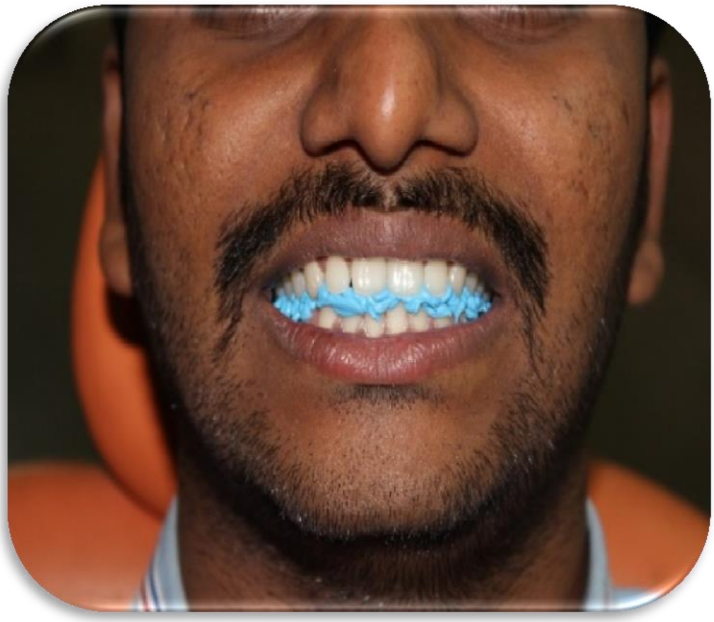
PICTURE 10

AlphaBite Bite Registration Material

PICTURE 11a

Making of the Jaw Relation Record

PICTURE 11b



Making of the Jaw Relation Record

PICTURE 12

Making of the CBCT Images

PICTURE 13

CBCT Machine

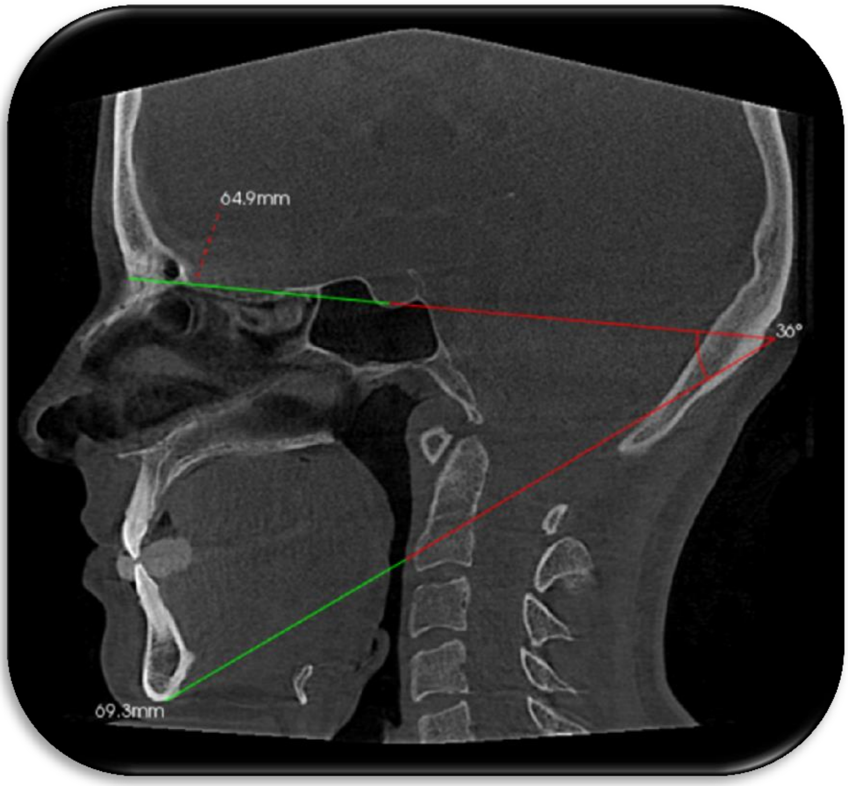
PICTURE 14

Radiation Protection

PICTURE 15

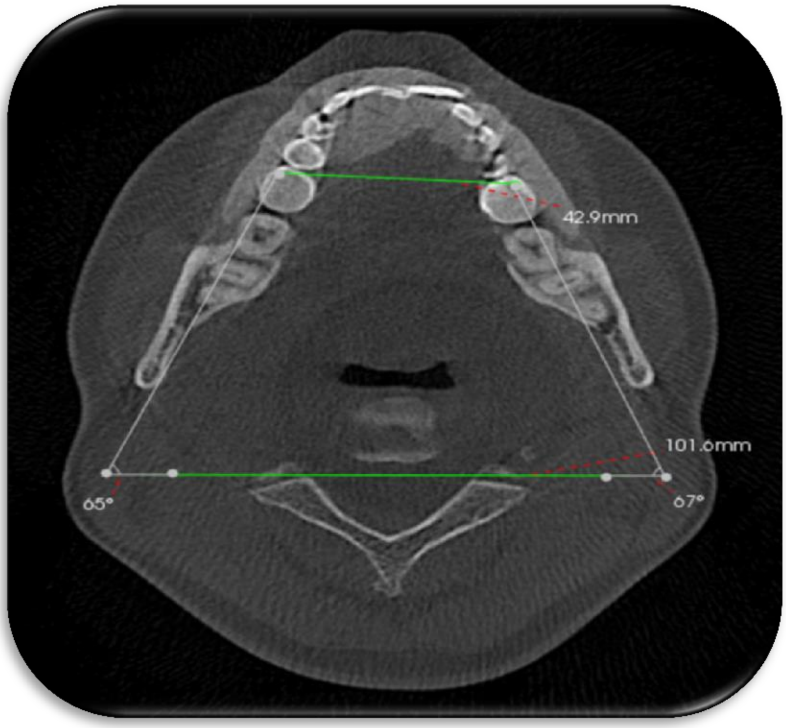
Overjet Measurement

PICTURE 16



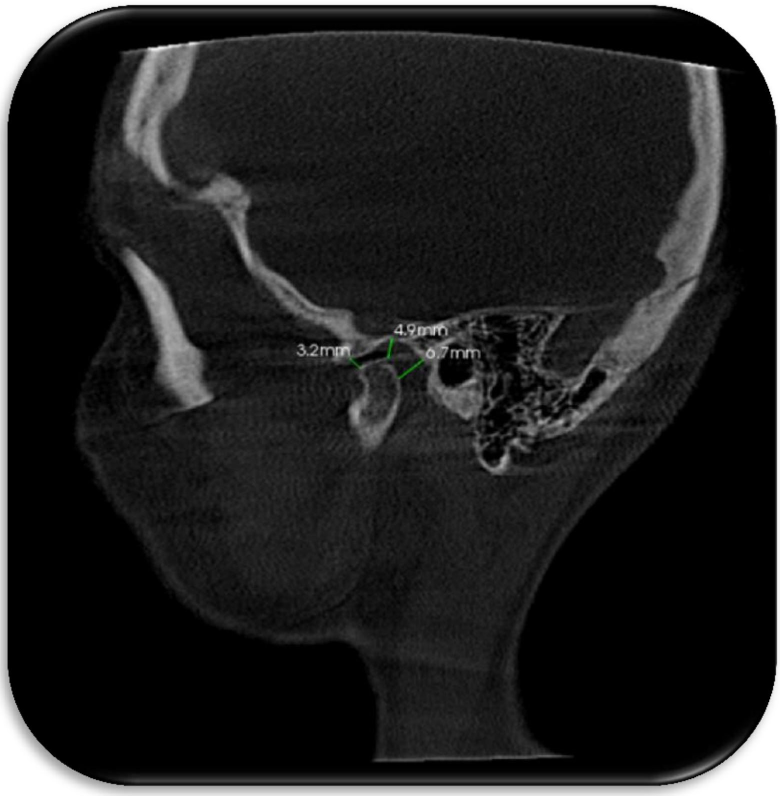
The angle formed between SN plane and Go-Gn planes

PICTURE 17



The angle formed between FH plane (Po-Po) to Inter Molar plane.

PICTURE 18



Joint space Measurement in centric relation

INSTITUTIONAL ETHICS COMMITTEE AND REVIEW BOARD

ADHIPARASAKTHI DENTAL COLLEGE AND HOSPITAL

Melmaruvathur, Tamilnadu-603019

An ISO 9001:2008 certified institution. Accredited by NAAC with 'b' grade.
Recognised by DCI, New Delhi. Affiliated to: The Tamil Nadu Dr. M.G.R. Medical University, Chennai.

This ethical committee has undergone the research protocol submitted by **S. ELAKKIYA** Post Graduate Student, **Department of Prosthodontics** under the title "**Influence of dental chair backrest inclination on the three dimensional positioning of the mandible – A Clinical Trial.",** Reference No: **2015- MD-BrI-ASR-01/APDCH** under the guidance of **DR. T. RAMAKRISHNAN** for consideration of approval to proceed with the study.

This committee has discussed about the material being involved with the study, the qualification of the investigator, the present norms and recommendation from the Clinical Research scientific body and comes to a conclusion that this research protocol fulfils the specific requirements and the committee authorizes the proposal.

Date:

CHAIR PERSON

- Inform IEC/IRB immediately in case of any issue(s) / adverse events.
- Inform IEC/IRB in case of any change of study procedure, site and investigator.
- Annual report to be submitted to IEC/IRB.
- Members of IEC/IRB have right to monitor the trial with prior intimation.