# OCCLUSION IN COMPLETE DENTURE

By

**Dr. AMRUTHALAL**

*Library Dissertation Submitted to the*

*Kerala University of Health Sciences, Thrissur, Kerala*

*In partial fulfillment of the requirements for the degree of*

**MASTER OF DENTAL SURGERY**

*in*

**BRANCH 1**

**PROSTHODONTICS AND CROWN & BRIDGE**

*Under the guidance of*

**Dr . GEORGE FRANCIS**

Professor And Head of the Department

**ST. GREGORIOS DENTAL COLLEGE**

Chelad

2018-2021

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I hereby declare that this library dissertation entitled **'OCCLUSION OIN COMPLETE DENTURE'** is a bonafide and genuine research work carried out by me under the guidance of **Dr. GEORGE FRANCIS , Professor and Head of the department , Dept. of Prosthodontics, St. Gregorios Dental College.**

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**Dr . GERORGE FRANCIS**
Guide , Professor and
Head of the Department
Department ofProsthodontics

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**Dr. GEORGE FRANCIS**
Professor & Head of the
DepartmentDepartment of Prosthodontics

Date:
Chelad

## ACKNOWLEDGEMENT

I offer my fervent thanks to the Almighty for the blessings showered on me and guiding me through every step.

This dissertation wouldn't have been possible without the help and guidance of many people for whom I am extremely thankful. I take this opportunity to thank everyone who has contributed in completing this manuscript.

I really fall short of words in thanking my beloved guide**Dr. George Francis**, Professor,Head of the Department , Department of Prosthodontics who has been an enormous source of inspiration. I am extremely thankful to him for being so encouraging and guiding me patiently.I express my sincere gratitude to **Dr. Mathew M Alani** Professor, Department of Prosthodontics, for his guidance and unstinting encouragement.

I extend my sincere thanks to **Dr. Susan Mathew** and **Dr. Donny Philip**for their valuable suggestions and enormous support.I would like to take this opportunity to thank**Dr. Reba P.B, Dr. Paul Karyatty**and **Dr.Arun K Joy** for their encouraging presence and timely help and suggestions.

I would like to express my deep sense of gratitude to my parents**,Mr.T . Lal and Mrs. Dolly Lal** and my elder sister's **Surya Lal** and **ResmiLal** and all my dear friends without whose love and care I would not completed this work.

**Dr.AMRUTHA LAL**

Date:

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# INTRODUCTION

## INTRODUCTION

India is the second most populous country in the world with over 1 billion persons. There isgrowing population of elderly patients in India. Although the elderly population in India is 7.7% of total population, but this is expected to increase up to 19% by the year 2025. India ranks fourth amongst nations with the highest number of elderly persons[1].

Nowadays, with the improvement of oral hygiene controls, more people retain a functionalnatural dentition into their old age, but this dentition will not last lifetime in some cases. As a fact, the elderly still suffer from various dental diseases, which makes them more likely to have large numbers of loss of natural teeth. Dentists need to have the necessary skill to produce high quality complete dentures.To attain this goal, retention, stability, and support are three key factors for a successfulcomplete denture. The aim of prosthodontic treatment is restoring the patient to a state of normalfunction, health and aesthetics. Unlike natural teeth , the artificial teeth act as a single unite.

Thestudy of occlusion and its relationship to function of the masticatory system has been a topic ofinterest in dentistry since many years. One of the chief aims of preventive and restorative dentistry has been to maintain an occlusion that will function in harmony with the other components of the masticatory mechanisms, thereby preserving their health and at the same time providing the optimum, if not maximum masticatory function. Several researchers of science have engaged their attention to achieve this objective. The growth and development and refinement of the present day , gnathoscopes and articulator systems, is only but one example of the efforts of these men of science. Tremendous interest in this area, accompanied bylack of complete knowledge has initiated numerous concepts, theories and treatment methods

## Development of the occlusion[2]

The evolution and development of the dentition and temporomandibular joint is a useful study in that it gives us clues as to how our present dentition functions molars Mammals evolvedfrom a group of mammal-like reptiles‖ about 280 - 190 million years ago. Reptiles cannot bring their upper and lower teeth together and cannot chew; their teeth cannot move because they are ankylosed. But by the time the earliest

known mammal had evolved, these now had two sets of dentitions, and the upper and lower teeth could be occluded. The development of a joint thatcould allow lateral movements, allowed the newly evolved mammalian cheek teeth to come intoa definite occlusal relationship. The earliest known mammal had as precise a relationshipbetween upper and lower molars as nearly all known mammals, the upper lying just behind theequivalent lower molars.

Diphyodonty (one replacement set, i.e. two dentitions) probably evolved as a result of the increasing efficiency of the dentition created by the use and wear of teeth that would shear against each other. On eruption, the (unworn) teeth do not fit accurately together and so work inefficiently. There is no point in producing a succession of such inefficient dentitions, as every newly erupted molar, because of its high unworn cusps, would have disrupted the smoothly efficient shearing edges which are created by attrition (see Figures 1 and 2).

**Figure 1**: Early wear of teeth in a gorilla

**Figure 2**: Early wear of teeth in a human who lived about 10,000 yearsago. The wear has produced a sharp edge ofenamel on the firstmolar, which is very efficient for shearing and cutting of coarsefood, and the flatter occlusalsurface allows for

efficientgrinding. This person was a coastal-dweller, and lived on avariety of foods, including fishand crustaceans.

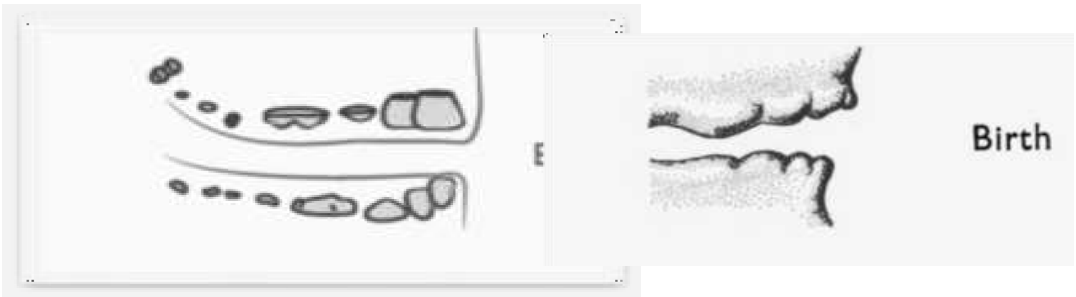
A deciduous dentition also helps to solve the problem of providing a child with a most effective masticatory apparatus appropriate to their needs at that time, and consistent with thespace available in the jaws. The potential functional weakness of a transition period is minimizedby the sequence of events: when the central incisors are lost, the deciduous lateral incisors andcanines can be used to incise food, whilst loss of the deciduous molars does not prevent crushingand grinding because the first permanent molars are already in place.The allied development of a gomphosis (periodontal ligament type attachment) allows theposition of each tooth to be adjusted after eruption, in response to forces produced during chewing, so that it normally ends up in the most efficient position. This adjustment can onlytake place within very narrow limits, so that it seems that environmental forces provide afine adjustment for the basic developmental controls that ensure that the jaws, and the teeth within the jaws.

**Postnatal development of the dentition**

When a child is born, mineralization of all the primary tooth crowns is well underway, withthis process also beginning in the first permanent molars. The primary dentition will start to eruptin the first year of life and will be established by the end of the third. The permanent dentition isheralded by eruption of the first molars at around 6 years of age and is completed in most cases,by the appearance of the third molars in the late teenage years.

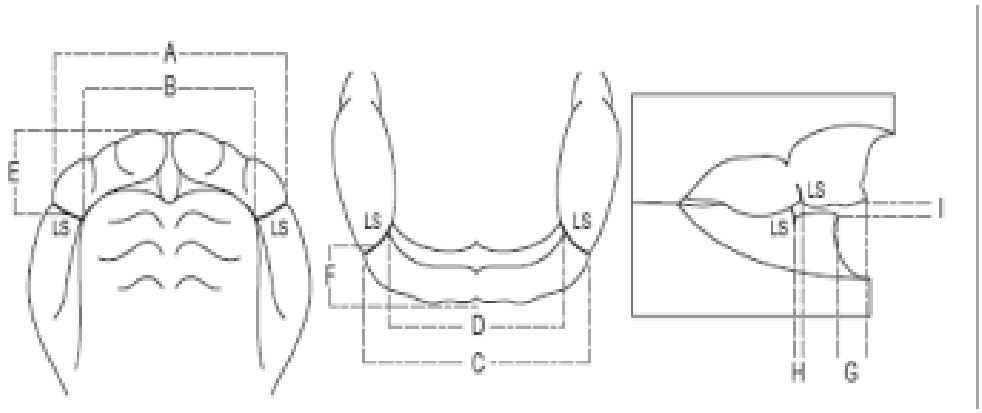
**Jaws at birth**

At birth, the maxillary dental arch is characteristically horseshoe-shaped whereas the mandibular arch assumes a wider U-shape. The mucous membrane of both the maxilla andmandible is thickened in the newborn infant to produce gum pads, which cover the alveolarprocesses containing the developing primary teeth .



Usually the upper jaw overlaps the lower jaw in antero-posterior and in transverse direction, in other word: the upper jaw is wider than the lower jaw and at the same time, the lower jaw is in aretrognathic position in relation to the upper. On the upper jaw, we can see the lateral sulcus, which express to the distal margin of the upper deciduous canine and the gum pads, which is separated from the masticatory mucosa by a long and continuous groove called gingival groove. The upper lip at this stage is usually short, and the anterior oral seal of the mouth occurs due to the contactbetween the lower lip and the tongue. At this age the anterior gum pads is averted anteriorly and when the child closes his mouth there is a space between the anterior gum pads and the only part that is in contact are the future growing;E(s)(Es,region).

The elevations of the Es cannot be seen clearly, until the age of 5 months, the anterior opening ofthe mouth will facilitate the feeding process without discomfort to the mother, at this age usuallythe labial frenum is attached to the incisive papillary region and after the eruption of the deciduous it will migrate in upward direction and gives the incisive papillary attachment this is due to alveolar bone formation in association with the development of the deciduous teeth.




Occasionally a child is born with teeth already present or that undergo precocious eruption within the oral cavity

- Natal teeth are present at birth.
- Neonatal teeth erupt within the first month of life; and
- Pre-erupted teeth appear within the second and third months of life.

Natal and neonatal teeth occur in around 1: 3000 children and are usually mandibular primaryincisors, although rarely they can be supernumerary teeth. They are often

poorly developed,mobile and can cause ulceration of the mouth and nipple during suckling. If these teeth give riseto problems, they should be removed.

**Eruption sequence of deciduous dentition: This includes:**

Lower (As) at 6th month, Lower (Bs) at 7th month, Upper (As) at 8th month, Upper (Bs) at 9$^{th}$month, Lower (Ds) at 12th month, Upper (Ds) at 14th month, Lower (Cs) at 16th month, upper(Cs) at 18th month, Lower (Es) at 20th month, Then finally, upper (Es) at 24th month.

The first sign of the formation of the deciduous teeth is at the age of 4-6 months IUL, andtheir roots will be completely formed after 12 – 18 months after their eruption. When these teeth

erupt in the mouth, they will erupt in a vertical direction i.e. the upper long axes of the centrals

coincide with the long axis of the lower incisors, and usually there is slightly increase in the overjet. These teeth usually present in their crept in a rotated manner, this is to occupy a less space in the child's mouth; so that, when they erupt, they will erupted in a spaced conditions, and these spaces usually present at the mesial aspect of the upper canine and the distal aspect of the lower canine. These spaces are termed as primary spaces or anthropoid spaces, since it looks like the spaces that are present between the teeth of the higher Apes. Such spaces also present mesial to the Ds, these spaces that are anterior to the Ds, try to close in a way that: the distal surface of the D (upper and lower) will be located on the same terminal plane and usually the lower D is larger in mesiodistal dimension than the upper D. The Es when erupt, they erupt in the same terminal plane (flush terminal).

In summary the complete primary dentition is classically associated with a number of characteristic features:

- The arches are semi-circular in shape;
- The incisors are spaced, upright and associated with a positive overjet and overbite;
- Primate or anthropoid spaces are present, mesial to the maxillary primary canines and distal to the mandibular canines;
- The molar and canine relationship is class I; and
- The distal edges of the second primary molars are flush in the vertical plane.

**Permanent Teeth:**

Variations in the eruption sequence of the permanent teeth are common, but as a rule, the

mandibular teeth erupt prior to the maxillary. Permanent teeth begin their eruption once

crown formation is completed, taking between 2 and 5 years to reach the alveolar crest

and a further 1 to 2 years to reach occlusion. Root development is usually completed within 2 years of eruption. Permanent teeth replace the deciduous teeth (A, B, C, D and E)

by (1, 2, 3, 4 and 5); while, the molars (6, 7 and 8) are developed in a separate entity.

- The sequence and timing of emergence of permanent teeth include:

  1-First stage for permanent teeth emergence (development);

  Lower 6 ⇒ at 6 years

  Upper 6 ⇒ at 6 – 6.2 years

  Lower 1 ⇒ at 6.5 years

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  Upper 1& lower 2 ⇒ at 7.5 years

  Upper 2 ⇒ at 8.5 year

  There is a silent period extend from 8.5 years of age to 10 years of age, this period is called (Lull period). In this stage: there is no teeth emergence (development) or exfoliation, but there is changes in the occlusion including the anteroposterior and vertical dimension.

2-Second stage of permanent teeth emergence:

Upper 4& lower 3⇒ at 10 years

Lower 4⇒at 10.5 years

Upper & lower 5⇒ at 11 years

Upper 3⇒ at 11.5 years

Upper & lower 7⇒at 12 years

3-Third stage of permanent teeth emergence: It is the stage of emergence of the third molars atthe age between 18 to 24 years of age (some time above 25).

The sequence of teeth emergence:- For the upper permanent teeth is (61245 3 7) ⇒ 100%. While the sequence of emergence of the lower permanent teeth is either: (6123457) ⇒ in 50% of cases, or: (6124357). In the lower arch, the first premolar may erupt after the emergence of the lower canine or before it.

**Occlusal changes in the permanent dentition**

The dentition does not remain static throughout life. Crowding of the mandibular incisors isone of the most common problems encountered in the permanent dentition and lower incisoralignment is one of the most likely things to relapse after orthodontic treatment. Studies ofuntreated subjects followed from the mixed dentition into adulthood have shown a tendency forthe width and length of the mandibular arch to decrease and for crowding of the anterior teeth toincrease. Primary crowding refers to a discrepancy of tooth dimension and jaw size, mainlydetermined genetically. Secondary crowding is caused by environmental factors, including localspace conditions in the dental arches and the position and function of the tongue, the lips and thebuccal musculature. Tertiary crowding occurs during adolescence and post-adolescence with apredilection for the lower labial segment.

# REVIEW OF LITERATURE

## REVIEW OF LITERATURE

**Finn Brudevol**[3]et al in 1951 conducted a study to evaluated chewing forces of a denturewearer. The method used in the present investigation permits measurements of the verticalforces in the mouth of a denture wearer during normal comfortable chewing. Measurementsmof the chewing forces on the two left maxillary bicuspids and the first molar of a denturewearer were made using a newly developed method which permitted measurements to betaken in the mouth during normal chewing. Nineteen different foods were tested, includingmeats, fish, fruits, vegetables and cereals. The forces required to chew a mouthful of foodvaried from 72 Kg for dried apricot to 271 Kg , for raw carrot, with the chewing confined toone side of the mouth. The mean force of a chewing stroke was in the range of 0.6 to 1.5 Kg.on the first molar and second bicuspid, with the magnitude somewhat less on the firstbicuspid. It should be emphasized that the chewing force of a denture wearer is surprisinglysmall, and, therefore, artificial posterior teeth with a good cutting edge are desirable.

**Schultz** [4] conducted a study in the year 1951, in his test that chewing efficiency was reducedby16 and 32% when the maxillary lingual cusp of anatomic 33 degree set to balancedocclsion were reduced to a flatter cusp form. A reduction of maxillary buccal cusp to aslightly negative cusp angle showed a 15% loss of efficiency.

**RaymondCohen**[5]et al conducted a study in 1956 to evaluated the relationship of anteriorguidance to condylar guidance in mandibular movement .This result shows that within therange of opening of the vertical dimension used, there is no change in the paths of condylarmovement regardless of the vertical dimension or the shape of the anterior guidance for themandible ; within the range of opening of the vertical dimension used, there is conclusiveevidence of the existence of the hinge action of the mandible. The paths of movement of themandible are governed by the condylar guidance and the anterior guidance. In any individualthe condylar guidance is fixed and immutable.The anterior guidance may be alteredsometimes within certain limits. It can be done only when we can change the degree ofvertical or horizontal overlap of the anterior teeth. Once the vertical and horizontal overlap of the anterior teeth, the plane of occlusion, and the compensating curve have been established for a given patient, there is one tooth form, andonly one, that will function best for that individual.

**Kapur**[6]et al in 1957 6 conducted a study an evaluation of centric relation record obtained

by various techniques, using three standard methods of recording centric relation, ie,intraoral tracing procedure , the wax registration procedure, extraoral tracing procedureand they came to a conclusion that the intraoral and extraoral method were more consistentas compared to the wax registration method. In patient with flabby ridges, the intraoral andextraoral tracing procedure became less consistent as compared to wax registrationmethod.

**Frush and Fisher** [7] **(1959)** suggested the use of specific molds for males and femalesrather than making a single mold work for both. They also advocated rotational andpositional changes with individual anteriors to achieve different light deflections; thisenhances the appearance of vitality in non-vital substances. Using non-interceptive linearocclusion posterior teeth and a bilateral fulcrum of protrusive stability, anterior teeth areplaced in the positions where they were prior to loss. This allows functional anteriorrotational contacts to be avoided. Promoting stability and positioning that enhances

phonetics and esthetics of the prosthesis. Besides this following this concept with lapping,rotation, and long axis angulation of individual teeth make prosthesis literally come alive.

**R.Trapozzano**[8]conducted a study in 1960 to differentiate balanced and nonbalancedocclusion. Among 12 patients studied, 2 preferred a balanced occlusion, 3 preferrednonbalanced occlusion, and 7 had no preference. Tracings made in the frontal planeindicate that patients will make eccentric movements during mastication in varying degreesif the occlusion permits this movement. Ten patients in this investigation adapted theirmandibular movements to the lack of provision for free movements in eccentric positionsduring function. Nine patients chewed with greater efficiency with a balanced occlusionthan with a nonbalanced occlusion. The difference was decisive in 2 patients. When the

entire diet and the patients' subjective reactions were considered, neither type of occlusionwas considered to have greater over-all efficiency. Neither type of occlusion produced agreater degree of soreness than the other. Neither type tested in this investigationdemonstrated a marked superiority over the other.There are some patients who do use eccentric movements during mastication, but thisstudy indicates the percentage who need them is small. A simple test of masticatoryfunction should be devised which will indicate, the construction of dentures is started,whether or not patients need provision for bilateral balance.

**Vincent** et al [9] in 1960 done a comparative evaluation of different occlusal schemes wascarried

out in the patient's mouth under normal conditions of wearing dentures. Test denture bases with interchangeable inserts with balanced and nonbalancedtypes of occlusion were made. There was slightly more complaint about the relative looseness of thedentures with the nonbalancedocclusion than there was with the balanced occlusion.

**Allen A. Brewer and Donald C. Hudson[10]**in 1961 studied the adjustment to completedentures 18 edentulous subjects clinically and electromyographically. Factors evaluated inthe included previous denture experience, retention and stability of the dentures, thesubjects own assessment of their progress, the pattern of chewing activity as observedelectromyographically, correlation between the subject's assessment of his chewing abilityand the electromyographic chewing pattern, and the subject's ability to shift his masticatoryactivity from one side to the other as observed electromyographically. Electromyographicexamination of muscle activity during mastication in edentulous subjects seems to be avaluable method for studying the adjustment to new dentures. Study have shown thatcomplete denture teeth do contact at times during mastication. However, it will last for 17min in a day.

**Woelfel, Mickey, and Allison[11]**, in 1962, tested anatomic (33°), modified anatomic (20°),and nonanatomic (0°) teeth to determine the influence of occlusal form on the jawmovements during chewing and the denture movement on its foundation. The shape of themasticatory cycle as shown with cinephotography was not influenced greatly by occlusalform. The closures in all three types of teeth were in close

proximity to the posterior bordermovement. Where the ridges of the subjects were good, the denture base movement wasminimal and approximately the same for the three types of teeth, but where the ridge waspoor, there was least movement with nonanatomic teeth.

**Peter Mjord[12] in 1965**conducted a study to evaluate the effect of the end controlling guideson cusp inclinations on the the working side and on the balancing side both with and withoutthe influence of a 15 degree lateral condylar guidance. In the protrusive position, cuspaalinclinations increased toward the steeper of the end controlling guides. The same was true forcusp inclinations on the balancing side during lateral movements. Cusp inclinations on theworking side were controlled mainly by the lateral incisal guidance. The degree of cuspinclination on the working side, as compared with the inclination of the lateral incisalguidance, increased or decreased posteriorly depending on the inclination of the condylarpathway on the balancing side.

**Atikins[13]** in 1967 conducted a study to evaluate various positions of mandible duringmasticatory cycle and relate them to the force developed. When the position of mandible andforce in the bicuspid area were recorded simultaneously, they found very little forcedeveloped until the teeth were through the bolus of food and nearly in contact. Aftercontact,the force buildups without significant mandibular movement.

Test conducted by **Shepperd[14]**in the year 1971 that second bicuspid to carry the heaviestload followed by the first molar and the first bicuspid. This is not surprising as the denturebase finds the antero-posterior centrecentre of the occlusal table to provide the best leverbalanace to stabilize the base in function.

**Kantor [15]** et al in 1972 conducted a comparative evaluation on centric relation techniquerecording by four technique i.e. swallowing or free closure , chin point guidance withanterior jig and bilateral maupulation , and concluded that most protrusive position wererecorded with free closure , the most retrusive were made with the chin point guidancewith anterior jig.

**Martti et al[16]** conducted a study in the year 1973 to compare different methods in active And passive recording of retruded position of the mandible.six methods of active and passiverecording of retruded position of the mandible were compared in an

inestigation carried outon 10 males volenteers. The position of the mandible was recorded with intraoral graphicmethod , the precision of the recording of retruded position was highest when recored bypassive hinge movement and lowest when recorded by active hinge movement and activeretrusion from habitul occlusion. No differences in the anterioposterior position of themandible in the retruded position were found between the active and passive recording.

**Bearn in 1973**[17]demonstrated the ratio of tooth size to the required force . When hemeasured the load carried by group of posterior teeth when chewing a biscuit. Three types ofocclusal tables were used broad, narrow, and knife edge. The pressure for the average strokewas 4.2,3 and 2.2 kg respectively, for the tree types of occlusal table.it is interesting to notethat same number of chewing stroke were generally used to complete the chewing beforeswallowing.

**Mehringer et al**[18]conducted a study in 1973 to evaluate the function of steep cusp in

mastication with complete denture , he evaluated the penetrating potential of various toothform used in denture construction .when the estimated amount of force is greater than 5pounds per molar almost any of the posterior tooth form will provide adequate normalpenetrating function , when the force is less than 5 pounds inadequate penetrating functionregardless of tooth. When the force-tolerance level is subminimal, the judicious use of steepcusp can be effective if opposed by shallow (10- 20 degree) occlusal surface Steep cusp dopenetrate food more easily and thereby produce less vertical trauma.

**Javidet al**[19]in 197519 evaluated the importance of the Hanus formula in construction of complete denture fabrication .The casts of five patients whose kinematic mandibular axes hadbeen previously located and tatooed on the face were mounted on six articulators . Thehorizontal and lateral condylar guidances of all articulators were adjusted by using 15interocclusal records (five protrusive and 10 right and left lateral) made in cold-curingacrylicresin. The adjustments for each articulator were repeated 20 times within fivedays.The lateral condylar guidances as adjusted by the interocclusal records were comparedwith those established by Hanau's formula. A significant difference in the means of the condylar readings occurred when theHanau articulator was adjusted with a lateral interocclusal record and the Hanauformula.The

rangeof means of lateral condylar guidances of Hanau articulators using theHanau formula was small. This small possibility of variation in the lateral condylarguidance would suggest the use of lateral interocclusal records when precise restorativeprocedures are necessary.The Hanau formula is the only formula available at this time to determine theaverage lateral condylar guidance as related to the horizontal condylar guidance.

In 1976**, Koyama, Inaba, and Yokoyama**[20]conducted a study on denture wearerpreference and masticatory efficiency for balanced, organic (cuspid protected), andlingualized occlusions in three complete denture patients. Masticatory efficiency washighest for the lingualized occlusion, next highest for the balanced occlusion, and lowestfor the cuspid protected occlusion. The differences in efficiency between lingualized andbalanced occlusions and also between lingualized and cuspid protected occlusions weresignificant .

In 1976, **Woelfel and Winter21** studied three groups of denture wearers over a 5–8 yearperiod. There were 15 subjects in each group wearing anatomic (33°), modified anatomic(20°), and nonanatomic (0°) teeth. The greatest bone loss and closure of the occlusalvertical dimension were observed in the group of denture wearers with nonanatomicposterior teeth and the least in the group wearing anatomic posterior teeth. Thenonanatomic group also needed the most adjustments over a 5 year period.

**Renner**[22]**et al** in 1976 to located the hinge axis for the edentulous patient by use of themodified Loma Linda hinge-axis locator. Advantage of this includes These include: (1)alteration of the vertical dimension of occlusion on the articulator may be accomplishedsince the opening or closing takes place around the patient's terminal hinge axis; (2) validand verified centric and eccentric relation records may be obtained at an increased verticaldimension of occlusion that is in harmony with the patient's terminal hinge axis; (3) cuspformposterior teeth can be articulated and verified in the mouth with minimal occlusalcorrection by use of a terminal hinge axis. Some disadvantages to the procedure mayinclude: (1) the additional procedure of making a modeling compound clutch for hinge-axis

location; (2) the initial modification of the edentulous trays to accommodate the recordingdevice; and (3) the technique is used with the Whip-Mix articulator; however, it can bemodified for use with other articulators.

**Mahamoud et al[21] in 1981**conducted a study to compare clinical evaluation of methodsused in locating the mandibular hinge axis . Five methods were used to locate the arbitraryhinge axis of the mandible on 120 dentulouspatients. The obtained axes were compared withthe kinematic axis which had been located on each patient.While none of the arbitrarymethods used proved to be ideal for locating the hinge axis, the axis located by Dawson'spalpation method fell consistently closer to the kinematic axis. A combination of the arbitrarymethods should therefore be used if it is not feasible to record the axis kinematically.

The force used in mastication by denture patients has been studied, and the findings aresignificant. In a study of 100 denture wearers with ages varying from 26 to 83 years, theaverage force in the molar and bicuspid area during mastication was 22–24 pounds. The forceexerted in the incisor area dropped to nine pounds. **Gibbs [24]** et al.1981 showed that theaverage closing force during mastication of complete denture wearers is only 11.7 pounds,which is considerably below the weakest closing force of subjects with natural teeth. Thecomparison between natural and artificial teeth shows that complete denture wearers canexert only from 10% to 15% of the force of a patient with good natural teeth. It appears,therefore, that the average complete denture wearer has barely adequate force for the work

required during mastication.

**Harold E . Clough in 1983[25]**compared the lingualized occlusion and monoplane occlusionin complete dentures. Sixty-seven percent of those people preferred the lingualized occlusalscheme because of improved masticatory ability, comfort, aesthetics.

**Hobo in 1985 [26]**conducted a study to evaluate reproducibility of mandibular centricity inthree dimensions and he uses three centric recording methods, i) unguided closure, ii) chin point guidance, iii) bilateral manipulation and concluded that bilateral manipulation showedthe most consistent reproducibility and is recommended for

centric relation registration. Theminimal condylar displacement by this technique indicated the existence of point centricposition.

**William A. Eichhold, et al in1986** [27]introduced a formula to determine the lateral condylarguidance from intraoral needlepoint tracings.Maxillary and mandibular master casts weremade for 10 patients seeking complete dentures. Stable denture bases with wax occlusionrims were used clinically to establish the vertical dimension of occlusion. A Hanau earpieceface-bow was used for mounting the maxillary cast.The mandibular cast was articulated bythe centric relation record from an intraoral needlepoint tracing. The centric relation positionwas at the gothic arch apex. The initial 5 mm distances traced from the apex along the rightand left lateral border paths were analyzed in this research. A formula to determine the lateralcondylar guidance (L) on a Hanau model H-2 articulator based upon intraoral lateral borderpaths (BP) was derived: L=l.O6BP-46 .Determination of L based on a BP can be madethrough geometric drawings.

**F. A. Colaizzi**[28] et al conducted a study in 1988 to evaluate the condylar and incisal bordermovements it was a comparative study of complete denture wearers and natural dentitionsubjects. Five edentulous patients having previous denture experience for a duration of 10 to21 years were selected for this study. Each had residual ridges of favorable morphology, firmmucosa, and a class I skeletal jaw relationship. Complete dentures with interchangeable posterior teeth were made for each patient. The two types of occlusal schemes tested were teeth without cuspal inclines (O-degree teeth) and teeth with cuspal inclines (30-degree teeth). They found out that denture teeth of both O-degree and 30-degree designs produced a rounded, poorly defined intercuspal like position in contrast to a sharp well-defined intercuspal position in the natural dentition subjects, denture wearers had a shallow angle of disocclusion in the frontal view compared with the natural dentition subjects, side shift (Bennett movement) was more than twice as great in the longterm denture wearers as in the natural dentition subjects , nonworking-side side shift was greater on the left than on the right side for the denture wearers, In the denture wearers, the working-side condylar movements were greater with a more lateral protrusive component than in the natural dentition subjects,the working-side movements were relatively limited,sometimes with a slightly lateral retrusive component.

**G. Grubwieser et al in 1989**[29]evaluate the Influence of balanced occlusion and guidance on electromyographic activity of elevator muscles in complete denturewearers.Lower muscle activity in patients wearing dentures providing anterior canineguidance compared to those with balanced bilateral balanced occlusion.

**Wilbur .O. Jensen in 1991**[30] published an article on alternate occlusal schemes. Bilateralbalance and reverse occlusions are the recommended physiologic occlusions to use when amandible disparity exists. Accurate reproduction of the posterior determinants is necessary. The arbitrary removal of balancing contacts can introduce imbalance, pain, lack ofguidance, and serious compromise of an otherwise sound occlusion.

**Uttz in 1955**[31], mandibular position indicator (MPI) was used to compare condylar positionbetween centric relation (CR) and centric occlusion (CO) for 107 patients beforeorthodontic treatment. The MPI data were examined to determine frequency, direction, andmagnitude of CO-CR difference. Twenty patients (18.7%) experienced a superoinferior (SI)or anteroposterior (AP) condylar displacement of at least 2.0 mm on one or both sides; 17(15.9%) displayed a transverse shift at the level of the condyles of 0.5 mm or greater.

**Dubojska et al in 1998**[32]evaluated the importance of occlusal balance in the control ofcomplete dentues. The complete denture of five patients who were having difficulty incontrolling their prostheses was accurately duplicated. The artificial teeth were replacedwith occlusally balanced teeth. Patients were asked to report their experiences with newdentures after 1 week, 3 weeks, 6 weeks By the end of 6 week, improvement in denturestability and eating comfort were reported by all patients.

In a study by **Ohguri**[33]in the year 1999 estimated which occlusion scheme shows bestconditions of pressure distribution on supporting structures in a complete denture prosthesisit was found that in a lingualized occlusion and fully balanced occlusion a great occlusalforce was not required for crushing hard food, and the stress to the supporting tissues issmaller than with monoplane occlusion.

**Sutton et al in 2000** [34]conducted a study to compare the level of subject satisfaction with 3type of occlusl forms in complete dentures. Lingual and anatomic occlusal forms wereperceived to be significantly superior in terms of chewing ability, when compared with zerodegree posterior Occlusal surfaces.

**Kimoto in 2006**[35]did a study carried out in 28 patients to evaluate whether patientstreated with complete dentures with lingualized occlusion (LO) exhibited more positiveresults than patients treated with complete dentures with bilaterally balanced occlusion(BBO). Despite limitations of this study attributed to the small sample size and lack ofrandomization, this pilot study found that edentulous patients fitted with completedentures with LO experienced and expressed greater satisfaction with their dentureretention. In addition, it was observed that a higher alveolar ridge resulted in greatermasticatory performance.

**Jameson in 2001** [36] presented an alternative approach to treating a patient who requires anew prosthesis and who exhibits conditions consistent with combination syndrome. The useof an alternative tooth form and occlusal concept (linear occlusion), with its inherentabsence of anterior vertical overlap, had been agreed on by both the patient and thepractitioner. According to this concept, there is no need for the traditional 2- to 3-mminterocclusal rest space. This is not to say that no interocclusal clearance is needed, just thatless is required. For this reason, the centric relation record was made at the verticaldimension of rest, which allowed the teeth to be arranged at a vertical height that reducedvertical overlap of the anterior teeth. Using linear occlusion concepts and alternative toothform, a functional and esthetically pleasing prosthesis was fabricated. The patient

experienced no problems phonetically and was pleased with her appearance as well as herability to chew. Anterior contact was eliminated, thereby reducing the potential for furtherbone loss caused by anterior hyperfunction syndrome.

**Michael FredericoManzolli Basso** et al in 2006 [37]conducted a study to compare theocclusal vertical dimension after processing complete dentures made with lingualizedbalanced occlusion and conventional balanced occlusion. Thirty sets of complete denturewith 15 sets of complete dentures were arranged in conventional balanced occlusion (control)and 15 sets in lingualized balanced occlusion. The

occlusal vertical dimension was measuredwith a micrometer before and after processing each set of dentures. After processing,dentures set in lingualized balanced occlusion showed an increase in OVD similar to thoseset in conventional balanced occlusion.

**A. F. Sutton et al in 2007** [38]conducted a study to compare subject satisfaction with 3 typesof posterior occlusal forms for complete dentures in a randomized cross-over controlledtrial. 3 sets of complete dentures were fabricated, each of which had a different posteriorocclusal form (0-degree, anatomic, and lingualized).Lingualized posterior occlusal formswere perceived to be significantly superior in terms of painful aching in the, mouth sorespots, eating ability and meal interruptions, compared with 0-degree posterior occlusalforms. Subjects with anatomic posterior occlusal forms had significantly fewer problems ineating compared with 0-degree posterior occlusal forms. There was no significant differencefound between the lingualized and anatomic posterior occlusal forms.

**Ramesh Chawdhary in 2008** [39]conducted a finite elemental analysis. A two dimensionalmodel of maxillary and mandibular complete denture mucosa and alveolar bone in the firstmolar region was designed. The occlusal aspect of denture teeth was altered to make 33, 20and 0 cusapal angulation. A functional load of 50 N was applied through mandibular modelbase.Stresses of greater mangnitude were observed in cuspal teeth, 33 and 20 respectively,whereas 0 teeth showed a slightly less magnitude of stresses generated.

**Baulos PJ et al** [40]in 2008 conducted a study to compare different recording method for Bennett angle.The use of interocclusal records with semi-adjustable articulators has beenproposed as an easier alternative to axiograph. The operator measured the Bennett angle of 30participants using an axiograph Quick-Axis, an arcon Whip-Mix and non-arconDentatusarticulators. Wax and polyether interocclusal recording materials were used with both typesof articulators. Compared to the reference axiograph, the Whip-Mix plus wax combinationwas the nearest one and the Dentatus plus polyether was the most significantly differentcombination..

**Arcelino fariasneto**[41]et al in 2010 conducted a study to evaluate the masticatoryefficiency in denture wearers with bilateral balanced occlusion and canine

guidance A totalof 24 edentulous patients who wore sets of complete dentures with both occlusal conceptsduring equal period of 3months.The masticatory efficiency test performed by thecolorimetric method with the beads in which capsules of a synthetic material enclosingfuchsine-containing granules were used. Subjective data were recorded by patient's ratingsof their chewing function. No significant statistical difference was found for masticatoryefficiency between the two occlusal concepts studied. The results suggest that bilateralbalanced occlusion does not improve the masticatory efficiency in complete denturewearers.

**MansuangArksornnukit(2011)**[42]conducted a study to evaluate the Pressuretransmission and distribution under denture bases using denture teeth with differentmaterials and cuspal angulations **,** three types (acrylic resin, microfilled composite resin,and ceramic) and 4 different cuspal angulations (0 degree, 20 degree, 33 degree, and 35degree) of denture teeth were evaluated. Pressure transmission, distribution, and maximumpressure were observed with pressure-sensitive sheets under an impact load. He found outdenture tooth materials and cuspal angulations had significant interactions with respect toaverage pressure. maximum pressure transmission. Zero-degree denture teeth showedsignificantly lower average and maximum pressures than 33- and 35-degree denture teethfor all 3 denture tooth materials . Denture teeth with greater cuspal angulationsdemonstrated significantly higher average pressure transmission for all ceramic dentureteeth groups. Cusped denture teeth presented significantly higher average pressure andmaximum pressure transmission compared to 0-degree denture teeth.

In a study by **Matsmaru in 2010**[43], he evaluated the influence of mandibular residual ridgeresorption on masticatory measures of lingualized and fully bilateral balanced denturearticulation(FBBA). Mandibular movements were measured at 3- and 6-month follow-ups.Mandibular RRR was assessed as the sum of the mandibular bone height at the midline, firstpremolar region, and least vertical height region, and from the mental foramen to the alveolarcrest, measured on panoramic radiographs; the treatment groups were sub classified intosevere or moderate RRR subgroups by the value of the sum of individual measurements.Significant differences were observed in the between-subgroup comparison of the MPI andlinear deviation from intercuspal position .The patients with severe RRR in the FBBA groupshowed a significant

decrease in the MPI and increase in linear inferior deviation fromintercuspal position at 3 months (post hoc comparison) as well as a significant increase in the

linear posterior and inferior deviation from intercuspal position at 6 months. Lingualized is thepreferable occlusal scheme for patients with severe RRR.

**Srdjan D. Poštić**[44]in 2012 evaluated the influence of balanced occlusion in completedentures on the decrease in reduction of an edentulous ridge, using their panoramicradiographs and parameters of vertical dimension of edentulous ridges. All the patients wereclinically examined by the same and qualified dental practitioner. Results shown that verticaldimension and heights of edentulous ridges were different after comparison of parameters incomplete denture wearers with balanced occlusion and complete denture wearers withoutbilaterally balanced occlusion.Balanced occlusion is a favored occlusal design in setting ofartificial teeth in conventional complete dentures,which preserves edentulous ridge andinfluence the stability of dentures.

**Paleari AG** [45]**et al in 2012** compared the effect of canine guidance (CG) and bilateralbalanced occlusion (BBO) on denture satisfaction and kinesiographic parameters of completedenture wearers by means of cross over trial Outcomes were assessed after 30 days of eachocclusal scheme. The results showed no difference between occlusal schemes on participantsatisfaction and in any of the kinesiographic parameters studied, except for the verticalintrusion of the maxillary complete denture during chewing, which was lower with CG.

**Mridul Thakur** [46] in 2012 evaluate and compare the centric relation and horizontal condylarguidance using interocclusal wax and extraoral gothic arch method.These records weretransferred to articulator and difference in both values were recorded. Response of dentureswas evaluated using Woelfel subjective evaluation criteria. Centric relation record didcoincide in 7.42% of patients. Centric relation recorded by interocclusal wax was posterior togothic centric relation in 21.43% of patients, and anterior to gothic centric relation in 71.42%.Gothic arch method records the centric relation at amore posterior position than static method,but it doesnot make any difference in clinical performance of dentures. Horizontal condylarguidance angle was approximately similar by both the methods.

**Mohhamadjavad Shirani**[47]**,**et al in 2013 compared the patient satisfaction levels with complete dentures of different occlusions**.** Three sets of complete dentures were made for eachof 15.They received (1) fully bilateral balanced occlusion (BBO), (2) lingualized occlusion,and (3) buccalized occlusion (BO) denture sets in random order. After wearing each set for 6weeks, patient satisfaction was assessed. BO resulted in lower avoidance of particular foodsand physical disability scores than fully BBO.

**Sowjanya**[48] et al in 2015 evaluated the feasibility of using panoramic radiograph as analternative to an interocclusal recording method for determining the condylar guidance indentate and edentulous condition. Result shown that condylar guidance values obtained by theinterocclusal method and radiograph method in dentate individuals on the right side and left side 40.50, and 37.1 0 and 40.1 and 34.75 o respectively. In the edentulous patient , thevalues on the right side and left side was 36.70, and 36.10 and 35.950 and 33.60respectively.The difference is statistically.

**Krishnaprasad**[49]et al conducted a study in the year 2016 to determine the average condylarinclination using ultrasonic axiograph; to determine the average condylar inclination usingprotrusive interocclusal bite records; to compare whether there is any marked difference in thevalues obtained by these techniques. This clinical study compares the mean horizontalcondylar inclination of the ultrasonic axiographand the manual programming using protrusiveinterocclusal records. The average condylar inclination by axiograph is 42.125°. The averagecondylar inclination by interocclusal record is 33.25°. Comparison of both values shows adifference of 8.88° ± 4.03° that showed a significant difference

**Poornima Madalli**[50] et al in 2015 evaluated the effect of occlusal schemes on the pressuredistribution of complete denture supporting tissues. Overall monoplane occlusion had lesser pressure value compared to completely balanced and lingualized occlusal scheme.Lingualized occlusal scheme was found to transfer stresses from working side to non-workingside to stabilize the mandibular denture.

**Sanjay Vasanth**[51]et al a study carried out in 2015 to evaluate and compare the lateralcondylar guidance using the Hanu's formula and computerized jaw tracking device(kinesiograph) , on right and left side using both these methods. A comparative evaluation wasmade on obtained values. Statistically significant differences exist.

**Coelho et al in 2015**[52] a study was conducted to identify the influence of backrest inclinationon the registration of the mandibular position.Ten participants aged between 18 and 30 years with a complete permanent dentition, uncompromised motor function, no tooth mobility, andno temporomandibular disorders were selected. To register interocclusal contacts, anautopolymerizingmethylmethacrylate device was adapted to the maxillary anterior teeth and acomposite resin increment was added to the mandibular central incisors. Contacts wereregistered with the following variations in the inclination of the dental chair backrest: 90degrees, 120 degrees, and 180 degrees. A standardized digital photograph was made of eachmark in each backrest position, and the images were superimposed to measure the distances inregistration from 90 to 120 and from 90 to 180 degrees. When the chair was inclined from the 90-degree to the 120-degree position, the mandible was repositioned posteriorly by a mean of0.67 mm, but the difference was not statistically significant. When the chair was inclined fromthe 90-degree to the 180-degree position, however, the mandible was repositioned posteriorlyby a statistically significant mean of 1.41 mm.Mandibular position is influenced by increasinginclination, and this influence was statistically significant at a 180-degree incline.

**Nohre- Solvang A** et al in 2015 [53] conducted a study to evaluated relationship betweenretruded contact position (RCP) and maximal intercuspal position (MIP) has receivedconsiderable interest in dental literature, but there are still unanswered questions. The aimswere to establish a method for accurate measurement of the distance between RCP and MIP ina group of healthy young adults and to analyse the relationship between RCP-MIP distancesand some other variables. Recording of RCP was performed in 79 healthy subjects using bothoperator and patient guidance of the mandible. Horizontal and vertical distances between thesepositions and MIP as well as overjet and overbite were measured with a precision apparatus.There were significant differences between positions recorded with operator and patientguidance; RCP was on average 0.24 mm more posterior with operator than with patientguidance. Mean overjet and overbite were 3.42 mm and 2.85 mm, respectively. Means of the horizontal and vertical operator-guided RCP-MIP distance were 0.84 and 0.72 mm,respectively; the range was 0 to 2.5 mm. There were no significant differences for horizontalRCP–MIP distance between subjects with Angle Classes I

and II, nor between those with and without previous orthodontic treatment. There was no sex difference for means of themeasurements.

**Oliver Schierz**[54]in 2016 compare the impact of canine guided vs. bilateral balancedocclusion on oral health related quality of life (OHRQoL) as a patient-reportedoutcome measure. When wearing dentures with bilateral balanced occlusion,participants showed on average 1.6 points higher OHIP-49 scores and 0.9 points higherOHIPEDENT scores compared to canine guided dentures. This effect of the occlusalconcept was neither statistically nor clinically significant in dentate group and was not statistically insignificant in edentulous group.

**Mahmod**[55] in 2016 compare the numbers of post insertion appointments for occlusaladjustments in removable complete dentures made with and without facebow record. It wasan observational, retrospective study. Complete data record of 18 patients who receivedremovable complete dentures (rcds) made using a facebow transfer and 24 patients whoreceived removable complete dentures (rcds) without using face–bow transfer was recoveredtotal number of post insertion appointment for occlusal adjustments were tabulated forpatients treated with complete denture made with or without facebow. All the materials,instruments and techniques which may have some influence on treatment outcomes had beenkept similar for dentures made with and without using face bow. Result show that thenumber of post insertion visits by the patients whose dentures were made with face–bowrecord was significantly less as compared to the patients whose dentures were made withoutusing face–bow record. Face–bow transfer record in the fabrication of removable completedenture reduces the number of post insertion visits for occlusal adjustments and hence save asvaluable time of the dentist and the patient.

**Suredran in 2016**[56]conducted a study is an attempt to evaluate the curve of Spee and curve of Wilson in young Indian population using three dimensional analysis. This study comparedthe radius and the depth of right and left, maxillary and mandibular curves of Spee and theradius of maxillary and mandibular curves of Wilson in males and females. The cusp tips ofcanines, buccal cusp tips of premolars and molars and palatal/ lingual cusp tips of secondmolars of 60 maxillary and 60 mandibular casts were obtained. Three-dimensional coordinatesof the cusp tips of the molars, premolars, and canines of the right and left sides of the maxillaand mandible were

obtained with three dimensional coordinate measuring machine. Thevalues of curve of Spee and curve of Wilson in Indian population obtained from this studywere higher than the 4 inch (100 mm) radius proposed by Monson. These findings suggestethnic differences in the radius of curve of Spee and curve of Wilson.

**Lee et al in 2017**[57]conducted an in vitro study to examine potential occlusal error by usingaverage condylar guidance settings during nonworking side movement of thearticulator.Three-dimension positions of the nonworking side maxillary first molar atvarious condylar and incisal settings were traced using a laser displacement sensor attachedto the motorized stages with biaxial freedom of movement. To examine clinically relevantocclusal consequences of condylar guidance setting errors, the vertical occlusal error wasdefined as the vertical-axis positional difference between the average setting trace and theother condylar guidance setting trace. In addition, the respective contribution of the condylarand incisal guidance to the position of the maxillary first molar area was analyzed by

multiple regression analysis using the resultant coordinate data. Results showed thatalteration from individual to average settings led to a positional difference in the maxillaryfirst molar nonworking side movement. When the individual setting was lower than average,vertical occlusal error occurred, which might cause occlusal interference. The verticalocclusal error ranged from -2964 to 1711 μm. In addition, the occlusal effect of incisal guidance was measured as a partial regression coefficient of 0.882, which exceeded theeffect of condylar guidance, 0.431 potential occlusal error as a result of adopting an averagecondylar guidance setting was observed. The occlusal effect of incisal guidance doubled theeffect of condylar guidance.

**Kawai Y**[58] et al in 2017 conducted a study to compare LO and FBBA in edentulousindividuals with compromised ridges. Sixty edentulous individuals were randomly allocatedinto groups and received dentures with either LO or FBBA. Following delivery, severaldenture-related satisfaction variables were measured using 100 mm visual analogue scales;oral health-related quality of life (OHRQoL) was also assessed using the Oral Health ImpactProfifile (OHIP). Sub-group analyses of the effect of moderate and severe mandibular boneloss were also carried out.No significant differences were detected between LO and FBBAwith the primary outcome. At 6 months, participants with severelatrophied mandibles andFBBA rated

their satisfaction with retention of mandibular dentures signifificantly lower thanthose with LO. The results indicate that the LO occlusal scheme with hard resin artifificialteeth is more effificient for patients with severely resorbed mandibular ridges. The 'tetrahedral hypothesis'[59] of occlusion states that a regular tetrahedron, derived fromBonwill's equilateral triangle, constitutes the unifying 3D geometrical figure of all wellknowntheories of occlusion (Bonwill's equilateral theory of occlusion, Spee's sagittalcurves of occlusion, Monson's spherical theory of occlusion and Hall's conical theory ofocclusion); and the height of the regular tetrahedron represents the rest vertical dimension.

**Khan in 2017**[60] did a case study to evaluate importance of lingualised occlusion . Teetharrangement was done using lingualized occlusion- concept given by Payne in 1941. The teeth arrangement wadone such that only the maxillary palatal cusp touching the lowercentral groove. Both the buccal cusp was free of contact. The denture fabricated with thistype of occlusion in centric working and non-working mandibular positions articulate whenthe maxillary lingual cusp was in contact with mandibular occlusal surfaces. The buccalcusps are free of contact and free of interference when allowed for movement in lateralexcursions. The lingualized tooth set up creates more room for tongue, reduces the risk ofcross bite and is excellent for atrophied ridges. Giving this type of occlusion to the patientenhances esthetics, increased chewing efficiency and no post insertion adjustment for tissueirritation. Hence patient is satisfied with this type of occlusion. The various treatmentoption would be fabricating a complete denture using neutral zone technique, monoplane occlusion. The lingualized occlusion is certainly one of the choices for many reasons- It is very efficient for mastication. The number of contact points to control greatly reduced andeasier to manage with this form of occlusion. Easier to achieve in the laboratory. Whenesthetically viewed gives natural and pleasing appearance

**Abdelhamid**[61]in 2017 conducted a study to evaluate the effect of bilateral balancedocclusion (BBO) and canine guidance occlusion (CGO) on the masseter muscle activityusing implant-retained mandibular overdentures. Cone beam computed tomographyevaluation of twelve edentulous patients was completed.Mucoperiosteal flaps werereflected and two implants were placed in the interforaminal region for each of the twelvepatients. After a healing period of 3 months, acrylic resin maxillary

complete dentures andmandibular overdentures were fabricated with BBO for six patients and CGO for the othersix patients. Positioner attachments were used. Electromyographic evaluation of the masseter muscles, during clenching on a silicon index and chewing peanuts and cake, wasconducted on the patients after using their dentures for 4 weeks. Each occlusion conceptas then converted into the other concept using the same dentures and the procedure ofevaluation was repeated after 4 weeks.Result was the highest electromyographic activity ofthe masseter muscles was recorded during clenching on a preformed silicon index followedby chewing peanut then cake for both occlusal concepts. The recordings of the massetermuscle associated with CGO were higher than BBO but with no statistically significantdifference. The results show that by applying CGO, muscle activities similar to bilaterallybalanced occlusion were obtained.

**Vijay Kumar Peddinti**[62]et al conducted a study in 2017 to evaluate and compare themasticatory efficiencies of complete dentures with different occlusal scheme. Fourteencompletely edentulous patients from the age group of 5-70 years were selected according tothe inclusion criteria followed in this study. The dentures were made with three differentocclusal schemes, i.e., anatomic occlusion without balancing, anatomic occlusion withbalancing, and lingualized occlusion and stored in water till the date of denture insertion.Postinsertion instructions were given to the patients at the time of delivery of the dentures.Patients were recalled after seven days and then masticatory efficiency was performed. Thetest was performed using boiled peanuts and Sieve system. Within the scope of this study, itcan be concluded that the masticatory efficiency will be generally higher in patientsprovided with complete dentures fabricated using the lingualized occlusal scheme.

**Shala**[63]et al in 2018 conducted a study to evaluate maximum bite forces (mBF) indominant (DS) and non-dominant sides (NDS) at certain time periods after the insertion ofnew complete dentures based on prior experience and gender. A total of 88 patients,complete denture wearers (CDWs), were examined. The maximum bite force at theintercuspal position between the first molars in 3 seconds was registered and recorded withpiezoelectric gnathodynamometer. The procedure was repeated 3 times in identicalconditions, with relaxation intervals of 1 minute between repeats and the limiting factorwas the subjective feeling of pain. The average MBF values increased

during the observational period both on the DS and NDS, with significant difference in DS, whichwas greater. The analysis of one-factor variance showed that there were differences of average Mbf` values in DS and NDS during six consecutive measurements.Significant changes in the masticatory force (mBF) on the DS and NDS is explained by different measurement times and with the prior experience with complete dentures.

**Paul R** [64]in 2018 conducted a study to evaluate and compare the correlation betweenlateral condylar guidance values in edentulous people using protrusive interocclusalrecorded mounted on a semiadjustable articulator with manual tracing of panoramicradiograph and lateral cephalograph . Radiographic method yielded greater value of HCG as compare to clinical values.

**Prithivi Udhyaraja**[65]et al conducted a study in 2018 to evaluate the knowledge, attitude,and practice of occlusal concepts in complete denture among general dental practitioner .Majority of general practitioner preferred balanced occlusion and for V shaped arches theyprefer canine guided occlusion. For patient with increased interarch space, they preferbalanced occlusion followed by lingualized occlusion. For patient with highly resorbed aswell as well formed ridges, balanced occlusion was the choice.

**Jonatha**[66] et al in 2018 Conducted a study to identify those aspects or attributes within theexisting definitions of CR in which there was agreement or disagreement among themembers of the AP.After pretesting and institutional review board approval, a secondsurvey of the AP membership was performed using both email and postal mail surveymethods of contact. The CR Attributes Survey separated and stratified the previousdefinitions of CR into 5 domains: spatial relationship, condylar position, articular disks,mandibular movement, and recording. Each domain attribute was evaluated by agreeuncertain-disagree assessments. Also recorded were demographics, perception of scientificevidence, and open comments.Of the total 146 fellows, 100 completed the survey for anoverall response rate of 68.5%. The query completion rate ranged from 96% to 98%. TheCR Attributes Survey revealed those components within each domain in which there wasstrong agreement, disagreement, or uncertainty. The survey assessment of those querieswith a moderate to strong agreement were that CR is “spatial relationship” that is (1) aclinically determined relationship of the mandible to the maxilla, (2) a repeatable position,(3) is

independent of tooth contact, and (4) is a physiologic position. Relative to “disks,”the condyles articulate with the thinnest avascular intermediate zone of their respectivedisks; however, there is a lack of sufficient evidence to determine the position of the disksand the condyles. Relative to “mandibular movement,” CR is (1) a starting point forvertical, lateral, or protrusive movements, (2) is where the individual can make to and from lateral movements, and (3) is restricted to pure rotary movement about a transversehorizontal axis. Relative to “recording CR” (1) it can be determined in patients without painor derangement of the temporomandibular joints (TMJs), (2) but may not be recordable inthe presence of dysfunction of the masticatory system, or (3) due to the neuromuscularinfluence or proprioception from the dentition, (4) is a clinical useful repeatable referenceposition for mounting casts, or (5) for developing a functional treatment occlusion, (6) at anestablished vertical dimension, and (7) may vary slightly by recording method.

**Kharzinejad**[67] et al in 2018 , a study was conducted with the aim of correlating thecondylar slope size in panoramic . This is a descriptive-analytic study. Both jaws were molded in patients. The upper jaw’s cast was mounted using FaceBow record on thearticulator and the lower cast was mounted by using maximum intercuspation relationship.To record protrusive movements, the patient was asked to move their mandible to the pointin which the jawbone were edge to edge. Condylar slope was also determined onradiographic images **:** The findings indicated that mean slope of the right interocclusal record was 33.9 ± 19.3 and for the left side it was 33.79 ± 3.22, right panoramicradiography has been 35.88 ± 3.37 and for the left side it was 35.93 ± 3.27. The correlationbetween the gradients recorded by panoramic radiography and interocclusal records inprotrusive movements in the right condyle was in the left condyle. The tests showed asignificant difference in the difference in the condylar slope in panoramic radiography andinterocclusal recording method in the left and right sides.

## HISTORY

- ✓ The first description of the occlusal relationships of the teeth was made by Edward angle in1809.
- ✓ Occlusion became a topic of interest and much discussion in the early years of modern dentistry, as the restorability and replacement of teeth became more feasible.
- ✓ Many authors laid down theories of occlusion Bownwill in 1858 described the equilateral triangle theory based on points of occlusal balance. He was the one who coined the word articulation.
- ✓ Spee in 1890 introduced the concept of curve of spee.
- ✓ The biomechanical concept of lingualizedocclusionwas rooted in Alfred Gysi's 1927 design forhis Cross-bite Posterior Teeth
- ✓ 1n 1941 described a technique developed by Dr. Edison J. Farmer, of Buffalo. Basically, 30° anatomic porcelain teeth were modified by careful grinding to achieve a mortar and pestle effect
- ✓ Manson 1918 put forth the spherical theory of occlusion. Rehall gave conical theory ofocclusion.
- ✓ Balanced occlusion was based on the 3 theories of occlusion. This concept advocated bilateral and balancing tooth contacts during all lateral and protrusive movements. Hanau in 1926formulated laws of balanced articulation (called hanau's quint). Stransbury and kurth were advocates of this theory
- ✓ Box, miller, sorrin in 1950 pointed out the importance of balanced occlusion and emphasizedthe need for wide distribution of stresses.
- ✓ Sears 1952 published some axioms for planning complete denture occlusion.
- ✓ Moses 1954 suggested that the pleasure curve is desirable in all patients.
- ✓ Jakelson in 1955 disagreed with bilateral balanced theory in all patients.
- ✓ In 1955, Chastain G. Porter, of Kansas City, advocated use of nonanatomic teeth with no cusp height, sharp cutting ridges, and excellent sluiceways. His method of altering the mandibular teeth left working contacts only on the lingual half of the of the occlusal surfaces. The buccal halfwas left in "subocclusion
- ✓ Dr. M.B. Sosin's, 1961 Cross Bladed Occlusal Inserts consisted of nonanatomic metal occlusals set in the maxillary arch. These were used to functionally

generate the mandibular metal occlusal anatomy. Sosin's metal occlusals provided a lingualized occlusion.

- ✓ The late 1960s and 1970s, Dr. Earl Pound, of Los Angeles, emerged as a champion of lingualizedocclusion.
- ✓ Dr. S. Howard Payne, whose 1941 article defined lingualized occlusion as it has come to be understood.
- ✓ Trapazzano in 1963 and Levin in 1978 laid down laws called triad and quad of articulation.
- ✓ Devan in 1954 suggested the concept of neutrocentric occlusion which embodies the centralization of occlusal forces which act on the basal seat when the mandible is in centric relation to the maxilla.
- ✓ Organic occlusion concept was put forth by stuart, stallard in 1961 and Thomas in 1967.
- ✓ Schweitzer in 1963 put forward the theory of transographics. Payne in 1941 and pound in 1973 described the lingualized concept of occlusion
- ✓ 1967 Frush Linear occlusal concept
- ✓ Swenson in 1964 , yurkstas in 1968 , bruce in 1971 described methods of establishing occlusion in single complete denture.

# TERMINOLOGY

## OCCLUSION:

Watt &McCrager defined occlusion as static closed relationship of cusps/ masticating surfaces of upper and lower teeth.

Or

The act of closure or state of being closed.

According to Dorland Dictionary -Occlusion is the relation of the maxillary and mandibular

teeth when in functional contact during activity of the mandible.

Occlusion is the act or process of closure or of being closed or shut off; 2. the static relationship

between the incising or masticating surfaces of the maxillary or mandibular teeth or tooth

analogue.(GPT9)

## ARTICULATION

Is the dynamic sliding contact of cusps of upper and lower teeth that takes place during closed

grinding movements of the mandible. Articulation is the continuous change from one occlusal position to next.

## BALANCED OCCLUSION:

It has been defined in more than one manner.

-Balanced occlusion is the simultaneous contacting of the maxillary and mandibular teeth on the right and left and in the posterior and anterior occlusal areas when jaws are in either centric or eccentric relation‖. (Hartwell)

-Balanced occlusion in complete denture can be defined as stable simultaneous contact of the

opposing upper and lower tooth in centric relation position and a continuous smooth bilateral

gliding from this position to any eccentric position within normal range of mandibular function.

Balanced articulation is defined as the bilateral, simultaneous occlusal contact of theanterior and posterior teeth in excursive movements (GPT 9)

**BALANCED ARTICULATION:**

Is a continuing sliding contact of upper and lower cusps all around the dental arches during all

closed grinding movements of the mandible.

**FREE OCCLUSION:**

The inference here is that there are no cuspal interferences in lateral and protrusive movements,

but balancing tooth contact are not necessarily present on the side opposite to the occluding

side of the denture. The difference between free occlusion and balanced occlusion can be easily distinguished by asking the patient to grind his teeth firmly and then open the mouth, the denture with free occlusion will loosen but the denture with balanced occlusion will become firmer than ever

.

**BENETT ANGLE:**

The angle formed between the sagittal plane and the average path of advancing condyle as viewed in horizontal plane during mandibular movement.

**BORDER MOVEMENT:**

Mandibular movements at the limits dictated by anatomic structures as viewed in given plane.

**COMPENSATING CURVE:**

The anteroposterior curvature (in the median plane) and the mediolateral curvature (in the frontal plane) in the alignment of the occluding surfaces and incisal edges of artificial teeth that are used to develop balanced occlusion.Anteroposterior curve: (GPT 9). The anatomic curve established by the occlusal alignment of the teeth, as projected onto themedian plane, beginning with the cusp tip of the mandibular canine and following the buccalcusp tips of the premolar and molar teeth, continuing through the anterior border of themandibular ramus, ending with the anterior most portion of the mandibular condyle.

**CURVE OF WILSON** : Eponym for the MEDIOLATERAL CURVE; 2. in the theory thatocclusion should be spherical, the curvature of the cusps as projected on the frontal planeexpressed in both arches; the curve in the mandibular arch being concave and the one in themaxillary arch being convex

**CURVE OF MONSON**

Eponym for a proposed ideal curve of occlusion in which each cusp and incisal edges touches or conforms to a segment of the sphere with 8 inches in diameter with its center inglabella.

**CURVE OF PLEASURE / ANTIMONSOON CURVE / FREQUENCY CURVE / PROBABILITY CURVE / REVERSE CURVE**:

In excessive wear of the teeth, the obliteration of the cusps and formation of either flat/ cupped out occlusal surfaces, associated with the reverse of the occlusal plane of premolar, first and second molar teeth, whereby occlusal surfaces of the mandibular teeth slope facially instead of lingually and those of max illary teeth incline lingually.

**FISCHER'S ANGLE:**

Angle formed by the intersection of the protrusive and non-working side condylar paths as viewed in the sagittal plane.

**FACE BOW:**

A caliper like instrument used to record the spatial relationship of the maxillary arch to someanatomic reference point/ points and then transfer this relationship to an articulator.

It orients the dental cast in the same relationship to the opening axis of the articulator.

Another term,which deals with the relationship of the maxillary and mandibular teeth is Dentalarticulation.Dental articulation is defined as, ―The static and dynamic contact relationship between theocclusal surfaces of the teeth during function – GPT

It is generally considered that occlusion deals with the static relationship of opposing teethand articulation deals with the dynamic (during movement) relationship of the opposing teeth.In this chapter, we have grouped for convenience occlusion and articulation as a singlephenome.

## DIFFERENCES BETWEEN NATURAL AND ARTIFICIAL OCCLUSION[69]

| Natural teeth | Artificial teeth |
|---|---|
| Natural teeth function independently and each individual tooth disperses the occlusal load | Artificial teeth function as a group and the occlusal loads are not individually managed. |
| Malocclusion can be non-problematic for a long time | Malocclusions problems |
| Non-vertical forces are well tolerated | Non-vertical forces damage the supporting tissues |
| Incising does not affect the posterior teeth. | Incising will lift the posterior part of the denture |
| The second molar is the favoured area for heavy mastication for better leverage and power | Heavy mastication over the second molar can tilt or shift the denture base |
| Bilateral balance is not necessary and is usually considered a hindrance | Bilateral balance is mandatory to produce stability of the denture. |

# CONCPTS OF OCCLUSION IN COMPLETE DENTURE

# CONCEPTS OF COMPLETE DENTURE OCCLUSION

1. Balanced occlusion
2. Lingualised occlusion (Gysi, Payne, Pound and Murrel)
3. Spherical concept of occlusion (monsoon)
4. Organic concept of occlusion
5. Neutrocentric concept of occlusion (De-Van)
6. Monoplane occlusion
7. Linear occlusion
8. Lineal occlusion
9. Physiologically generated occlusion

**A) Spherical concept of occlusion: (monson)**[68]

According to this concept, the anteroposterior and mesiodistal inclines of the artificial teethshould be arranged in harmony with a spherical surface. ( as mentioned in curve of monson). In1949, Harry Young described the established and traditional concepts of complete dentureocclusion: the spherical theory dictates that tooth contacts be multiple and in harmony with theanatomic guides and functional characteristics of each patient. With a variation in the angulationof the condylar and incisal guidance, the movement paths of intervening teeth must be arced andthe paths must lie principally in the horizontal plane. The teeth, therefore, must be arranged witha compound curve running anterio-posteriorly and a Monson curve running transversely." In thepaper, Young added, "Arrangement for the spherical concept has been standard practice forperhaps half a century."

**B) Organic concept of occlusion [69] :**

In this concept, the anterior teeth are arranged according to the requirements of esthetics andphonetics. Extreme vertical overlaps producing cuspid guidance are frequently used, resultingin disocclusion of the posterior teeth away from centric occlusion. Characteristic of thisconcept is the use of pantographic tracings and the transfer of these recordings to an instrumentto eliminate all potential deflective contacts in the arrangement of posterior teeth. Thisocclusion is based on the muscles and joint determines the mandibular position without toothguidance and that the teeth in the function should always be passive to the parts of themandibular movements.

In organic occlusion

- The posterior teeth should protect the anterior teeth in the centric occlusion position
- The maxillary incisors should have sufficient vertical overlap to provide separation of the posterior teeth when the incisors are in edge-to-edge relation
- In lateral mandibular position outside the masticatory movements, the cuspids should prevent contacts on all other teeth.

C)**Neutrocentric concept**

In 1954, De van [70] formalized guidelines for using flat teeth in his-Neutrocentric concepts,which stated flat occlusal surfaces should have:

- Flat planes in all directions with no inclination at all in respect to theunderlying denture foundation
- Balance was considered undesirable, as theresulting inclines would createinstability of the dentures.

Thus, the teeth are not inclined to form compensatory curves. In mediolateral direction, the teeth are set with no medial and lateral inclination. Thus, the concept of occlusion eliminates anyanteroposterior or mediolateral inclines of the teeth and directs the forces of occlusion to theposterior teeth. The occlusal plane is parallel to the mean plane of the denture foundation.

This concept was carried out by limiting the mesiodistal extent of the occlusal table to avoid arranging the teeth over the lower molar slope inherent in the posterior portion of the residual ridge. To direct the forces towards the center of support and to reduce the functional forces, the buccolingual width of the teeth is reduced and the number of teeth is also reduced to direct the forces in the molar and bicuspid area of support and to refrain from placing a tooth on the ridge incline.

If the teeth are arranged in any other manner than described above, excessive pressure or

pain is caused due to lateral interferences.

There are five elements in this occlusal scheme:

- Position
- Proportion
- Pitch

- Form
- Number

**Position :** Arrange the teeth in central position in reference to the foundation as the tongue willallow, in order to provide greater stability for the denture. He felt this was the most important factor and that off ridge contact for the purpose of balance created more problems.

**Proportion**: De van reduced tooth width to 40% to correct tooth proportion. Reduced widthof the artificial teeth reduces the vertical stresses on the ridge. In addition, horizontal stresseswere also reduced due to the decrease in friction between opposing surfaces . Forces werecentralized without encroachment on the tongue space.

**Pitch**: Tooth pitch (inclination, tilt) was corrected by placing the occlusal plane parallel to theunderlying ridges and midway between them. This positioning directed forces perpendicular tothe mean osseous foundation plane. There was no compensating curve and no incisal guidance.Patients were educated not to incise or protrude.

**Form** :Tooth form was modified using flat teeth with no deflecting inclines. This arrangementreduced destructive lateral forces and to direct the masticatory forces perpendicular to thesupport. All contacts were in a single plane with no projections above or below the plane tointerfere with the mandibular movements.

**Number** :The posterior teeth were reduced in number from 8 to 6. This decreased the magnitude of the occlusal force and centralized it to the second premolar and first molar area.

**Advantages of neutrocentric occlusion**

- This techniqueis simple and requires less precise records. Therefore, it is ideal for a patient who has resorbed friable ridges with mobile tissue .
- By removing inclines, the lateral forces which are destructive to the residual ridges are reduced.
- Teeth arranged with a neutrocentric occlusal scheme are easier to adjust
- Because the neutrocentric technique provides an area of closure and does not lock the mandible into a single position.

- Also the centric occlusion–centric relation discrepancy introduced by the denture settling would tend to be less destructive because of the unlocked nature of the occlusion
- Neutrocentric occlusion is especially indicated in class II (retrognathic), class III (Prognathic), and crossbite cases.

**Disadvantages of neutrocentric occlusion**

- The greatest criticism of this occlusal scheme is that it is the least esthetic as there is no incisaloverlap and no posterior cusps. Moving the teeth lingually andaltering their vertical positionmay not be compatible with the tongue, lip, and cheek function. This is offsetted by narrowingof the tooth width
- The flat nature of teeth results in impaired mastication.

D) **Lineal occlusion** [71]

A line of occlusal contacts in one dental arch opposing a flat occlusal table in the other dental arch has the potential of creating the smallest lateral component of force against the denture bases. Since the area of contact is minimal, the frictional resistance is reduced. Furthermore, in the dental arch with the line of occlusal contacts, there is no change in the location of the contact during lateral movements. Therefore, the direction of force in the dental arch remains fairly constant .

- Locating the line of occlusal contacts
- The linear ridge of occlusal contacts may be located in either of the dental arches
- The decision as to whether to locate the ridge of contacts in the maxillary or mandibular arch depends on the factors of denture stability and esthetics

**Locating the line of occlusal contacts**

The lineal ridge of occlusal contacts may be located in either dental arch. The decision as towhether to locate the ridge of contacts in the maxillary or mandibular arch depends on thefactors of denture stability and esthetics.Stabilization of the mandibular denture. With the ridge of occlusal contacts located in themandibular arch, occlusal forces in any jaw position will be applied to the mandibulardentures at the same point; this is not true with other types of occlusion. The result will beincreased stability for the mandibular denture. Since mandibular dentures are

almost alwaysless stable than maxillary dentures, the line of occlusal contacts is usually placed on thelower denture. If, for some reason, the maxillary denture need more stabilization than isrequired by the mandibular denture, the line of occlusal contacts would be placed on themaxillary denture

Esthetics: Nonanatomic maxillary first bicuspids can usually be contoured to be anatomically and esthetically pleasing. However, in rare instances where esthetics of the maxillary posterior teeth is an overwhelming consideration, the line of occlusal contacts isdeveloped using anatomic maxillary posterior teeth to occlude with nonanatomic mandibular teeth. It is easier to use an anatomic tooth for the line of occlusal contacts thanto try to make a nonanatomic tooth appear anatomic. The best way to achieve the line ofocclusal contacts in the maxillary arch is to set the lingual cusps in a straight line andremove the buccal cusps from contact. Then, the lingual maxillary cusps will form the lineof occlusal contacts in centric and eccentric positions.

**Tooth positioning for lineal occlusion**

The anterior teeth are arranged with no vertical overlap to prevent interference in lateral and protrusive mandibular movements . When the length of the anterior teeth must be sacrificed to eliminate vertical overlap, most or all of the reduction should be made on the mandibular anterior teeth. A vertical overlap of the anterior teeth is acceptable when the horizontal overlap is sufficient to preclude interference of opposing anterior teeth. The mandibular incisors establish the anterior end of the occlusal plane. The posterior landmark is usually the top one third of the retromolar pad. The occlusal plane should be kept as high posteriorly as practical to aid in developing protrusive balancing contacts with a flat plane of occlusion. The lower posterior teeth are set first and centered over the crest of the residual ridge whenever possible. The buccal line of contacts should be set in a straight line anteroposteriorly . The lingual part of the mandibular posterior teeth is positioned approximately 0.5 ram. below a plane contacting the right and left lines of contact . A clearance greater than 1.0 ram. between the noncontacting cusps decreases the crushing efficiency of the teeth. Often, the clearance can be developed more easily by grinding than by resetting the teeth. The maxillary posterior teeth are arranged against the mandibular

posterior teeth so that the line of contacts of the lower teeth is centered buccolingually. The flat occlusal surfaces of the maxillary posterior teeth should be parallel to a crossarch horizontal plane.

**E) physiologically generated occlusion**

Mehringer[72] developed physiologically generated occlusion to harmonize complete denture occlusion, neuromuscular system, and the temporomandibular joint. The completedenture fabrication is preceded till try in and processing of only maxillary denture is done.After it is polished, a conical disc is attached to the palatal region of the maxillary denture.The lower denture base is attached with plexiglass followed by fabrication of plaster (1/3 talcand 2/3 plaster) and attaching central bearing device exactly fitting into the upper conicaldisc. The patient is asked to make chewing and swallowing movements, which createdfunctionally generated paths.

Then apply separating medium to obtain maxillary stone cast of generated paths. Lowerteeth are arranged according to maxillary cast of generated path. Two point contacts on working side are eliminated and converted to one point contact, this increases stability andtransmit forces on lingual cusps only.

**F)Linear occlusion**

The occlusal arrangement of artificial teeth, as viewed in the horizontal plane, wherein the masticatory surfaces of the mandibular posterior artificial teeth have a straight, long, narrow occlusal form resembling that of a line, usually articulating with opposing monoplaneteeth[73.]Teeth are arranged on a flat plane, which extends from the tip of maxillary centralincisors to the top of the retromolar papilla. The 2–3 mm of interocclusal clearance is notneeded (centric relation recorded at vertical dimension at rest with 0.020 inch verticalclearance). The anterior vertical overlap is absent to provide noninterception in eccentricmovements. The posterior teeth used are nonanatomic with mandibular blade form of teeth.They exhibit bilateral fulcrum of protrusive stability – on protrusion blade form of mandibularsecond molar contacts maxillary first premolar bilaterally and prevent anterior rotationalcontact.

**Linear occlusion consists of following basic parameters:**

- **Plane of occlusion**

  The plane is set steeper.

  Esthetics and phonetics determine the maxillary anterior tooth position

- **Stabilization of mandibular denture**

  Mandibular dentures are almost always less stable than maxillary dentures, the linear ridge isusually placed on the lower ridge.

- **Esthetics**

  For esthetic purpose anatomic teeth are used in maxillary posterior region, which occlude withnon- anatomic mandibular teeth.

## IDEAL REQUIREMENTS OF COMPLETE DENTURE OCCLUSION

Complete denture occlusion should fulfill the following characteristics:

- Stability of the denture and its occlusion when the mandible is in both centric and eccentricrelations.
- Balanced occlusal contacts (tripod contact) during all eccentric movements.
- Unlocking (removing interferences) the cusps mesio-distally so that the denture ca settlewhen there is ridge resorption.
- The cuspal height should be reduced to control the horizontal forces.
- Functional lever balance should be obtained by vertical tooth to ridge crest relationship.

  (Lever balance is balance against leverage forces acting on the denture. Presence of positivecontact on the opposing side provides lever balance. It differs from bilateral balance in that itdoes not necessarily require three-point contact).
- Cutting, penetrating and shearing efficiency of the occlusal surface is equivalent to that ofnatural dentition.
- Incisal clearance during posterior functions like chewing.
- Minimal area of contact to reduce pressure while crushing food (Lingualized occlusion).
- Sharp ridges, cusps and sluiceways to increase masticating efficiency.

## SEARS AXIOMS OF COMPLETE DENTURE OCCLUSION

Published the following factors to be considered that helps plan the complete denture occlusion

1. The smaller the area of occlusal surface acting on food , smaller will be the crushing force onfood transmitted to the supporting tissue .
2. Vertical plane applied to an inclined occlusal surface causes nonvertical force on thdenture.
3. Vertical plane applied to the denture base supported by yielding tissue causes the base to teeterwhen the force is not centered on the base.
4. Vertical force applied outside to the ridge crest tipping forces on the base.
5. Vertical force applied to inclined supporting tissue.

## OCCLUSAL SCHEME REQUISITES TO FULFILL THE REQUIREMENTS:

Each occlusal scheme has three characteristics, namely, the incisal, working and balancingunits. The incisal unit includes all the four incisors. The working unit includes the canine andthe posterior teeth of the side towards which the mandible moves. The balancing unit includesthe canine and the posteriors opposite to the working side. The ideal requirement of a complete denture occlusion can be fulfilled by creating or providing the following characteristics for each unit.

**Incisal Units**:

1. Sharp units for improved incising efficiency.
2. The units should not contact during mastication. The units should contact only during protrusion.
1. Shallow incisal guidance.
2. Increased horizontal overlap to avoid interference during settling (the mandibular denture may slide anteriorly as it settles).

**Working Units:**

1. Cusps for good cutting and grinding efficiency
2. Smaller bucco-lingual width to decrease the occlusal load transferred to the tissues.
3. Group function at the end of the chewing cycle in eccentric positions. (During lateral movement if there is simultaneous contact of the posterior teeth of the working side, it is called group function. In the same situation if the canine alone contacts then it‘s called canine guided occlusion. Canine guided

occlusion and group function are usually described in relation to the natural teeth).

4. The occlusal load should be directed to the anteroposteriorcentre of the denture.
5. The plane of occlusion should be parallel to the mean foundation plane of the ridge.

**Balancing Units**:

1. The second molars should be in contact during protrusive action (Protrusive balance).
2. They should have contact along with the working side at the end of the chewing cycle.
3. Smooth gliding contacts should be available for uninterfered lateral and protrusive movements

# CENTRIC RELATION

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Centric relation (CR) is the most controversial concept in dentistry. The concept of CR emerged due to the search for a reproducible mandibular position that would enable the prosthodontic rehabilitation. Research in the field of CR has been controversial for more than100 years. There are over 26 definitions of CR since the term was first developed as a startingpoint for making dentures. Most of the controversies are pertaining to the position of the head ofthe condyle in the glenoid fossa during centric relation position. This ranges from a retrudedposterior position, to superior position and then to an anterior superior position . The definitionof centric relation has evolved over the years and with advanced understanding of mandibularmovement it may change again in future.

CR is a position of the condyles independent of tooth contact, whereas centric occlusion (CO)is an interocclusal dental position of the maxillary teeth relative to the mandibular teeth.Maximum intercuspation (MI) has been defined as the complete intercuspation of opposingteeth independent of condylar position [74]

**Centric relation:** acronym is CR; a maxillomandibular relationship, independent of tooth contact, in which the condyles articulate in the anterior-superior position against the posteriorslopes of the articular eminences; in this position, the mandible is restricted to a purely rotarymovement; from this unstrained, physiologic, maxillomandibular relationship, the patient canmake vertical, lateral or protrusive movements; it is a clinically useful, repeatable referenceposition (GPT 9)

**Centric occlusion** :The occlusion of opposing teeth when the mandible is in centric relation; thismay or may not coincide with the maximal intercuspal position.

**Centric relation, terminal hinge axis position and retruded contact position (RCP)**

Centric relation describes the jaw relationship between the maxilla and mandible when themandible is in a retruded position. Differing definitions of centric relation have focused onslightly different positions of the condyle in the glenoid fossa and some on the relationship of thehead of the condyle to the interarticular disc. These are rather academic arguments as clinicallythe position of the condyle cannot be visualized or confirmed without complex equipment. Amore pragmatic and practical definition was proposed by Christensen in 2004 which conforms tomost dentists' clinical practice. He described centric relation as the most comfortable

posteriorlocation of the mandible when it is bilaterally manipulated gently backward and upward into aretrusive position‘. When this is done the mandible opens and closes on an arc of curvaturearound an imaginary axis drawn through the centre of the head of both condyles; this imaginaryaxis is termed the *terminal hinge axis* . Measured in the incisor region the arc of opening aroundthe terminal hinge axis position takes place for about 20 mm before the condyles start to translatedown onto the articular eminence . When the mandible closes in the terminal hinge axisposition the first tooth contact is called the***retruded contact position* (*RCP*).** The terminalhinge axis position is said to be the most reproducible jaw relationship; however, small variations from day to day and at different times during the day may occur. For most dentate patients there is a slide of the teeth and mandible from RCP into ICP of about 1–2 mm in an anterior and upwards direction. It is important to identify the RCP contact and record the direction and smoothness of the slide.[75,76]

## MANDIBULAR HINGE POSITION

The mandibular hinge position is arcing mandible to the ―rest of the skull‖ relation durispecified conditions. The second edition of the Glossary of Prosthodontic Terms briefly lists seven stipulations, which broaden our understanding and improve our communication in the anatomic nature and use of this condylar hinge position, this imaginary line we call the hinge axis, and this maxillomandibular orientation we call centric relation. It is an obvious and conspicuous fact that the normal mandible will arc or swing when held retruded in its two joint compartments. It is also obious that this arcing is an abnormal, nonfunctional, dentist-directed phenomenon. Since this hinging action of the mandible is fundamental to many techniques working for optimum occlusion, its meaning and its intended LISP are part of our centric occlusion story Location of an individual patient‘s mandibular hinge position is a human effort requiring both cooperation and coordination between the dentist and his patient.

(1) The muscles that move the mandible must be completely relaxed.

(2) The patient, or the patient with the dentist‘s gentle guidance, may retrude the mandible to itsunstrained posterior limits and arc the jaw in a true hinge rotation.

(3) The range of pure arcing without translation is limited to approximately 15.

(4) If mechanical extensions can be firmly secured to this mandible and adjustable pointers placedexternally in the vicinity of each condyle, a practical point of rotation may be found on the skin in the vicinity of each temporomandibular joint. everyone relaxes, the dentist-patient teamcoordinates, and within this narrow arcing range the operator perseveres in adjusting themechanical pointers. These rotation centers may be found and marked.

**Clinical importance of centric relation** [77]

Only a sparse number of patients function naturally in centric relation occlusion; but centricrelation is an invaluable position in restorative dentistry. The question for a dentist is when isthe occlusal scheme restored in CR and when in the habitual maximal intercuspal position(MIP) of the patient? The answer is not absolute because each patient possesses a different setof clinical circumstances that influence this decision.

Some guidelines for this clinical decision are as folllows:

1. Use MIP for an individual crown.
2. Use MIP when there are 3 to 4 units of posterior fixed partial dentures (FPDs) or removable partial dentures (RPDs).
3. Use MIP when there are 3 to 6 units of anterior FPDs or RPDs.
4. Adjust the occlusion of the remaining posterior teeth to CR and build occlusion to CR if only 2 to 3 posterior teeth remain in contact after preparation of the abutments.
5. Use CR when there are no posterior occlusal contacts remaining at the desired vertical dimension of occlusion.If a clinical decision is made to place the patient in an occlusal scheme based on centricrelation for options 1 to 3, then occlusal adjustment, based on principles on biologicocclusion, should be accomplished before fabricating a prosthesis.

The principles of biologic occlusion (and occlusal adjustment) are as follows:

1. No interference between CR and MIP.
2. No balancing contacts in eccentric jaw movements.
3. Cusp-to-fossa occlusal scheme.
4. A minimum of one contact per tooth, but multiple contacts per tooth are desirable.
5. Canine guided or group functin in lateral mandibular movement.

6. No posterior contacts with protrusive jaw movements.
7. No cross-tooth balancing contacts.
8. Eliminate all frenitus, if possible. It is unreasonable to demand that the condyles remain in their hinge position for long periods when teeth are in a maxillary intercuspal position. It is no unreasonable to ensure that there are no cuspal interferences between CRposition and the MIP if present that interference are eliminated.

## CENTRIC RELATION AND THE MANDIBULAR POSTURE

With the broad, general meaning of the terms, function relates to nonfunction when centricocclusion coincides with centric relation during optimum maxillo-mandibular posture. This isthe ideal situation seldom found even in good, healthy dentitions and is a transient relation incomplete dentures. Maxillomandibular relations, functional or nonfunctional, are dependent onthe state of health of the supporting and controlling tissues. Centric relation is a retruded,postural position. How the mandible is held and maneuvered and how it responds to thewarnings of stress are postural problems of the patient and should be given the same seriousconcern the orthopedic physician provides his patient. Along with his emergency measures, theorthopedic physician guards against growth divergencies and prescribes therapeutic exercisesthat will promote the maximum physical potential of a given patient, at a given time. Realizingthat this potential varies with age, physical and mental health status, and environment, thephysician encourages activity and exercise that will promote the best synchronizedneuromuscular joint balance and a more healthful basis for body and mind functioning.

### Critical evaluation of methods to record centric jaw relation[78]

The rationale behind recording Centric Relation records is to establish guidelines as startingpoint to develop occlusion, with artificial teeth, in harmony with various structures ofmasticatory apparatus including TMJ. It aids to maintain physiologic and anatomic health oftissues. When maximum intercuspation coincides with centric position, it provides stability tothe prosthesis and thereby, preservation of the health of remaining tissues (edentulousfoundation, remaining natural teeth, musculature and TMJ) is accomplished.

## VARIOUS METHODS TO RECORD CENTRIC RELATION

Based on various methods of recording Centric Relation records a review and evaluation ofthese methods is presented:

**Direct check-bite inter-occlusal recordings:**

The direct inter-occlusal record is the oldest type of Centric Relation record. The interocclusalcheck record method is referred to as a Physiologic Method. Normal functioning of the patient‘s proprioception and the tactile sense is essential for an accurate record. Visual acuity and the sense of touch of the dentist also enter into the making of a Centric Relation record using the physiologic method. This phase of the procedure is developed with experience and is exceedingly difficult to teach to another individual.

―In 1756, Phillip Pfaff, the dentist of Fredrick the Greatof Germany was the first to describethis technique of ―taking a bite.Until the end of nineteenth century it was the most commonlyused method. The direct inter-occulusal record, during that period, was a non-precision jaw record, obtained, by placing a thermoplastic material, usually wax or compound, between theedentulous ridge and having the patient close into the material. This was known as the Mush,Biscuit, Or Squash Bite. One early method was to adjust the occlusal rims to the chosenvertical dimension of occlusion, have the patient close in a retruded position, and attach therims together for mounting on an articulator.

-In 1954, recommended repeated closure into softened wax rims.

Greene had his patients hold their jaws apart for 10 seconds to fatigue the muscles and then had them snap the rims together. He then made lines in the rims to orient them after removal from the mouth. Gradually, these procedures evolved into inter-occlusal records as they are usually done today. Small amounts of wax, compound, plaster or Zinc-Oxide Eugenol Impression paste were placed between the occluding rims, and the patient closed the jaws into centric relation. These improvements were an attempt to equalize the pressure of vertical contact.

**Indications:**

Interocclusal check record is particularly indicated in following situations:

- Abnormally related jaw.
- Supporting tissues that are excessively displaceable.
- Large awkward tongue.
- Uncontrollable or abnormal mandibular movements.
- Occlusion of teeth in existing dentures.
- It is the most practical and acceptable method to check teeth arranged as trial dentures There are many opinions regarding the best material for interocclusal record.

-Trapozzano, in 1955, stated that the wax ―Check-bite method is the technique of preference in recording and checking centric relation.

-Schuyler in 1932, observed that if the recording medium was not of uniform density and viscosity, uneven pressure would be transmitted to the record bases which would cause disharmony of occlusion. He said modeling compound was preferable to wax for occlusal records because it can be softened more evenly, cools slower, and doesn‘t distort as much as wax.

-Payne in 1955, and Hickey, in 1964, stated a preference for dental plaster because less material had to be placed in the patient‘s mouth for the record.

Wright in 1939, described the four factors he believed affected the accuracy of records:

- Resiliency of tissue
- Saliva film
- Fit of bases
- Pressure applied .

He concluded that since the dentist wouldn‘t control the pressure at which the recordwas made, the best technique would be to record occlusal record at zero pressure. Itcould thus be duplicated.

Hanau in 1923, considered various factors that influenced the recording of Centric Relation andhe modified the intra-oral wax method. He pointed out the -Resiliency and Like Effect (Realeff)of the denture-supporting tissues. He advocated making registrations of the positionalrelationships, under zero pressure ,to minimize the error caused by -RealeffectHanau, Block, and others agreed with the zero pressure‘

philosophy, Schuyler, Payne andTrapozzano, among others, advocated the use of light pressure

**Criticism of inter-occlusal method of recording centric relation**

There has been much criticism of check-bites for Centric Relation records. Most of these

criticisms were from individuals who favoured some type of graphic recordings.

- Schuyler, in 1932, stated that he did not consider a record secured on compound or wax occluding rims sufficiently free from error to compete with the restorations withoutadditional checks.
- Simpson felt wax records were unscientific and commented that such methods as holding thejaw back on closing the mandible, elevating the tongue, and having the patient swallow as hecloses the jaw, and the like, are condemned for the paramount reason that they are unscientificand always carry with them the fallacy of guess.
- Phillips stated that in the hands of, by, for the largest majority of operators, it is worse thanuseless.

**Graphic methods record**

The graphic methods record a tracing of mandibular movements in one plane and an arrowpoint tracing. It indicates the horizontal relation of the mandible to the maxillae. The apex of aproperly made tracing presumably indicates the most retruded relation of the mandible to themaxillae from which lateral movements can take place. Do not confuse this with other graphictracings made in additional planes. Pantographic tracings, for example, are made in threeplanes. Graphic methods are either intra-oral or extra-oral, depending upon the placement of therecording devise. The intra-oral tracings cannot be observed during the tracing; therefore themethod looses some of the value of a visible method.

Techniques -The earliest graphic recordings were based on studies of mandibular movements by Balkwill in 1866. The intersection of the arcs produced by the right and left condyles formed the apex of what is known as the Gothic arch tracing.

The first known -needle point tracing was by Hiesse in 1897, and the technique was improvedand popularized by GYSI around 1910. The tracer made by Gysi was an extra-oral incisal tracer.The tracing plate coated with wax, was attached to the mandibular rim. A spring-loaded pin ormarker was mounted on the maxillary rim.

The rims were made of modeling compound tomaintain the vertical dimension of occlusion. When a good tracing was recorded, the patient heldthe rims in the apex of the tracing while notches were scored in the rims for orientation.

Clapp, in 1914, described the use of a Gysi tracer which was attached directly to the impression trays.

Sears used lubricated rims for easier movement. He placed the needle point tracer on the mandibular rim and the plate on the maxillary rim. He believed this made the angle of the tracing more acute and more easily discernible. He would then cement the rims together forremoval.

Phillips, in 1927, recognized that any lateral movement of the jaw would cause interference ofthe rims which could result in a distorted record. He developed a plate for the upper rim and atripoded ball bearing mounted on a jack screw for the lower rim. The occlusion rims wereremoved, and when the patient had produced the proper extra-oral tracing, softened compoundwas inserted between the trial bases. This innovation was termed the central bearing point.

In 1929, Stansbery introduced a technique which incorporated a curved plate with a four-inchradius (corresponding to Monson‘s curve) mounted on the upper rim. A central bearing screwwas attached to the lower plate with a three-inch radius curve (reverse-.Monson curve). After theextra-oral tracing was made, plaster was injected between the rims to form a biconcave centric registration.

Hall, in 1929, used Stansbery‘s method but substituted compound for Centric Relation record.Later, graphic recording methods used the central bearing point to produce the Gothic archtracing.Chandrasekharan Nair developed Chandra tracer. Nandini et al conducted a comparativeevaluation of hight tracer, Chandra tracer, intra-oral tracer, functiograph and check-bite and theyfound that there was no significant difference between height tracer, Chandra tracer, intra-oraltracer, functiograph and check-bite method.

**Functional recordings Functional records**

It have been described in dental literature as early as 1910 and are based on principle that the patient produces a pattern of mandibular movement by moving the mandible to protrusion, retrusion, and right and left lateral.

Greene in 1910, used pumice and plaster mixture in one of the rims and instructed the patient togrind the rims together. The denture teeth were set to the generated pattern.
Needles in 1923, mounted three studs on maxillary rims which cut arrow tracings into mandibular compound rims. After removal from the mouth, the rims were re-assembled with thefunctional grooves. House modified the Needles technique and used four styli to make needlepoint tracings.
Patterson, in 1923, used wax occlusion rims and he cut a trough in the upper and lower rims.These were filled with a carborundum and plaster mixture. The patient would move his jawand grind the rims until the proper curvature had been established. This would ensureequalized pressure and uniform tooth contract in all excursions.

The functional technique developed by Meyer, in 1934, used soft wax occlusion rims. Tinfoilwas placed over the wax and lubricated. The patient performed the functional movements toproduce a wax path. A plaster index was made of the wax path and the teeth were set to theplaster.
Boos, in 1940, used the Gnathodynamo-meter to determine the vertical and horizontal position at which a maximum biting force could be produced. His bimeter was mounted onthe lower occlusion rim with a central bearing point against a plate on the upper occlusionrim. Plaster registrations were made with the bimeter in the mouth and the patient exerting pressure. BOOS theorized that optimum occlusal position and the position of maximum biting force would coincide. He also thought that it was essential that all registration bemade under biting force so that the displacement of soft tissues which occur in function would occur during bite registration index.
Shanahanb in 1955, in his Physiologic technique, placed cones of soft wax on the mandibular rim and had the patient swallow several times. During swallowing, the tongue forced themandible into its Centric Relation position. The cones of soft wax were moved and thephysiologic Centric Relation was recorded.

Bilateral manipulation suggested by Peter Dawson, in 1974, is the method that has been largely utilized by those who adhere to functionally generated path techniques. They have suggested that the condyles do not always move superiorly, but sometimes, in response to posterior guidance from the operators, they move inferiorly. Because of this clinical observation, theyemphasized the importance of superior placement of the condyles in the fossa when attemptingto record centric relation.

McCollum and Granger stated that Centric Relation is that position where the mandible rotatesaround the hinge axis. In securing maxillo-mandibular records, both investigators

recommended the use of Chin Point Guidance recommended by Gutchet in 1970 in retrudingthe mandible.

**Criticism of functional recording method**

The functional methods of recording Centric Relation requires very stable record bases.

Forces which can dislodge the record bases occur in any method which requires the mandibleto move into eccentric jaw position with the recording medium in contact. The record will notbe accurate unless the bases are stable.

The displaceable basal seat tissues, resistance of recording mediums, and lack of control ofequalized pressure in the eccentric relations contribute to inaccuracy in these methods.

## THEORIES OF OCCLUSION AS RELATED TO THE DESIGNS OF ARTICULATORS

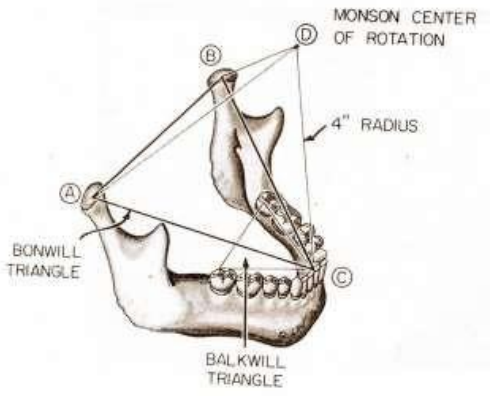
i) Bonwill's theory of occlusion

ii) Conical theory of occlusion

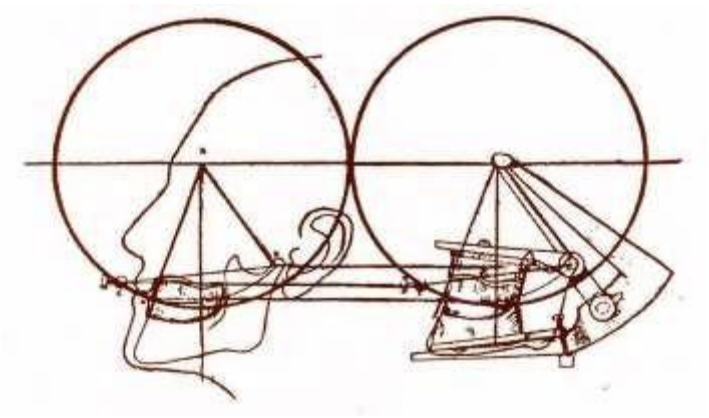
iii) Spherical theory of occlusion

**i)BONWILLS THEORY OF OCCLUSION (1885, Theory of equilateral triangle)**

Equilateral triangle with 10 cm (4 inch) sides connecting both condyles and mesioincisal angles of the mandibular central incisor.



**ii) ARBITRARY (MONSON SPHERICAL THEORY,1918)**



Monson felt that the condylar path and the occlusal plane form a curve. Bonwill" said that thetwo condyles and the incisors formed an equilateral triangle with sides of 4 inches. Monsonassociated Bonwill's triangle with his own observations and formulated his "spherical theory."

The condylar path and occlusal plane form a curve which is part of an 8 inch sphere , the centerof which is the common center of mandibular motion. This sphere touches the apices of theBonwill triangle.

The Monson theory states that the lower teeth move over the surfaces of ,the upper teeth asover the surface of a sphere with a diameter of 8 inches, with the (center of the sphere located inthe region of the glabella and the surface of the sphere passing through the condyles or centricwith the condyle paths.

Monson Articulator:Monson believed that all jaw movements take place around two axes. Oneaxis runs through the "common center" and the other is located around the condylar axis. Hisarticulator has shafts that correspond to the respective axes . The Hagman balancer differs fromthe Monson articulator in that it has a universal joint mechanism that allows movement fromMonson's common center."

**iii) CONICAL THEORY OF OCCLUSION (R.E.HALL)**

Lower teeth move over the surface of the upper teeth as over the surface of a cone with a generating angle of 45º and with a central axis of the cone tipped at a 15º angle to the occlusal plane .

# TYPES OF COMPLETE DENTURE OCCLUSION

## CONCEPTS OF COMPLETE DENTURE OCCLUSION[79]

### Static concept

The static relations in occlusion include centric occlusion, protrusive occlusion, right and leftlateral occlusion. All of these relations must be balanced with the simultaneous contacts of all theteeth on both sides of the arch at their very first contact. The cuspal inclines should be developedso that the teeth can glide from a more centric occlusion to eccentric positions without interferenceand without the introduction of rotating or tipping forces.

### Dynamic concept

The dynamic concept of occlusion is primarily concerned with opening and closing movementsinvolved in mastication. Jaw movements and tooth contacts are made, as the teeth of on jaw glideover the teeth of the opposing jaw. Movements of the mandible which occur when the teeth arenot in contact are termed as free movements. Patients need to have good neuromusculararcoordination to participate in the functional methods of recording centric relations and also becapable of following instructions if accurate records are to be obtained.

## TYPES OF COMPLETE DENTURE OCCLUSION

Complete denture occlusion can be of threetypes:-

1. Monoplane occlusion
2. lingualised occlusion
3. Balanced occlusion

Each type has its own indications and contraindications, advantages and disadvantages. Themost important type of occlusion employed in complete dentures is the balanced occlusion.

## MONOPLANE OCCLUSION

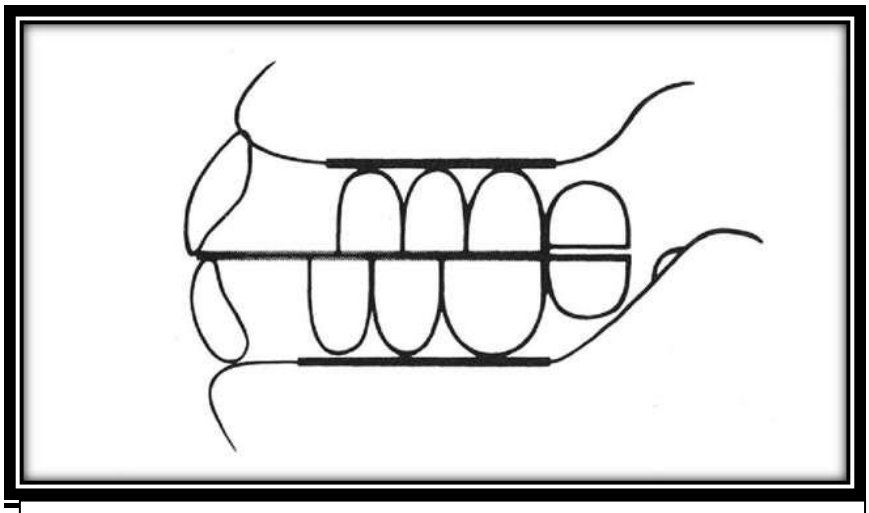


Fig 3.Monoplane occlusion on viewed from buccal

Sear introduced monoplane occlusion with balancing ramps or tooth at the distal part of themandibular arch which comes in contact only in eccentric excursions . De Van has used the sameprinciple without the balancing ramp . According to this concept teeth which are flatmesiodistally and buccolingually are used (fig 3), oriented as close as possible parallel to themaxillary and mandibular mean foundation plane [80].

**Indication** :

1. Abnormal closure imbalance, pathosis, trauma,
2. Neuromuscular disturbances.
3. Posterior displaceable mucosa.
4. Multilated, tortuous ridges with an excessive denture space
5. Ridges are flat or knife edge, rendering dentures more suspectible to horizontal force.
6. When chewing pattern is milling type with broad l excursions.
7. Maximum of vertical force and a minimum of horizontal stress is desired .
8. The amount of horizontal overlap is determined by jaw relation, ranges from 0mm (edge to edge)
9. Class III relation to as much as 12mm for severe class II relation . Usually the mandibular second molar will be placed on the molar slope area, called 'skid row'. In this the occlusal surface of the maxillary second molar set parallel to

the occlusal surface of the mandibular second molar but 2 mm above the occlusal plane, well out of occlusion

**Advantages** :

- They are more adaptable to the unusual jaw relation such as class II and class III relations, used easily in cases of variations in the width of maxillary and mandibular jaws, cross bite. These impart a sense of freedom to the patients, do not lock mandible in one position.
- They eliminate horizontal forces, more damaging than vertical forces. Because the monoplane teeth occlude in more than one relationship, so centric relation developed to an area instead of a point..
- Monoplane teeth permit the use of a simplified and less time consuming technique and offer greater comfort and efficiency for a longer period. They accommodate better to the negative changes in the ridge height that occur with aging .

**Disadvantages** :

- No vertical component to aid in shearing during mastication.
- Patients may complain of lack of positive intercuspationl position.
- Esthetically limited.
- Occlude only in two dimensions, but the mandible has a 3D movement due to its condylar behavior

**Monoplane occlusion can be balanced by following methods:**

Incline the mandibular second molar to provide contact with the maxillary denture in all excursions, the maxillary second molars are similarly inclined but left out of centric contact.

The use of customized balancing ramp placed distal to the mandibular second molar. Rampprovides tripodal effect of contacts of denture bases. In eccentric relation, there is smoothcontact anteriorly on teeth and posteriorly on the balancing ramp. Balancing ramp improveshorizontal stability of the denture

The maxillary posterior teeth should be set first. Before this is done, the occlusal plane

should be determined. A plane can be considered to be a line drawn to connect two points in space. The anterior point is represented by the incisal edges of the canines. Then, the determination of the posterior point, as the articulator is viewed from the side, is made .

Three factors determine the location of that point.

— It should result in an occlusal plane that evenly divides the space between the upper and lower ridges.

—It should provide an occlusal plane that parallels the mean foundation plane.

—The occlusal plane should fall at the junction of the upper and middle thirds of the retromolar pads.

Usually, a harmonious relationship will be found between these factors; if not, then the dominant factor is the relationship of the occlusal plane to the retromolar pad. After he hasset the anterior teeth, the unexperienced operator may find it helpful to form the occlusalplane with wax rims on the lower base that extend from the distal side of the canines to theretromolar pads. These rims should be slightly wider than a molar tooth and must be flat buccolingually. At this point, lines can be scribed, on the occlusal surfaces of the wax rims,that extend from the distoincisal edges of the canines to points on the cast, immediately back of the buccolingual centers of the retromolar pads. The upper premolars and firstmolars then are set to the upper base so that their central grooves coincide with the line onthe wax rim. This is a tentative buccolingual position for these teeth, and may be changed after the lower posterior teeth are arranged. The wax rim is removed and the lower teethare set to occlude with the upper teeth. The anteroposterior relationship of a mandibular tooth to its antagonist is not critical. The lower teeth are placed buccolingually so that the central grooves form a straight line that coincides with the imaginary line from the distoincisal angle of the canine to the buccolingual center of the retromolar pad. The lowersecond molar is placed in the same manner with its occlusal surface on the occlusal plane. The buccal overjet is not considered as the lower teeth are being set but instead, the overjetis evaluated later. If the overjet is insufficient to guard against cheek-biting, the upper posterior teeth are moved more to the buccal aspect. Such an arrangement favors the lower denture at the expense of the upper one. The lower posterior teeth are always directly overthe crest of the lower ridge, and the upper teeth are usually to the buccal side of the upper ridge. This condition is well tolerated because of the greater retention of the upper denture.In extreme instances, the

crossbite arrangement should be used. Usually the lower secondmolar will be placed on the molar slope area, sometimes called " skid row." In thisinstance, the occlusal surface of the upper second molar would be set parallel to theocclusal surface of the lower second molar, but 2 mm above the occlusal plane, thus wellout of occlusion. From the standpoint of lower denture stability, the ideal position for amolar tooth would be the center of the bearing area of the lower ridge; this would result ina completely centralized occlusion. In the scheme of occlusion described, the occlusalforces are centralized to a great degree.

This arrangement might be described as keeping the load amidships .The primary purpose of anterior teeth is to produce a desired appearance. The first and second premolars and first molars masticate food. The second molars are space fillers and do not function. Without them, however, many dentures have a vacant look in that region. They may well be omitted whenever space is a problem..

## Concepts of Non-balanced Occlusion[81]

The concept of monoplane occlusion was a result of Sheppard's statementEnter Bolus, Exit Balance. This statement questioned the need for balanced occlusion.Consecutively many clinicians came with different concepts of non-balanced
occlusion for complete dentures.

**a ) Kurth's concept**:-

He proposed a non-balanced occlusion set with flat posterior teeth in a horizontal plane without any balancing ramps. The teeth were set in a flat plane anteroposteriorly with a reverse lateral curve. This reverse lateral curve is not a compensating curve. Philip M. Jones scheme of non-balanced occlusion: In this scheme, non-anatomical teeth were arranged with the following modifications:

- A different articulator that could fit large casts were used.
- The maxillary and mandibular teeth are arranged without any vertical overlap. The jaw relation determined the amount of horizontal overlap.

The maxillary posteriors are set first. The occlusal plane should fulfill the following requirements:

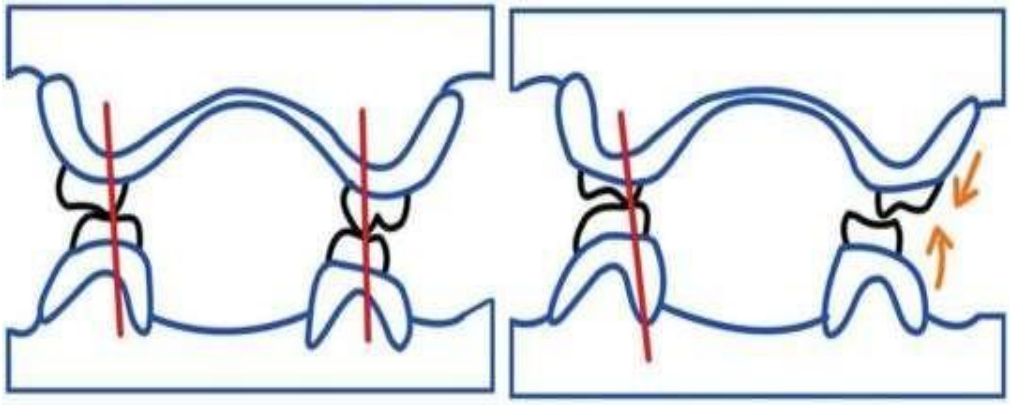
- The occlusal plane should divide the inter-arch space equally.

- The occlusal plane should be parallel to the mean denture base

**b) Pound's Concept:-**

He proposed a monoplane occlusion which stresses the importance of phonetic and aesthetics for anterior teeth. The posterior teeth on the other hand have a sharp upper lingualcusp and a wide lower central fossa. The buccal cusps of the lower posterior teeth werereduced to avoid non-vertical occlusal forces. Effectively, it was a lingualized occlusionwherein there is no buccal contact of upper and lower teeth and the occlusal surfaces arereduced such that they lie in a triangle formed between the mesial end of the canine and thetwo sides of the retromolar pad.

Fig 4 .Pound's concept: In centric occlusion. (b) Pound's concept: Right lateral position



**c) Cusp form gold occlusal concept:-**

As the name suggests, it uses teeth with a 33 o form made on a gold surface. According tothis concept, the anteriors are set by aesthetic and phonetic requirements and the posteriors areset with vertical overlap such that there is disocclusion due to the canine during eccentricmovement of the mandible.

**d) Hardy's concept:-**

He proposed a flat occlusal plane set with non-anatomical teeth for complete denture occlusion. Metal insert teeth were also proposed.

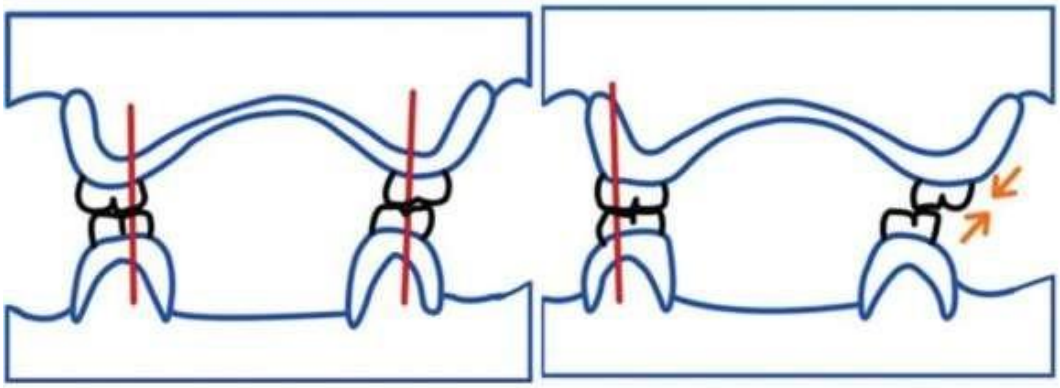


Fig 5. Hardy‘s concept: In centric occlusion. (b) Hardy‘s concept: In right lateral position

**e) Aull’sconcept**

**Features**

- Artificial maxillary posterior should have 33° cusp form teeth with full gold occlusal surface
- Anterior teeth arranged to meet the requirements of phonetic values
- Characteristic of this concept is recording pantographic tracing and transferring it to articulator to eliminate deflective contacts in the posterior arrangement
- Accurate retentive denture bases are a requirement in this concept.

  In centric occlusion, the contact forces are directed toward the ridges . In the right lateral position, the canine guidance disocclude the posterior teeth .

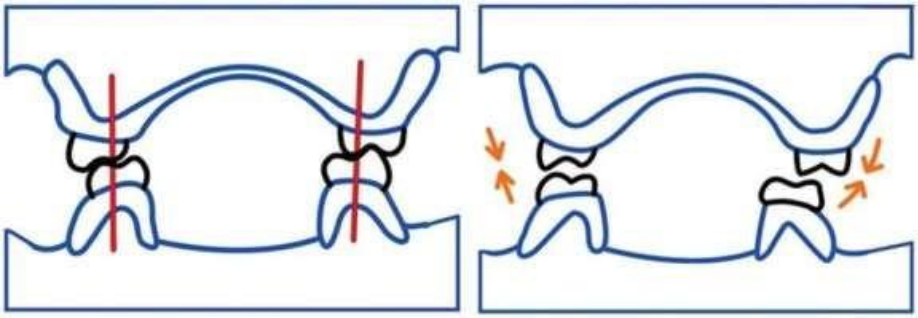


Fig6. a)Aull‘s concept: In centric. (b) occlusion Aull‘s concept: In right lateral position

**f) Occlusal pivot by Sear**

The pivots were used to place the mandible in equilibrium by concentrating the load in the molarregions. This scheme reduced the injury to the temporomandibular joint and also reduced the stress in the anterior region foundation.

- The occlusal plane should lie at the junction of the upper and middle thirds of the retromolarpad.
- During final arrangement, there should be complete intercuspation between the upper andlower posterior teeth except the second molar.
- The occlusal surface of the upper second molar should be 2 mm above the plane of occlusion(hence it is out of occlusion) and parallel to the occlusal surface of the lower second molar.These modifications are done so that the premolars and the first molars are the primary masticators and the second molars are just non-functional space fillers.

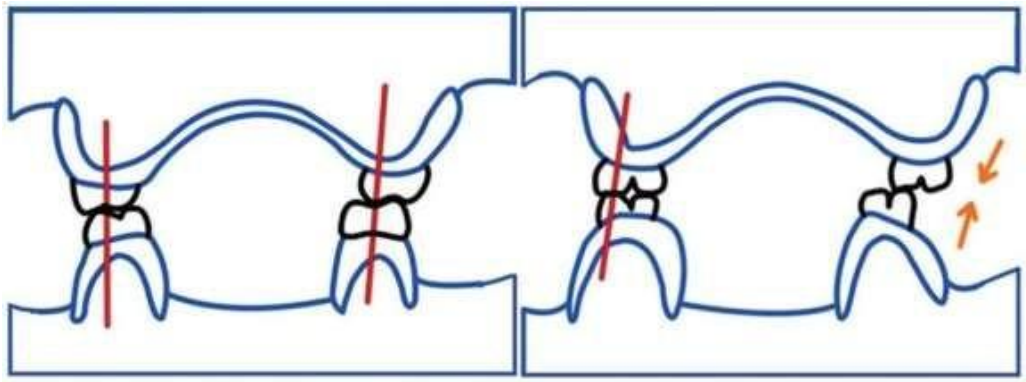


Fig . 7 (a) Sear‘s concept: In centric occlusion. (b) Sear‘s concept In right lateral position

General Considerations:

The following points have to be considered while using a non-balanced occlusion for a denture:

- Opposing artificial teeth should not contact when the jaws are in eccentric relation, because itmay give destabilizing forces to the basal seat area. The architecture of the basal seat does notallow tooth contact when the mandible is in eccentric position.
- Tooth contact should occur only when the mandible is in centric relation to the maxilla.
- The patient should be encouraged to repeat the mandibular movement‘s till there is no discomfort in centric relation

## LINGUALIZED OCLUSION

It was first proposed by Alfred Gysi in 192782. This type of occlusion involves the use of alarge upper palatal cusp against a wide lower central fossa. In this scheme, the buccal cusps of the upper and lower teeth do not contact each other (fig 8). Clough reported that 67% of the patients preferred lingualized occlusion due to its superior chewing efficiency.

Many clinicians contributed to the concept of lingual occlusion. Pound proposed nonbalancedlingualized occlusion. Payne proposed the use of 30 o anatomical teeth which arelater reshaped to obtain lingual occlusion. This scheme had complete intercuspation withoutany deflective occlusal contacts.

A.Normal occlusion and (b) lingualized occlusion

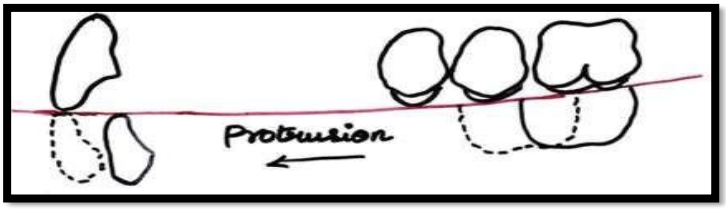
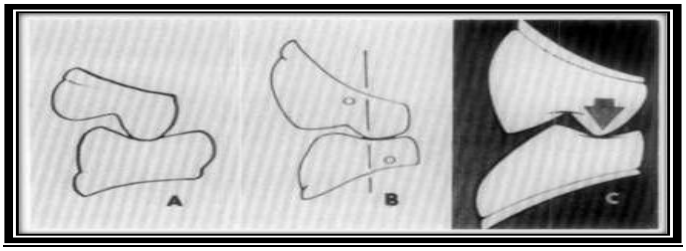


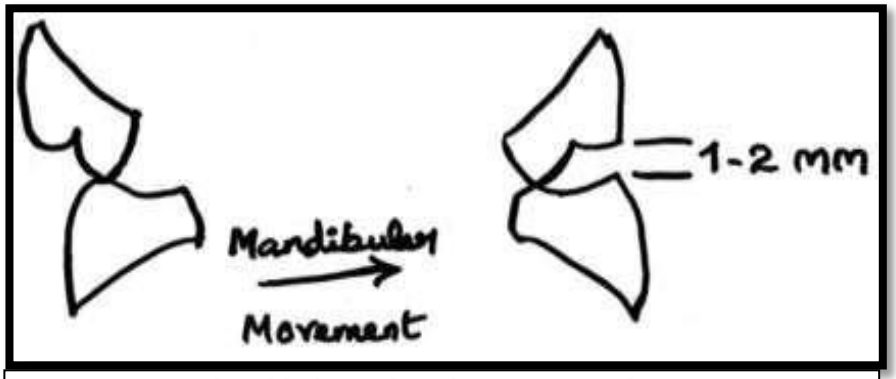

Fig 8. Lingualized occlusion

**Myerson's Lingualized Integration (MLI):**

Myerson proposed specialized tooth molds for arranging teeth in lingualized occlusion. He proposed two different molds for the maxillary posteriors namely control contact (cc) mold and maximum contact (MC) mold. The remaining teeth are common for both these molds.He advocates the use of MC' mold for patients who can reproduce accurate centric position and the CC' mold for patients with variations in centric position



These teeth provide maximal intercuspation, good cuspal height to perform occlusal reshaping, and a natural and pleasing appearance. The MC‘mold maxillary posteriors have taller cusps with a more anatomical appearance compared to the CC‘mold. The MC‘ mold also offers a more exacting occlusion.




Lingualized balanced occlusion: Lateral excursion

## I. INDICATIONS

Lingualised occlusion can be used in most denture combinations.

a) It is particularly helpful when the patient places high priority on esthetics but non-anatomicocclusal scheme is indicated because oral conditions such as severe alveolar resorption, a Class II jaw relationship, or displaceable supporting tissue. If the non-anatomic occlusal scheme is used, esthetics in the premolar region are compromised. With Lingualised occlusion, the esthetic result is greatly improved while still maintaining the advantages of a non-anatomic system.

b) Lingualised occlusion also can be used effectively when a complete denture opposes a removable partial denture as in case of combination syndrome and bilateral balance occlusion isdesirable.

c) Patients having parafunctional habits, so that reduced amount of horizontal forces are transmitted to supporting tissues.

d) In patients with implant supported overdenture.

## II. PRINCIPLES OF LINGUALIZED OCCLUSION

According to Becker Principles of lingualized occlusions are:

a) Anatomic posterior (30-33 degree) teeth are used for maxillary denture. Tooth forms withprominent lingual cusps are useful.

b) Non anatomic or semi anatomic teeth are used for mandibular denture . Either a shallow or aflat cusp form is used. Narrow occlusal form is preferred where resorption of residual ridge hasoccurred.

c) Modification of mandibular posterior teeth is accomplished by selective grinding which isalways necessary regardless of the material used.

d) Maxillary lingual cusp contact mandibular teeth in centric occlusion

e) Balancing and working contacts should occur only on the maxillary lingual cusps.

f) Protusive contacts only between upper lingual cusps and lower teeth.

## III. CRITERIA FOR ARRANGING TEETH IN LINGUALIZED OCCLUSION

In lingualized occlusion concept, only the lingual cusps of the posterior teeth of the upper denture make contact in centric relation in the central fossae of the lower posteriors. Thebuccal cusps are out of contact. There is therefore only one "centric stop" between upper and lower antagonistic pair of posterior teeth. This is achieved by arranging the teeth in such a way that on both the working (active) side and the balancing (passive) side there are simultaneous bilateral balancing contacts. In order to guarantee a balanced occlusion, a compensation curve is arranged during the set-up of the mandibular posterior teeth. No posterior teeth are placed in the ascending part of the mandible in order to prevent protrusive dislocation of the lower denture. During protrusive balance , anterior teeth should be out of contact. If anterior interference occurs, either move or grind the opposing lower anterior teeth slightly or increase the distal incline on the lower molars by increasing the compensating curve. The fossae of the lower posterior teeth must be broadened, mainly by means of selective grinding to allow for the free movement of the upper lingual cusp over the lower central fosaa. This way the working and balancing cusp contacts are

simplified, since only the upper lingual cusp contacts the lower occlusal surfaces

## IV. ADVANTAGES OF LINGUALIZED OCCLUSION

- Cross arch balance thus resulted in improved denture stability and enhanced patient comfort.
- Reduced lateral forces because only the lingual cusp of the maxillary teeth provides the solecontact with the mandibular posterior teeth
- Vertical forces are centered upon the mandibular residual ridges.
- Simplified tooth arrangements , simplified occlusal adjustments , reduced lateral forces, goodesthetics and efficient bolus penetration
- Provides a mortar and pestle type of occlusion with cusp teeth to provide a smaller occclusalcontact for more efficiency and control of resultant forces
- The upper posteriors can be positioned more buccally on the ridge, because only the lingual cusps are active and should be situated at the top of the maxillary ridge. In many cases, this eliminates the need for crossbite arrangement and improves the functional and the aesthetic aspects of the dentures.
- The facial muscles and the cheeks are well supported by the more buccally placed maxillarymolars, which increases the aesthetics value even more.Occlusion in compete denture . Linqualized occlusion is not a temporary trend, but a clinical necessity. This concept ofocclusion enables a reduction of the forces transmitted onto the denture bearing areas, a 50%higher masticatory efficiency, since teeth with cusps are used, and different approaches to solving specific clinical problems.

  In lingualized Occlusion: An emerging treatment paradigm for complete denture therapy:general it can be said that there are no contra-indications for the lingualized occlusion concept.This concept is indicated for doctors and patients who place high aesthetic requirements on theirdentures and when the goal is to minimize the horizontal forces during mastication and Parafunctional movements in cases of severe alveolar bone resorption, flabby and knife edgeridges, abnormal jaw relation like cross arch and

large interalveolarspace. Lingualized occlusion is a simple occlusal scheme to practice. It can be modified to fit many different situations like when anatomic or non-anatomic teeth are to be used with a balanced or non-balanced occlusion. It can also be used in complete or partial denture, overdenture, immediate dentures or transitionaldentures. It, indeed, is an occlusion for all reason.

# BALANCED OCCLUSION

## BALANCED OCCLUSION

It is defined as, ―The simultaneous contacting of the maxillary and mandibular teeth on theright and left and in the posterior and anterior occlusal areas in centric and eccentric positions,developed to lessen or limit tipping or rotating of the denture bases in relation to the supporting structures– GPT.

Balanced occlusion can be described as the position of the teeth such that they have simultaneous contact in centric relation and provide a smooth sliding motion to any eccentric position. A three- point contact (usually one anterior and two posterior) at centric relation isnot sufficient for balanced occlusion instead there should be simultaneous contact of all the teeth. Remember, balanced occlusion is absent in natural dentition.

**Characteristic Requirements of Balanced Occlusion:**

A balanced occlusion should have the following characteristics:-

1. All the teeth of the working side (central incisor to second molar) should glide evenly against the opposing teeth.
2. No single tooth should produce any interference or disocclusion of the other teeth.
3. There should be contacts in the balancing side, but they should not interfere with the smooth gliding movements of the working side.
4. There should be simultaneous contact during protrusion.

**Importance of Balanced Occlusion:**

Balanced occlusion is one of the most important factors that affect denture stability. Absence ofocclusal balance will result in leverage of the denture during mandibular movement.Sheppard stated that, ―Enter bolus, Exit balance. According to this statement, thebalancing contact is absent when food enters the oral cavity. This makes us think thatbalanced occlusion has not function during mastication; hence, it is not essential in acomplete denture. But this is not true.

Brewer reported the importance of balanced occlusion. He stated that on an average, a normalindividual makes masticatory tooth contact only for 10 minutes in one full day compared to 4hours of total tooth contact during other functions. So, for these 4 hours of tooth contact,balanced occlusion is important to maintain the stability of the

denture[83]. Hence, balanced occlusion is more critical during parafunctional movements.

**General Considerations or Principles for Balanced Occlusion:**

The following points should be considered while developing balanced occlusion:

- Ideal-balanced occlusion can be achieved in cases with wide and large ridges and in complete dentures, with teeth arranged close to the ridge.
- Complete dentures that have teeth arranged away from the ridge and those that rest on narrow and short ridges will have poor balanced occlusion.
- Teeth that have a narrow bucco-lingual width and those that rest on wide ridges provide ideal- balanced occlusion
- Ideal balance can be achieved by arranging the teeth slightly on the lingual side of the crest of the ridge. Arranging the teeth buccally will lead to poor balanced occlusion. If the teeth are set outside the ridge the denture may elevate on one side during tooth contact. Stability of the denture against these lever forces is called as lever balance. Lever balance is different from balanced occlusion. It can be safely quoted that lever balance is also necessary for balanced occlusion (Refer ideal requirements of balanced occlusion).
- The complete denture should be designed in such a way that the forces of occlusion are centered anteroposteriorly in the denture.

**Types of balanced Occlusion [84] :**

Occlusion balance or balanced occlusion can be classified as follows:-

- Unilateral balanced occlusion
- Bilateral balanced occlusion
- Protrusive balanced occlusion
- Lateral balanced occlusion

Unilateral balanced occlusion: This is a type of occlusion seen on occlusal surfaces of teeth on one side when they occlude simultaneously with a smooth, uninterrupted glide. This is notfollowed during complete denture construction. It is more pertained to fixed partial dentures.

Bilateral balanced occlusion: This is a type of occlusion that is seen when simultaneous contactoccurs on both sides in centric and eccentric positions. Bilateral balanced occlusion helps todistribute the occlusal load evenly across the arch and

therefore helps to improve stability of thedenture during centric, eccentric or parafunctional movements.

For minimal occlusal balance, there should be at least three points of contact on the occlusalplane. More the number of contacts, better the balance. Bilateral balanced occlusion can beprotrusive or lateral balance.

**Advantages of bilateral balanced occlusion:**

The statement ―enter bolus exit balance‖ has cast suspicion on the value of smooth, gliding,non- interfering bilateral tooth contacts.It implies that when a food bolus is kept on one side there will not be occlusion on other sideand the denture will tend to drop on that side. This will occur whether the occlusion isbalanced/not. It has therefore been argued that conventional balanced occlusion‖ is not necessaryin eccentric position. The advantage of balanced occlusion however occurs when the teeth do

finally penetrate the food in eccentric position then the all-around contact reseals the dentures.The bilateral balanced occlusion is more important during activities such as swallowingsaliva, closing to reseat the denture, and the bruxingofe teeth during times of stress.

**Disadvantages of Balanced Occlusion :**

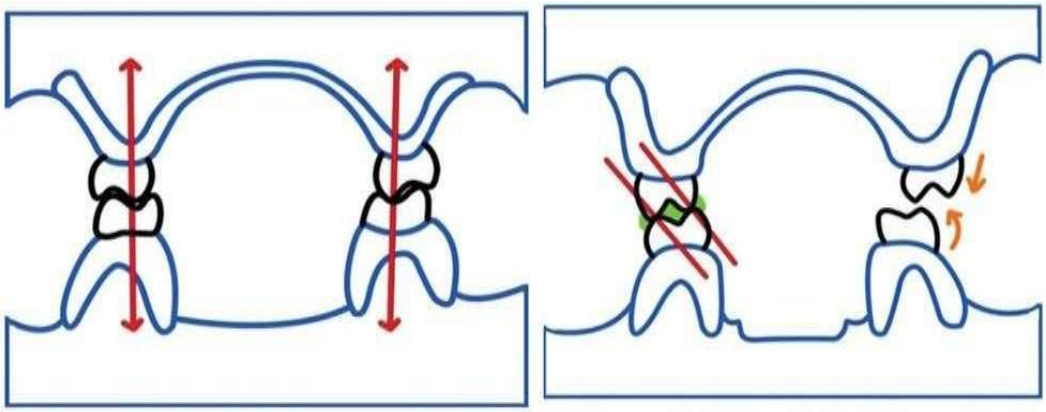
- It is difficult to achieve in mouths where an increased vertical incisor overlap is present.
- It may tend to encourage lateral and protrusive grinding habits.
- A semi adjustable or fully adjustable articulator is required

## CONCEPTS OF BALANCED OCCLUSION[85]

Many authors proposed different concepts for obtaining balanced occlusion. Most of them are not in use now and carry only a historical significance. Any way, we must know these concepts to understand how the present concepts have been derived from them..

**Gysi's Concept:** He proposed the first concept towards balanced occlusion in 1914. He suggested that arranging 330 anatomic teeth could be used under various movements of the articulator to enhance the stability of the denture.

Fig 9. a) Gysi‘s concept: In centric occlusion (b) Gysi‘s concept: In right lateral position



**French’s concept (1954):** He proposed lowering the lower occlusal plane to increase the stability ofthe dentures along with balanced occlusion. He arranged upper first premolars with 50 inclination,upper second premolars with 100 inclination and upper molars with 150 inclination. He usedmodified French teeth to obtain balanced occlusion

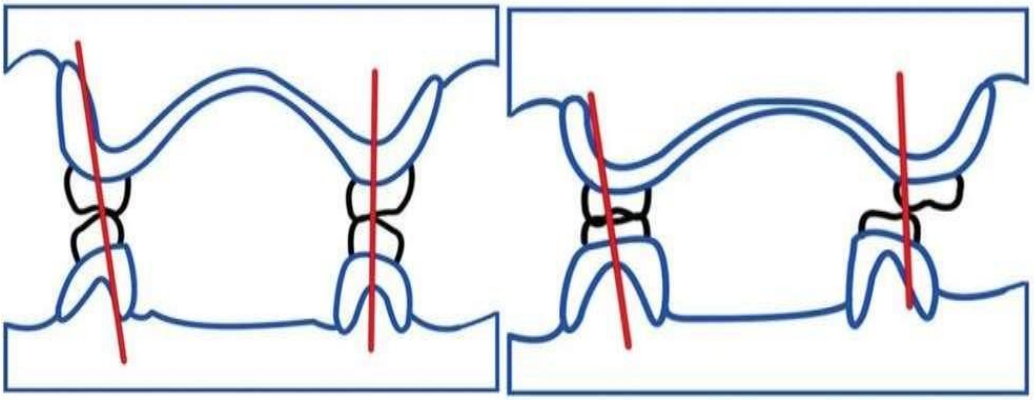


Fig 10. French’s concepts

**Sears’s concept**: He proposed balanced occlusion for non-anatomical teeth using posterior balancingramps or an occlusal plane which curves anteroposteriorly and laterally

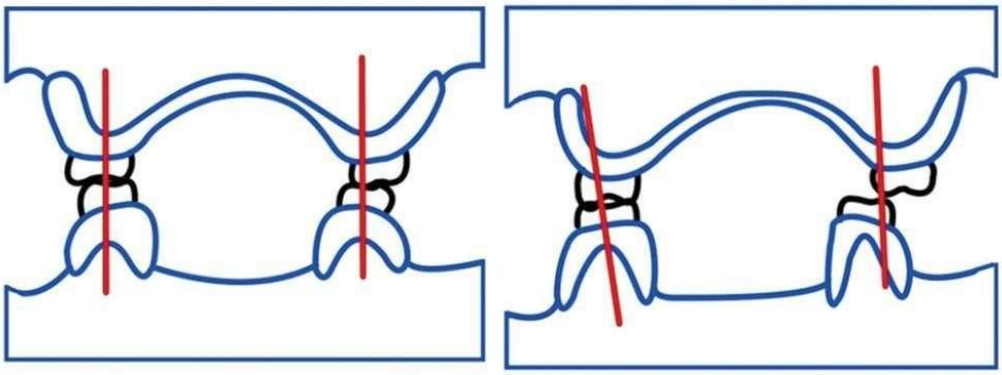


Fig 11. Sears concept

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**Pleasure's concept:** Pleasure introduced a pleasure curve or the posterior reverse lateral curve toalign and arrange the posterior teeth in order to increase the stability of the denture.

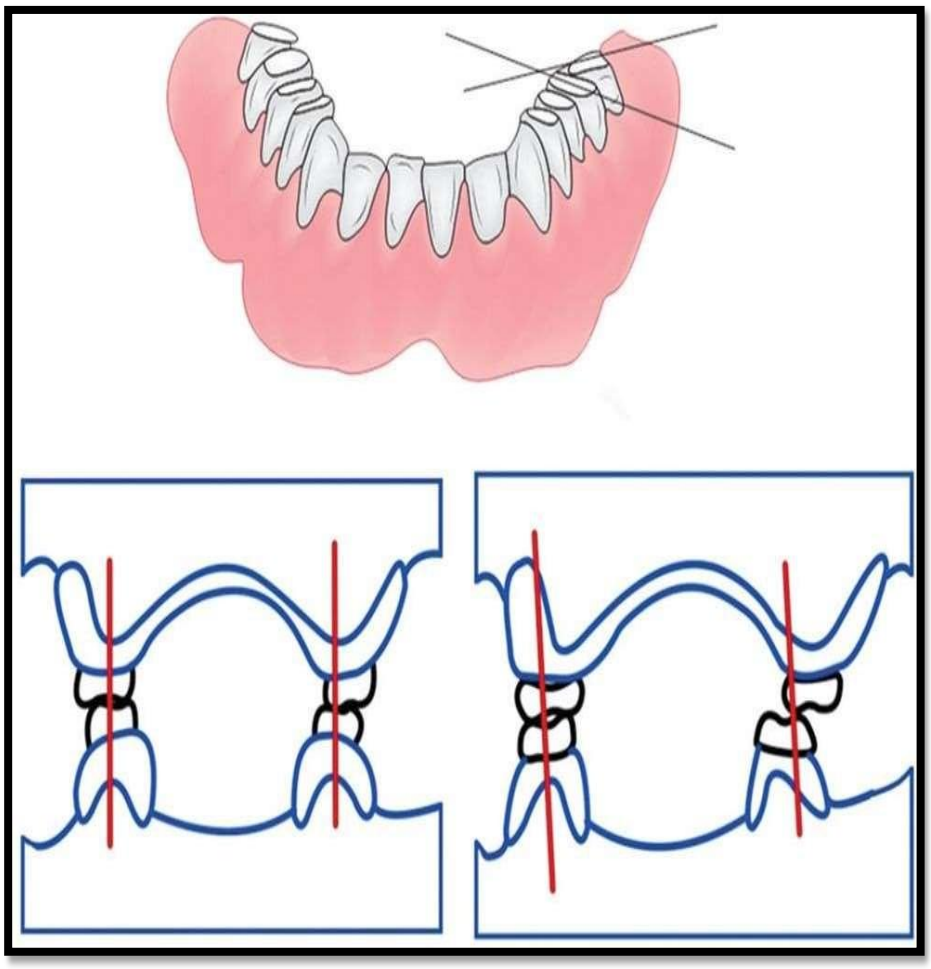

Fig 12. Pleasure concepts

**Frush's Concept:** He advised arranging teeth in a one-dimensional contact relationship, whichshould be reshaped during try-in to obtain balanced occlusion.

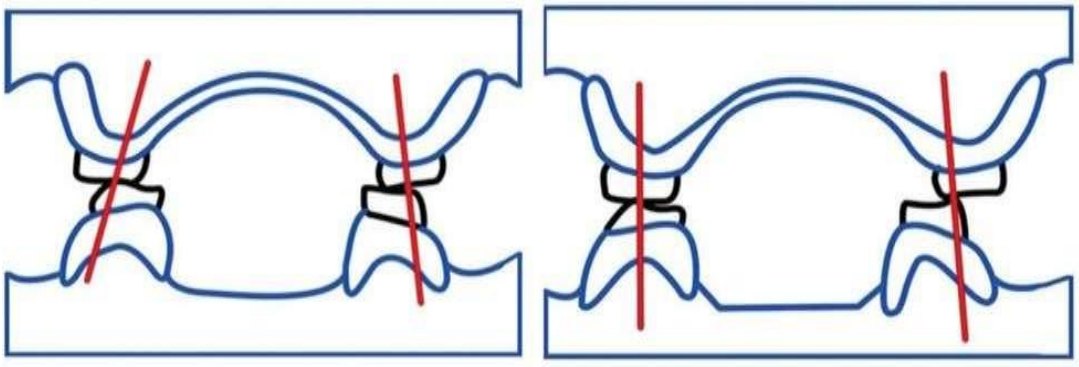

Fig 13. Frush's concept

**Hanau's Quint: Rudolph L. Hanau** proposed nine factors that govern the articulation of artificialteeth. They are:

1. Horizontal condylar inclination
2. Compensating curve
3. Protrusive incisal guidance
4. Plane of orientation
5. Buccolingual inclination of tooth axis
6. Sagittal condylar pathway
7. Sagittal incisal guidance
8. Tooth alignment
9. Relative cusp height

**Trapozzano's Concept of Occlusion :** He reviewed and simplified Hanau's quint and proposed his Triad of Occlusion. According to him, only three factors are necessary to produce balancedocclusion. He dismissed the need for determining the plane of occlusion to produce balancedocclusion. He said that the plane of occlusion could be shifted to favour weak ridges, hence, itslocation is not constant and is variable within the inter arch distance.

He also dismissed the need for setting compensating curves, because, he suggested that whenwe arrange cusped teeth in principle these curves are produced automatically. He considered thatcompensating curve as a passive factor, which is a

resultant of setting cusped teeth.Though his triad was simpler than the Hanau‘s quint, it eliminated the important compensating curves and plane of orientation.

**Boucher’s concept:** Boucher confronted Trapozzano‘s concept and proposed the following threefactors for balanced occlusion.

1. Orientation of the occlusal plane, the incisal guidance and the condylar guidance.
2. The angulation of the cusp is more important than the height of the cusp.
3. The compensating curve enables one to increase the height of the cusp without changing the form of the teeth.

He also stated that, the plane of occlusion should be oriented exactly as it was when natural teeth were present. According to him, the plane of occlusion cannot be changed to favour weak ridges and that the teeth should be located in their original position. He believed it was necessary to fulfill the anatomical and physiological needs.

Boucher also emphasized the need for the compensating curve. He stated that, ―the value of thecompensating curve is that it permits alteration of cusp height without changing the form of themanufactured teeth. If the teeth themselves do not have any cusps, the equivalence of a cusp can be produced by a compensating curve.

**Lott’s concept:** Lott clarified Hanau‘s laws of occlusion by relating them to the posterior separationthat is a resultant of the guiding factors.

- The greater the angle of the condylar path, the greater is the posterior separation during protrusion.
- The greater the angle of the overbite, the greater is the separation in the anterior and posteriorregions irrespective of the angle of the condylar path.
- The greater the separation of the posterior teeth the greater or higher must be the compensating curve.
- Posterior separation beyond the balancing ability of the compensating curve can be balancedby the introduction of the plane of orientation.
- The greater the separation of the teeth, the greater must be the height of the cusps of the posterior teeth.

**Levin's concept:** Bernard Levin believed that it was not necessary to consider the plane of occlusion because it was not very useful practically. Levin also states that the plane of occlusion can be slightly altered by 1-2 mm in order to improve the stability of a denture.

He named the other four factors of occlusion as the Quad.

- The condylar guidance is fixed and is recorded from the patient. The balancing condylarguidance will include the Bennett movement of the working condyle. This may or may notaffect the lateral balance.
- The incisal guidance is usually obtained from patient's aesthetic and phonetic requirements.However, it can be modified for special requirements. E.g., the incisal guidance is decreasedfor flat ridges

The compensating curve is the most important factor in obtaining occlusal balance. Monoplane or low cusp teeth must employ the use of compensating curve. Cusp teeth have the inclines necessary for balanced occlusion but nearly always are used with a compensating curve.

## FACTORS INFLUENCING BALANCED OCCLUSION

Though many authors questioned the necessity of all the five factors in a Hanau's quint, it is stillconsidered as the basic determinant of balanced occlusion. The five basic factors that determine the

balance of an occlusion are:-

i. Inclination of the condylar path or condylar guidance
ii. Incisal guidance
iii. Orientation of the plane of occlusion or occlusal plane
iv. Cuspal angulation
v. Compensating curve

There should be a balance within these five factors. The incisal and condylar guidances producea similar effect on balanced occlusion (they increase posterior tooth separation). Similarly, theother three factors have a common effect on balanced occlusion (they decrease the posterior tooth separation). The effect of the incisal and condylar guidancesshould be counteracted by the other three factors to obtain balanced occlusion. If this counteractive mechanism is lost, the balance of occlusion is lost.

Let us discuss in general how these factors affect the balance during protrusion. The incisalguide angle denotes the angle formed by the palatal surface of the upper anterior against thehorizontal plane. The incisal guidance can be raised by altering the labial proclination, overjet and overbite of the maxillary anterior, so that the incisal guide angle becomes steeper.

When the patient with a steep incisal guidance brings his mandible forward, there will be more jaw separation. This is because the movement of the mandible is controlled by the lingual surface of the upper anteriors (The upper incisors are more vertically placed in cases with a steep incisalguidance). Increase in jaw separation will lead to disocclusion of the posterior teeth leading to loss of tripod contact which in turn lead to lifting of the posterior part of the denture during incising functions. If the posterior part of the denture lifts during incisal function, it simply means that the balanced occlusion is absent. The condylar guidance has a similar effect on the denture.

To prevent the lifting of the posterior part of the denture, the compensating curve, cuspal angulation of the teeth, and the plane of occlusion should be modified such that a tripod contact is preserved during protrusion.

If the compensating curve is made steeper (raised), the posterior contact will be preserved duringprotrusion. If the cuspal height or angulation is increased, again the posterior contact will bemaintained during protrusion. Similarly, if the plane of occlusion is oriented / tilted so that it ishigher posteriorly, then the posterior contact will be maintained during protrusion.

Thus, we understand that when the incisal guidance or condylar guidance is high, the other threefactors should also be raised to compensate the effects of the incisal and condylar guidance andvice- versa. Now we shall discuss in greater detail about the significance of each factor in balanced occlusion. Inclination of the condylar path is also called as the first factor of occlusion. This is the only factor, which can be recorded from the patient. It is registered using protrusive registration (i.e. the patient is asked to protrude with the occlusal rims. Inter-occlusal record material is injected between the occlusal rims in this position. The occlusal rims with the inter-occlusal record are transferred to the articulation. Since the occlusal rims are in a protrusive relation, the upper member of the articulator is moved back to accommodate them. The inter-occlusal record is carefully removed and the upper member is allowed to slide forward to its original position. The condylar guidance should be adjusted

(rotated) till the upper member slides freely into position. It is transferred to the articulator as the condylar guidance.Increased in the condylar guidance will increase the jaw separation during protrusion. This factorof balance occlusion cannot be modified. All the other four factors of occlusion should be modified to compensate the effects of this factor. In patients with a steep condylar guidance, the incisal guidance should be decreased to reduce the amount of jaw separation produced during protrusion and vice versa. But it should be remembered that the incisal guidance cannot be made very steep because it has its own ill effects.

**i) Incisal guidance:**

This is defined as, ―The influence of the contacting surface of the mandibular and maxillary anterior teeth on mandibular movements.

It is called as the second factor of occlusion. It is determined by the dentist and customizedfor the patient during anterior try-in. It acts as controlling path for the movements of the casts inan articulator. It should be set depending upon the desired overjet and overbite planned for thepatient. If the overjet is increased, the inclination of the incisal guidance is decreased. If the overbite is increased, then the incisal inclination increases. The incisal guidance has moreinfluence on the posterior teeth than the condylar guidance. This is because the action of theincisal inclination is closer to the teeth than the action of the condylar guidance.

During protrusive movements, the incisal edge of the mandibular anterior teeth move in a downward and forward path corresponding to the palatal surface of the upper incisors. This isknown as the protrusive incisal path or incisal guidance. The angle formed by this protrusive path to the horizontal plane is called as the protrusive incisal path inclination or the incisal guideangle. This influences the shape of the posterior teeth. If the incisal guidance is steep compensatory curve is needed to produce balanced occlusion (explained previously). In a complete denture, the incisal guide angle should be as flat (more acute) as possible. Hence, while arranging the anterior teeth, for aesthetics, a suitable vertical overlap and a horizontal overlap should be chosen to achieve balanced occlusion. Also, the incisal guidance cannot be altered beyond limits. The location and angulation of the incisors are governed by various factors like aesthetics, function and phonetics, etc. The procedure for setting up the incisal guidance was described under articulation.

1. Orientation of occlusal plane to the ala-tragus or Camper‘s line:
   Boucher defines it as ―The line running from the inferior border of the ala of the nose to thesuperior border of the tragus of the ear.
2. Cephalometrically planned adjustable plane:
   Cephalometrically, a relationship has been shown to exist between the angle of occlusal planerelative to the Frankfurt plane on one hand and the angle formed between cephalometric points,porion, nasion and the anterior nasal spine (The Po NANS angle).

Y‘ = 83.4307 – (0.9907 – X)

Where X = PoNANS angle

value Y‘ = Occlusal plane angle

**Compensating curve:**

It is defined as, ―The antero-posterior and lateral curvatures in the alignment of the occluding surfaces and incisal edges of artificial teeth which are used to develop balanced occlusion – GPT.

It is an important factor for establishing balanced occlusion. It is determined by the inclination ofthe posterior teeth and their vertical relationship to the occlusal plane. The posterior teeth shouldbe arranged such that their occlusal surfaces form a curve. This curve should be in harmony withthe movements of the mandible guided posteriorly by the condylar path.

A steep condylar path requires a steep compensatory curve to produce balanced occlusion. If ashallow compensating curve is given for the same situation, there will be loss of balancing molarcontacts during protrusion.

There are two types of compensating curves namely:

1. Anteroposterior curves
2. Lateral curves

Curve of Spee, Wilson‘s curve and Monson‘s curve are associated only with natural dentition.In complete dentures compensating curves similar to these curves should be incorporated toproduce balanced occlusion.

**Anteroposterior Compensating Curves:**

OP – inclination of plane oforientation

OK – prominence ofcompensating curve Cusp plane andCusp plane angle:

When the two buccal cusp tips and the highest situated lingual cusp tip are connected with straight lines . these lines circumscribe a small plane which is called -Cusp plane.

The connecting line between the buccal cusps indicates the sagittal slope, and the alignment ofthese lines forms the compensating curve.The inclination of cusp plane to the plane of orientation is called -Cusp plane angle.

**Lateral Compensating Curves:** These curves run transversely from one side of the arch to theother. The following curves fall in this category.

**Compensating curve for Monson Curve**:

Monson‘s curve is defined as, The curve of occlusion in which each cusp and incisal edgetouches or conforms to a segment of the sphere of 8 inches in diameter with its center in the region of the Glabella. GPT.

This curve runs across the palatal and buccal cusps of the maxillary molars. During lateral movement the mandibular lingual cusps on the working side should slide along the inner inclines of the maxillary buccal cusp. In the balancing side the mandibular buccal cusps should contact the inner inclines of the maxillary palatal cusp. This relationship forms a balance.Only if the teeth are set following the Monson‘s curve there will be lateral balance of occlusion..

**Compensating Curve for Anti-Monson or Wilson Curve:-**

Wilson‘s curve is defined as, -A curve of occlusion which is convex upwards. -GPT.

This curve runs opposite to the direction of the Monson‘s curve. This curve is followed whenthe first premolars are arranged. The premolars are arranged according to this curve so thatthey do not produce any interference to lateral movements.

**Reverse Curve:-**

A curve of occlusion which in transverse cross-section conforms to a line which is convex upward. - GPT. It was originally developed to improve the stability of the denture.The reverse curve was modified by Max Pleasure to form the pleasure curve.

**Pleasure Curve:-**

A curve of occlusion which in transverse cross-section conforms to a line which is convex upwardexcept for the last molars. – GPT.

It was proposed by Max Pleasure. He proposed this curve to balance the occlusion and increase thestability of the denture. Hence the first molar is horizontal, the second

premolar is lingually tilted andsecond molar is buccally tilted. It is a modification of reverse curve in that it does not involve the secondmolars. This curve runs from the palatal cusp of the first premolar to thedisto-buccal cusp of the second molar.

i) Cuspal angulation:

Cusp angle is defined as, The angle made by the average slope of a cusp with the cusp plane measuredmesiodistally or buccolingually. – GPT.

The cusps on the teeth or the inclination of the cuspless teeth are important factors that modify the effect of plane of occlusion and the compensating curves. The mesiodistal cusps lock the occlusion, such thatrepositioning of teeth does not occur due to settling of the base during occlusal reshaping. In the absence of mesiodistal cusps, the buccolingual cusps are considered as a factor for balanced occlusion.

In cases with a shallow overbite, the cuspal angle should be reduced to balance the incisal guidance. This is done because the jaw separation will be less in cases with a decreased overbite. Teeth with steep cusps will produce occlusal interference in these cases.

In cases with a deep bite (steep incisal guidance), the jaw separation is more during protrusion. Teeth with high cuspal inclines are required in these cases to produce posterior contact during protrusion. Thus, wediscussed the various concepts and factors affecting balanced occlusion. The method of occlusal reshaping is not discussed in detail due to its complexity. It is necessary for a dentist to at least know that occlusal reshaping is done after teeth arrangement to produce balanced occlusion.

ii) Inclination of the Cusps:

It refers to the angle between the total occlusal surface of the tooth and the inclination of the cusp inrelation to that surface. For e.g. 33-degree tooth indicates that the mesial slopes of the cusp make 330-angle with a plane touching the tips of all the cusps of teeth. In other words the plane of reference (the horizontal plane) would be at right angles to the vertical axis of the tooth.

Swenson‘s Formula:-

Swenson‘s formula is an empirical formula and clarifies the relationship between thsagittal cuspinclination of the incisal guidance.

Cusp inclination = Incisal inclination + Fraction of distance from incisal guidance (Condyleinclination - Incisal inclination) on the working side.

Cusp inclination = Incisal inclination + Fraction of distance from incisal guidance (Differencebetween incisal guidance and condylar path inclination) here incisal inclination becomes zero.

Gysi‘s formula for the second molar:

Gysi‘s formula for the angulation of second molar is –

$$\text{Angulation of M2} = \frac{\text{Condyle guide inclination} + \text{Incisal guide inclination}}{2}$$

$$\text{That is EM 2} = \frac{B + V}{2}$$

B – Condyle guide inclination

V – Incisal guide inclination

Gysi‘s formula assumed to be an empirical formula, giving the dentist a conception of the approximatecusp angulation and setting of the incisal table of an adjustable articulator.

**LATERAL MOVEMENT**

Mandibular kinetics is made up of complex movements in addition to the opening and closingmovements of the jaw: they take place on the sagittal plane, on the vertical plane and on thetransverse plane . The Bennett movement is part of this group of movements . It is a complex lateral movement or lateral shift of the mandible resulting from the movements of the condyles along the lateral inclines of the mandibular fossae during lateral jaw movement. The Bennett movement can be studied in detail by a technique called “pantographic registration”, which shows that it consists of two movements: the immediate Bennett side-shift which occurs at the beginning of the translation, and the progressive Bennett side shift. In the immediate Bennett side shift, the orbiting condyle moves essentially straight medially as it leaves centric relation at the beginning of the lateral jaw movement, while the progressive Bennett side shift creates an angle (the Bennett angle) formed by the sagittal plane

and the path of the advancing condyle during lateral mandibular movement as viewed in the horizontal plane[86]

Working Side : Lateral mandibular movement is guided by condyle-fossa relationships and toothrelationships. During canine guidance the palatal surface provides guidance which may disclude all the other teeth on the side to which the mandible has moved (the working side). Alternatively,multiple working side contacts may be present, called group function, or a combination of initial group function with canine rise towardsthe end of the lateral exclusion can occur.

Non-working Side : The side away from which the mandible has moved is termed the non-working side but not the balancing side. Balancing side contacts are used in complete denture construction to gain balanced articulation and improve denture stability during excursive movements. Balance is a prosthetic term in edentulous cases whereas nonworking side contacts occur in dentate subjects. Nonworking contacts may become interferences should any of the previous situations exist as for the RCP–ICP slide and/or: Palatal cusps fracture; Increased tooth mobility occurs with a healthy periodontium

(1° Trauma from occlusion); Increasing tooth mobility occurs with pre-existing chronic adult periodontitis (2° Trauma from occlusion);Pain or pulpal necrosis is located to one or two teeth with no other obvious cause, e.g. caries.

**Movement = Lateral Shift = Immediate Side Shift or Bennett Shift**

These terms have caused great confusion to dentists, perhaps because all the terms describe thesame thing. Lateral Shift is the most descriptive term as it relates to the lateral movement of theworking side condyle. It may move outwards (laterally) and upwards (superiorly), backwards(distally) or downwards (inferiorly). The next effect consists mainly of rotation round the verticalaxis of the working condyle with concomitant lateral translation . The average lateral movement is 1mm. There is, therefore, a bodily shift of the mandible to the working side. Unfortunately, theAmerican literature also calls this shift laterotrusion.

**Bennett Angle = Progressive Side Shift or The Bennett angle** refers to the angle, in the horizontal plane, between the sagittal plane and the downward, inward and forward path of the nonworking condyle.

Bennett angle :the angle formed between the sagittal plane and the average path of the advancingnonworking-side condyle as viewed in the horizontal plane during lateral mandibular movements(GPT-4)

The mean Bennett angle is 7.5°. It is important to realize that this is viewed in the horizontal plane. The degree of forward and downward translation of the nonworking condyle, when viewed in the sagittal plane, is greater than for a protrusive movement. This angle between the translating pathway in protrusion and that of the non-working condyle has been called **Fischer‘s angle** .Fig 14. Right lateral excursion (RLE) viewed in the horizontal plane.

A= lateral shift or immediate side shift in mm

B= Bennett angle or progressive side sift in degrees

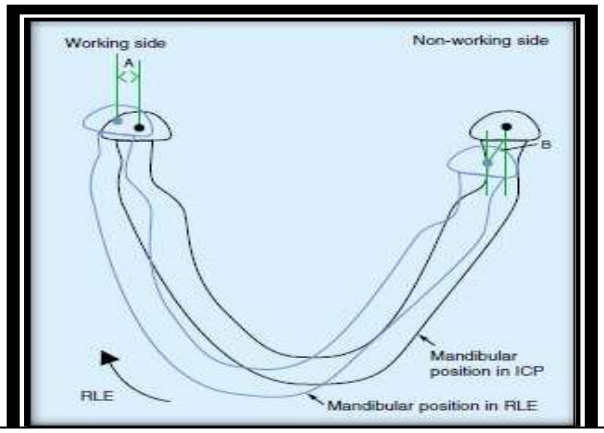


Fig 14. Right lateral excursion (RLE) viewed in the horizontal planeA= lateral shift or immediate side shift in mm B= Bennett angle or progressive side sift in degrees

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## THE BIOMECHANICS OF FUNCTIONAL OCCLUSAL CONTACTS

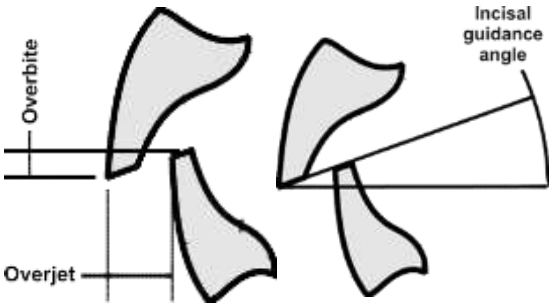
In order to understand how balanced articulation is achieved, the following discussions will bebased on the use of cusped artificial teeth; modifications of these arrangements will be dealt with in later sections. It is assumed that the teeth start by having cusp to fossa relationships that are similar to those of natural teeth, and that they are set in maximum intercuspation to maintain these relationships. This is fairly simple, because the teeth are manufactured to fit together maintaining these cusp-

fossa contacts. However, as soon as the mandible moves out of centric relation position, other factors come into play.

I

**Protrusive movements**

There are two determinants of mandibular movement in any forward direction, the *incisal guidance angle* and the *sagittal condylar guidance angle*.The incisal guidance angle (IGA) is formed by the vertical overlap (overbite) between the teeth.It is only dependent on the amount of horizontal overlap (overjet) to the extent that there is no guidance until the teeth actually contact fig 15. In natural teeth, these dimensions of overbite andoverjet are determined by the positions of the teeth; in complete dentures, they are determined byother factors, mainly aesthetics, phonetics, and function. This means they can be controlled bydentist, within the limitations of the other factors that determine overall tooth position (mainly the imperative to place artificial teeth in the positions occupied by the natural teeth in health).




The incisal guidance angle is formed by the amount of vertical overlap or overbite between theteeth, when viewed in the sagittal plane The sagittal condylar guidance angle (SCGA) is not under the control of the dentist at all, and is determined purely by the biomechanics of the joint itself. This is the net result of the condyle-disc assembly passing forwards and downwards, under the influence of the anterior slope of the glenoid fossa. In fact, the condyles do not traverse along a straightline path as in the diagrams given here, but take a very shaky zig-zagging pathway, the net result of which can be represented by a straight line. The actual pathway has a non-linearshape because of the nature of the joint itself – it is very slippery (about five times moreslippery than ice on ice) and yet the condyle has to resist any forces acting at the teeth, inall positions it may occupy within the glenoid fossa.

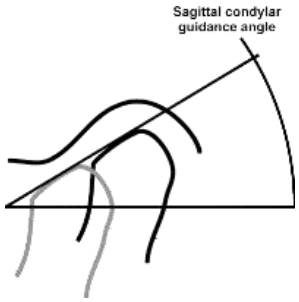
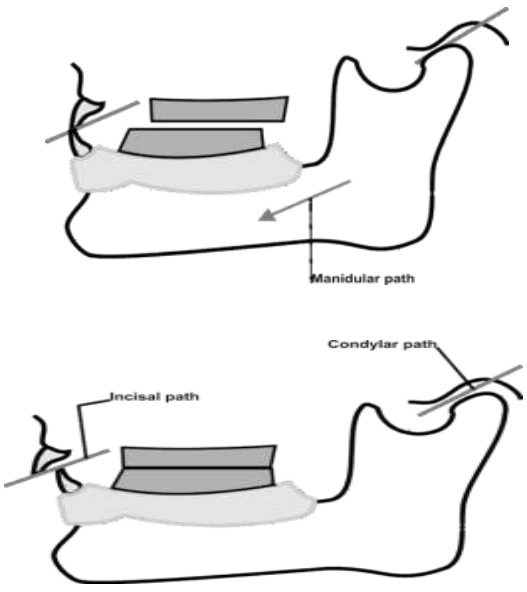



Fig 16.sagital condylar angle

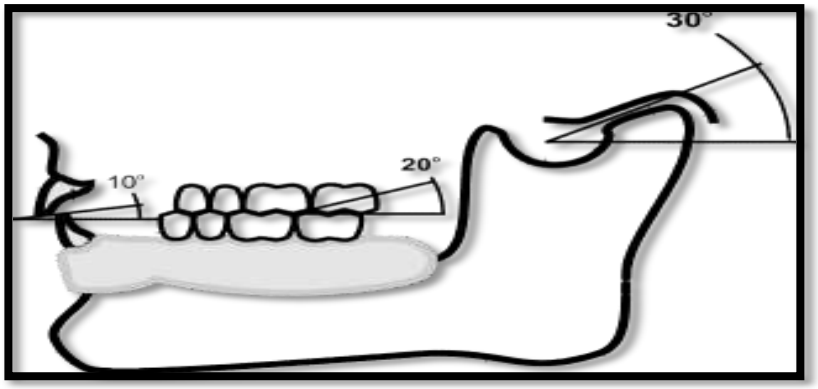
The sagittal condylar guidance angle is the average path taken by the condyle during a forward movement from centric relation position, when viewed in the sagittalplane.(fig 16)The form of the condyle and fossa means that any forward movement of themandible is also a downward movement: if record blocks are placed midway between theincisors and condyles on a flat plane, they will separate if the mandible moves forwards .Similarly, if teeth are placed in place of flat record blocks, again on a flat plane, they willalso separate, unless they can be given cusps with inclines that may fit in with thegeometry of the path of movement of the mandible.

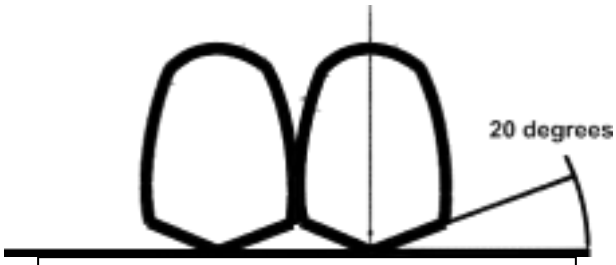



The so-called Christensen phenomenon, in which the mandibular path in a forwards directionproduces a downward displacement of the mandible. This means that record blocks, for instance, seton a flat plane will separate when the mandible moves forwards.

For example, consider , The IGA has been given a value of 10° and the SCGA a value of 30°. Teeth have been placed between, with very stylised cusps with angles of 20°.

The incisal guidance angle is 10° and the sagittal condylar guidance angle is 30°. Teeth have been placed on a plane, and have 20° cusp angles, as illustrated by the distal cusp of the upper first molar



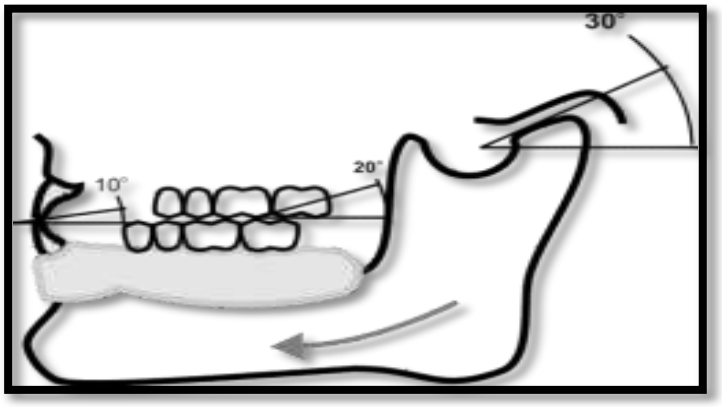




The cusp angle of these teeth is 20° when the teeth are positioned upright against flat plane.

The incisal guidance angle is 10° and the sagittal condylar guidance angle is 30°. Teeth have been placed on a plane, and have 20° cusp angles, as illustrated by the distal cusp of the upper first molar

The cusp angle of these teeth is 20° when the teeth are positioned upright against flat plane.If now the mandible moves forwards, it will do so on an arc which will be steeper posteriorly, as it is under the influence of the 30° condylar guidance angle, than anteriorly,where it is under the influence of the smaller 10° incisal guidance angle. As the mandiblemoves forwards, at a point mid-way between the posterior and anterior determinants of itspathway, the teeth will remain in contact, because they

have 20° cusp angles. However,anterior to this mid-point, and posterior to it, the teeth will separate, because the cuspangles need to be closer to 10° anteriorly, and closer to 30° posteriorly (note that the slopesof the cusps that remain in contact are the distal slopes of the uppers and the mesial slopesof the lowers)




The mandible's path is an arc which is steeper posteriorly than anteriorly. The only teeth that will remain in contact are those mid-way between the 30° movement posteriorly and the 10° movement anteriorly, i.e. whose cusp angles are 20° at the mid- point of the arc (30+10=40; half of 40=20). So how do the cusp angles of the teeth change? They could ofcourse be ground, but they could also change by changing the axis of the tooth relative tothe plane of occlusion. If the tooth is tilted five degrees say, then the *effective* cusp anglewill be 25° on one side and 15° on the other, depending on the direction of the tilt (fig 17) Effective cusp angle

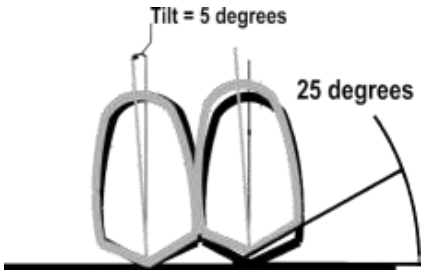
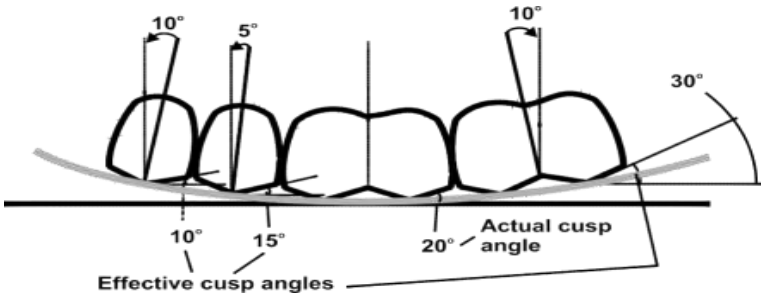


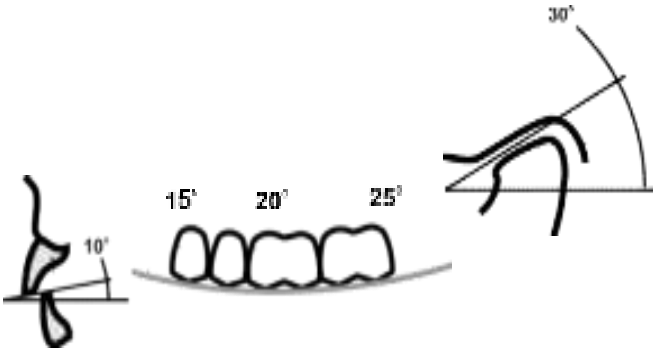

Fig 17. Effective cusp angle

The teeth are tipped fivedegrees, making the effective cusp angle of the distal slopes 25°, and reducing the mesial slopes to 15° (after Watt and McGregor, 1976).

This tilting of the teeth to correct the cusp angles can now be used to ensure that the teeth remain in contact during a protrusive movement of the mandible. For example, suppose theincisal and condylar guidance angles are such that it is necessary for the effective cuspangles of the distal slopes of the upper cusps (and therefore of the mesial slopes of thelowers also) to be 10° at the first premolars, and 30° at the second molars. If the teeth havean actual cusp angle of 20°, then the premolars must be tilted to *reduce* that angle to 10° atthe first premolar, and the second molar must be tilted to *increase* that angle to 30°




The teeth are tilted to increase or decrease the effective cusp angles to compensate for the arc of the path of the mandible in protrusion




If all the cusp tips are connected, it will be found that they now no longer lie on a straight plane, but on a curve: this curve will be in harmony with the arc of movement of the mandible,as it will have compensated for that arc, determined by the incisal and condylar guidance

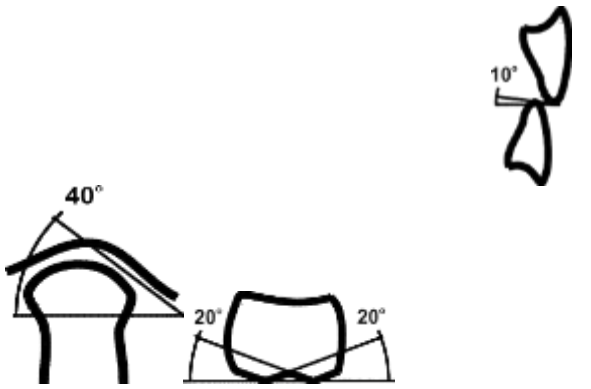
The steepness of the compensating curve varies according to the condylarangle as the incisal guidance angle remains the same. So with a 30° condylarguidance angle, the curve is shallower (upper diagram) than that required for a 40°condylar guidance angle (lower diagram)

## Lateral movements

When the mandible moves sideways, the side to which it moves is called the *working* side, and the opposite side of the arch, moving now towards the mid-line is the *nonworking*, or *balancing* side.

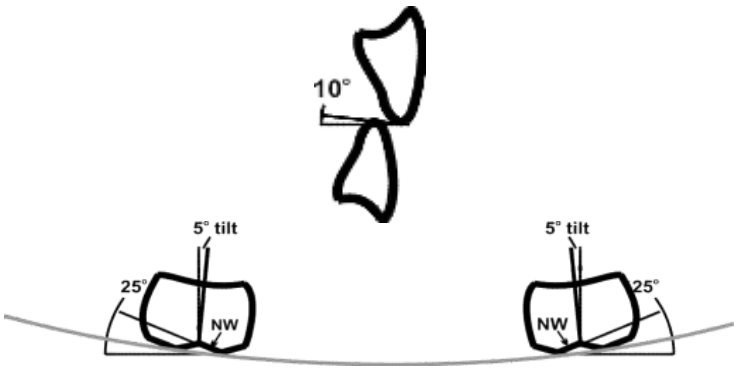
Consider a movement of the mandible to the left. As in protrusion, this movement is also not a flat one, but is under the influence of posterior and anterior determinants. The anterior determinant in this case will be any vertical overlap at the corners of the arch, i.e. at the canines. As with the incisal guidance angle, this *canine* guidance angle is under the influence of the operator but subject to the similar constraints of aesthetics, arch form, etc.The posterior determinant is, again, dependent on the anatomy of the joint, as the condylediscassembly now comes under the influence of the angulation of the *medial* wall of theglenoid fossa.

Precisely the same principles as followed for protrusive movements can be used to explainthe necessary changes in tooth morphology required to ensure tooth contact during lateralmandibular movements. Figure 14 illustrates the problem: the medial condylar guidanceangle when viewed from the frontal plane (what used to be called the Bennett angle) istaken to be 40° (for purposes of illustration) and the canine guidance angle, 10°. On thenonworking side a stylised molar is shown with 20° cusp angles. Figure 15 shows whichof the slopes of the cusps are involved in order to maintain simultaneous contact on eachside of the arch when the mandible moves to the left.




Shows a medial condylar guidance angle of 40°, a canine guidance angle of 10° on the

working side and a tooth with 20° cusp angles on the nonworking side When the mandible moves tothe left, the inclines marked **W** must remain in contact on the working side (**WS**) and the inclines marked **NW** must remain in contact on the nonworking side (**NWS**), for balanced articulation. Consider now just the requirements of the nonworking side cusps, that they remain in contact when the mandible moves to the left. These cusp angles are 20° but if this tooth is placed mid-way between the condylar guidance angle and the canine guidance, then their angle ought to be 25°. Once again, as in protrusion, this can be achieved by tilting the tooth to provide an effective nonworking inclined cusp angle of 25°. If this is done on both sides of the arch, and a line drawn through the cusp tips, another curve is created, this time compensating forthe arc of movement of the mandible in a lateral direction.




These examples have assumed that the condyle on the working side has no influence on the mandibular movement, but unfortunately this is not so. Althoughit is often called the ―orbiting‖ condyle because its movement is predominantly oneof rotation, it does in fact move sideways, this time under the influence of the slopeof the lateral wall of the glenoid fossa. This *lateral* condylar guidance angle willtherefore influence the inclinations of the *working side* slopes of the cusps thatmust remain in

contact. For purposes of illustration the predominant cusps involved have been shown in Fig, again at a point mid-way between the canine guidance and the condylar guidance. It is evident that the tilt of the tooth will produce the desired nonworking incline angles, but is insufficient in itself to produce the required *working* incline angles, given the angles shown. This clearly has implications for the way in which teeth are set up and adjusted, to achieve afully balanced articulation.

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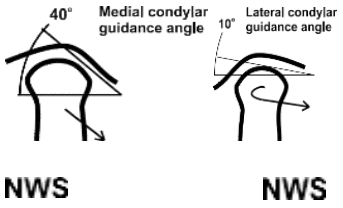
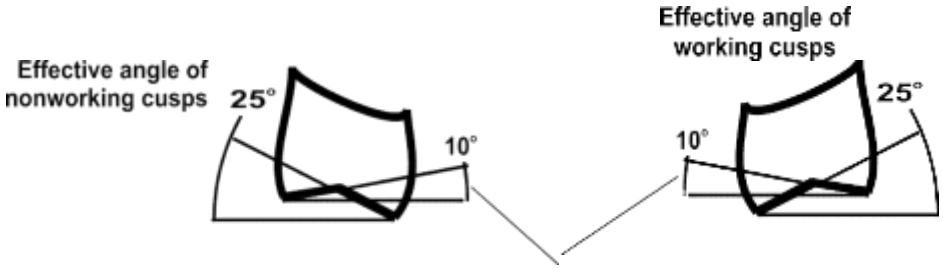
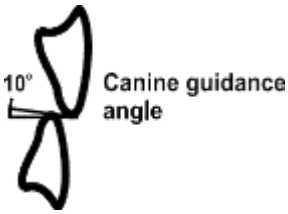


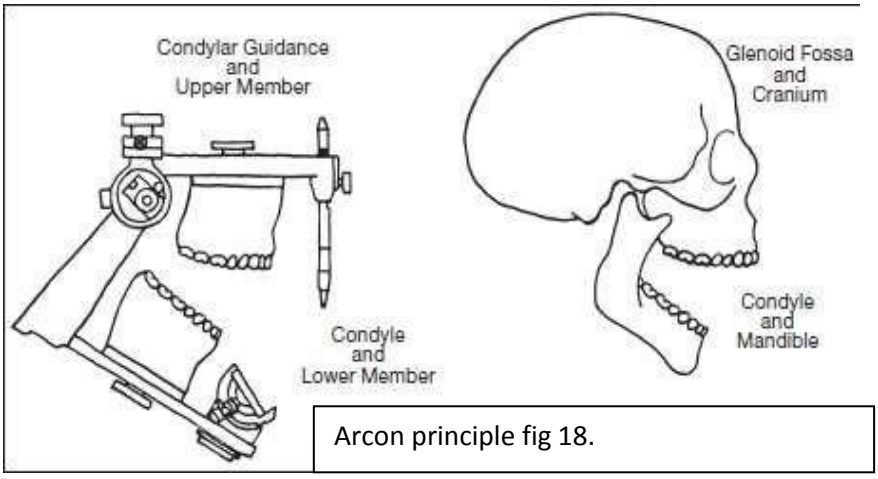






Effective angle of
working cusps

**HANAU WIDE-VUE ARCON ARTICULATORS AND WIDE-VUE II ARTICULATORS**

The HANAU Wide-Vue Articulators are classified as semi-adjustable. They are of Arcon principle, wherein the Condylar Guidances are associated with the Upper Articulator Member, as the patient‘s glenoid fossa is a portion of the cranium, Figure 18. The Condyle of the Articulator is a part of the Lower Member and functions as the condyle of the patient‘s mandible.Articulator movements may be directly related to the anatomical function of the patient.




Arcon principle fig 18.

**CONDYLAR GUIDANCE, Figure 19 :**

The Condylar Guidances are the control centers of the Articulator and they adjustably assimilate the multiple function of the glenoid fossa.The Condylar Track may be adjustably inclined on the horizontal transverse axis from azero to a plus 60 degree or to a minus 20 degree. These inclinations are termed theprotrusive inclination and simulate the patient‘s superior wall of the fossa.The Condylar Track may also be adjusted on the vertical axis from a -zero sagittal to 30˚. Thisangle is termed the progressive Bennett angle and corresponds to the medial wall of thepatient‘s fossa.

**CLOSED CONDYLAR TRACK, Figures 19 and 20 :**

The Condylar Guidance Track of the Items in Footnote 2 rotates in an enclosed housingwhich stops the Condylar Element, preventing the accidental disengagement of the UpperMember.

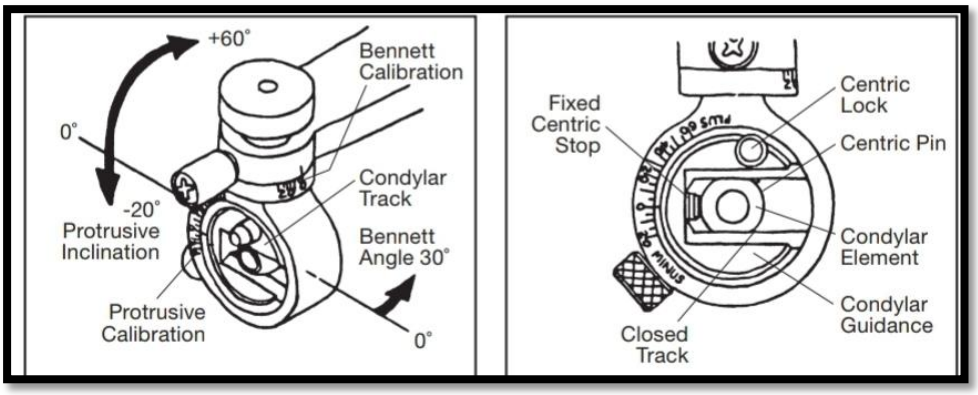


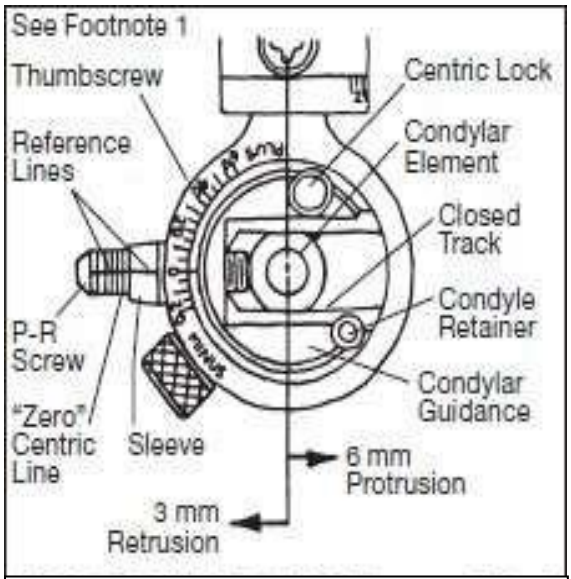

Fig 19 and fig 20

**FIXED CENTRIC STOP, Figure 20:**

The Items in Footnote 3 have a Centric Stop at the posterior end of the Track to limit anterior movement of the Condylar Element. When the Element rests against the Stop it is atcentric the point from which the protrusive or Bennett angles both emanate.

**ADJUSTABLE PROTRUSIVE-RETRUSIVE, Figures 21 and 22:**

This micrometer adjustment permits the Condylar Element to be protruded 6 mm from centric or to be retruded 3 mm from centric.




**Protrusive–Retrusive fig..21**

An axial reference line transcribes the one mm spaced lines on the P-R Screw and a like lineappears on the sleeve of the guidance.Loosen the Thumbscrew at medial side of the guidance and rotate the P-R Screw to abut the wide -zero centric line with the sleeve end. This centric position is then exactinglyrefined by aligning both axial lines as with a micrometer.Protrusion or retrusion of the condylar element can be fractionally adjusted by selectiverotation of this P-R Screw. One full turn of the one millimeter pitch Screw equals 1 mmprotrusion or retrusion. 1⁄2 turn equals 1⁄2 mm, 1⁄4 turn equals 1⁄4 mm and 1⁄8 turn equals 1⁄8mm.

This 1⁄8 turn equals .005 inch and may be equated with a recognized dimension of the.004 inch (.1 mm) thick U.S. dollar bill.Security of this adjustment is made by tightening the thumbscrew lock at the medial ofthe guidance. The micrometer adjustment may be returned to this exacting centric position atany time.

**CENTRIC LOCK fig 23 ,24**

Engagement of a centric lock depresses a centric Pin, causing it to arrest the condylar element at the centric position. When locked, the upper member is restricted to an openingand closing movement only.Releasing the centric Lock two full turns will disengage the centric Pin and return theelement‘s freedom of movement in the condylar track.

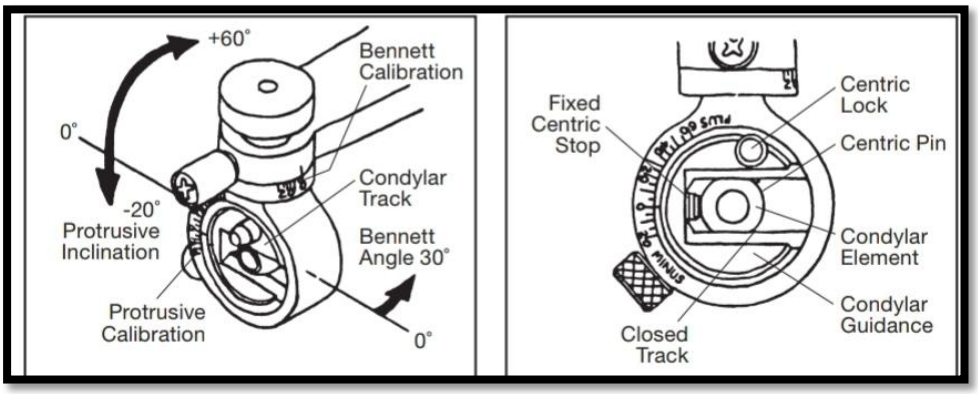


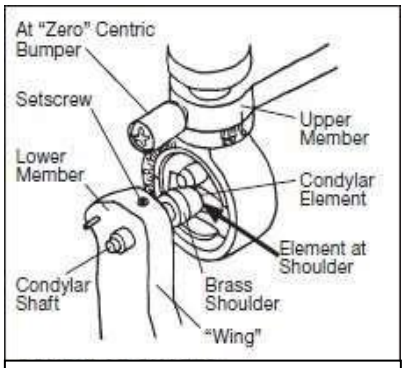

Fig 23 and fig 24

**CONDYLAR SHAFTS, Figure 25:**

The condylar shafts adjustably slide in the wings of the lower member. They have been

factory fixed by Setscrews when their brass shoulders rest against the flatted sides of the

condylar elements at the zero centric position.A resilient Bumper will protectively stop the upper member and rest against the Wing of thelower member when fully opening the articulator.




Condylarshaft fig. 25

**DUAL-END INCISAL PIN, Figures 26 and 27:**

Coinciding with these condylar shaft adjustments is an alignment of the chisel edge of the

Incisal Pin with the central table of the Incisal Guide.

The Incisal Pin serves as the forward control of the articulator. It cooperatively maintains avertical stop and provides a stylus contact for the excursive movements of the articulatoragainst the various inclined guiding surfaces of the Incisal Guide.

A mid-line groove is cut in the Incisal Pin about one inch from the spherical tip. Five additional lines calibrated in millimeters extend on either side . These lines are used for

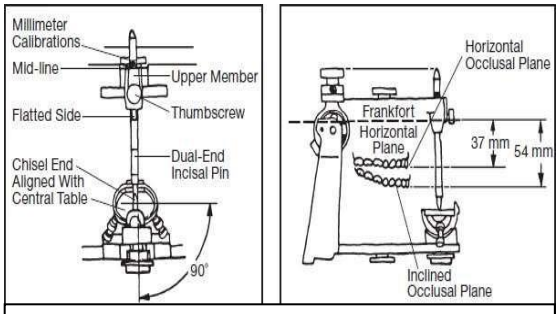
recording or altering the vertical dimension.The Incisal Pin is inserted into, and the wider mid-line of these metric grooves is alignedwith, the top edge of the upper member. It is secured by the Thumbscrew bearing against the

flatted side on the Pin. This adjustment places the chisel end at 90 degrees to and I contactwith the central table of the Incisal Guide and provides a parallelism of the Upper Member tothe Lower Member.

Two annular grooves, appear on the Incisal Pin at 37 and 54 mm below the Frankfort

Horizontal Plane. These grooves form arbitrary vertical landmarks for alignment of th\\

incisal edge of the maxillary centrals when making a facebowtransfer.The 37 mm line is based in part on the Bonwil Triangle and results in a generally horizontal appearing plane of occlusion.The 54 mm line forms an average landmark for alignment of the incisal edge of the upper centrals when making a facebow transfer. This reference line is based on the research study by Frank R. Lauciello, D.D.S., and Marc Appelbaum, D.D.S.,



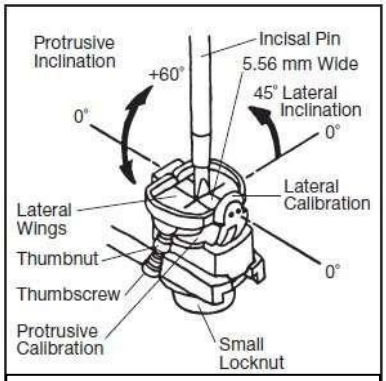

Dual end incisalpinfig.26

Anatomic Comparison to Arbitrary Reference Notch on Hanau™ Articulators, Journal of

Prosthetic Dentistry, December 1978, Volume 40, Number 6, Pages 676-681.

The Incisal Pin extends beyond the top of the Upper Member and provides a third point ofstability when inverting the articulator for mandibular cast mounting.The spherical tip of this Incisal Pin serves as the Dual-End and is useful for fabricatingcustomized acrylic anterior guide tables.

**ADJUSTABLE INCISAL GUIDE, Figures 28 and2 9:**




Adjustable incisal guide

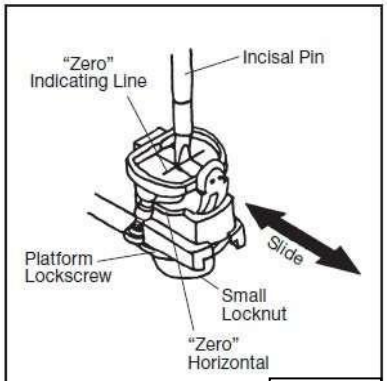


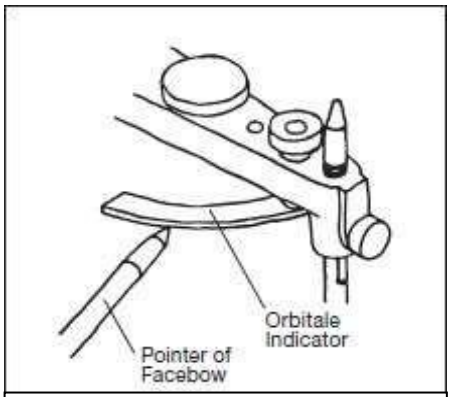

Fig29

The Adjustable Incisal Guide provides an independent adjustment of anterior guidance. It cooperates with the Incisal Pin and Condylar Guidances to present a stable, three-dimensionalprogrammed guide pattern for the mounted casts.

The Incisal Guide rotates antero-posteriorly from a horizontal -zero degree to a 6 degree positive inclination of protrusion which is then secured by the small Locknut. The central guiding table is 5.56 mm wide and forms the inclined surface for the protrusive guidance ofthe Incisal Pin.Separately adjustable Lateral Wings elevate by a Thumbscrew from a- zero horizontal to a45 degree incline and are fixed by a Thumbnut. The calibrations are very small and serveonly as a reference.An anterior slot (fig 29) , in the Lower Member, allows repositioning of the Incisal Guide. Adjust and lock the guide at a -zero horizontal and slightly loosen the Platform Lockscrew.Slide the Platform antero-posteriorly to align the chisel end of the Incisal Pin with the –zeroindicating line on the lateral wings.

This adjustment will place the Incisal Pin contact on the rotational center of the guide, thereby maintaining the vertical dimension when adjusting the inclination for protrusion. Loosening the Platform Lockscrew one turn will allow the Incisal guide .Assembly to be withdrawn from or returned to the anterior slot without any disassembly of parts.

**OBITALE INDICATOR, Figure 30:**




Orbital indicator fig.30

The Items in Footnote 1 are equipped with an orbitale indicator. This -crescent representsthe patient‘s infra-orbitale notch and is the anterior reference landmark of the Frankfort

Horizontal Plane.When used with an orbitale Pointer on a facebow it provides an anatomical verticalorientation for the upper arch, obviating the use of any average reference lines on the IncisalPin.

**LABORATORY PROCEDURE**

**ARTICULATOR PREPARATION**

A. Adjust the protrusive inclination of both condylar guidances to 30 degrees and tightenthe Thumbnuts, Figure 31.

   Note that the calibrations for these angles appear on both sides of the guidance housing and that the right and left can be seen and adjusted from the same side of the Articulator.

B. Adjust the Bennett angles of both condylar guidances at 30 degrees and tighten their thumbnuts.

C. Adjust the Incisal Pin to align the mid-line calibration to the top edge of the Upper Member.

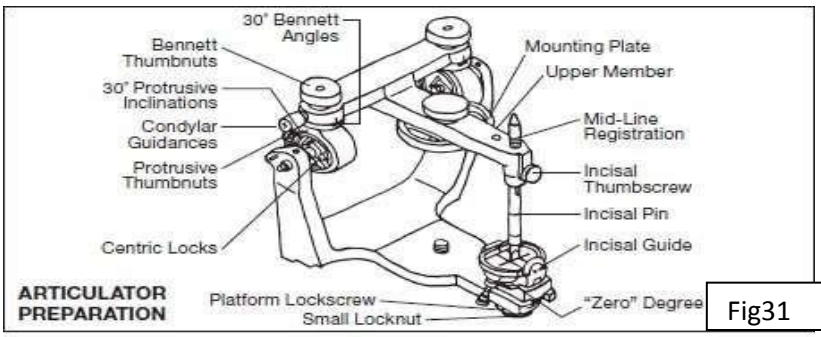



Fig31

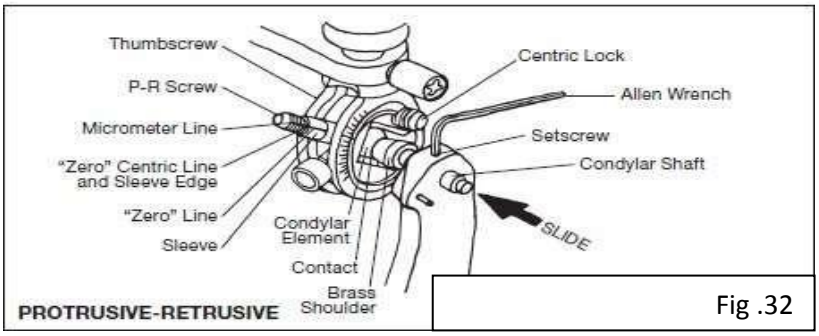



Fig .32

D. Adjust the Incisal Guide to a ―zero degree and tighten the small Locknut

E. Slide the Platform to align the Incisal Pin contact over the ―zero indicating line on guidance and tighten platform.

F. Articulators with Protrusive-Retrusive feature ONLY: must be adjusted to a ―zero centric, Figure 32.

Release the Centric Locks and the Thumbscrews at the medial site of the condylar guidances.

Adjust both P-R Screws to about the zero centric line (widest, most prominent and seventh from end) with the edge of the sleeve. Refine this ―zero centric position by aligningthe micrometer reference line on the P-R Screw with the ―zero line on the Sleeve.

Secure the zero centric adjustment by tightening the Thumbscrews at the medial side.

If the articulator condylar shafts were adjusted on a previous case, they must be realigned totheir original position.

Loosen the two Setscrews with the Allen Wrench. Slide the condylar shafts to contact theirbrass shoulders with the flatted sides of the ―zero centric positioned condylar elements –without binding or perceptible side-shift.

The chisel end of the Incisal Pin must exactly coincide with the central table of the Incisal

guide . Tighten the Setscrews to secure the condylar shafts in this position.

G. Tighten the centric locks, Figure 16, to restrict the articulator to opening and closing movements only.

H. Apply a thin coating of petroleum jelly to all surfaces of the articulator that will be exposed to the stone mounting media.

I. Firmly attach a mounting plate to the Upper Member.

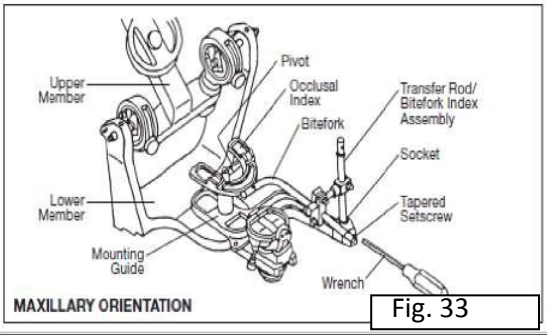


Fig. 33

**MOUNTING MAXILLARY CAST**

8. Swing the Upper Member of the Articulator OPEN to the Centric Bumper. Securely attachthe Mounting Guide (furnished with the Twirl-Bow) to the Lower Member, Fig 33.

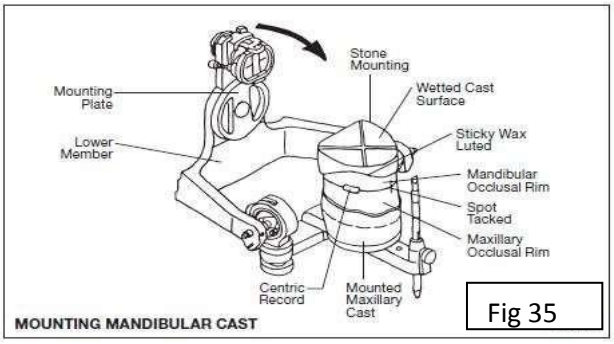
9. Insert the lower end of the Transfer Rod/Bitefork Index assembly into the Socket of the Mounting Guide, aligning the Tapered Hole to accept the Tapered

Setscrew in Socket. Tighten the Tapered Setscrew to enter and align the Transfer Rod.

10. Raise the Pivot (cast support) to contact the underside of the Bitefork Index and lock inposition by the Thumbscrew to stabilize and carry the weight of the maxillary cast and thestone mounting media.
11. Securely seat and accurately lute the upper occlusal rim into the occlusal wax index onthe Bitefork, Figure 34. The upper cast is then seated into and sticky wax spotted to thedenture base.
12. A mixture of stone is placed on the wetted mounting surface of the cast. The Upper Member is then swung forward to embed the Mounting Plate and to bring the Incisal Pin intocontact with the Incisal Guide. The mounting is completed with a wet finger and spatula to expose the top surface of the Mounting Plate. This permits convenient removal and accurate reattachment of the cast to theArticulator.
13. Upon complete set of the mounting, the sticky wax luting is carefully broken from the occlusal rim. The Mounting Guide and Transfer Rod/Bitefork Index assembly are removedfrom the Lower Member. Check that the occlusal rim is intact and that all of the sticky waxhas been removed.

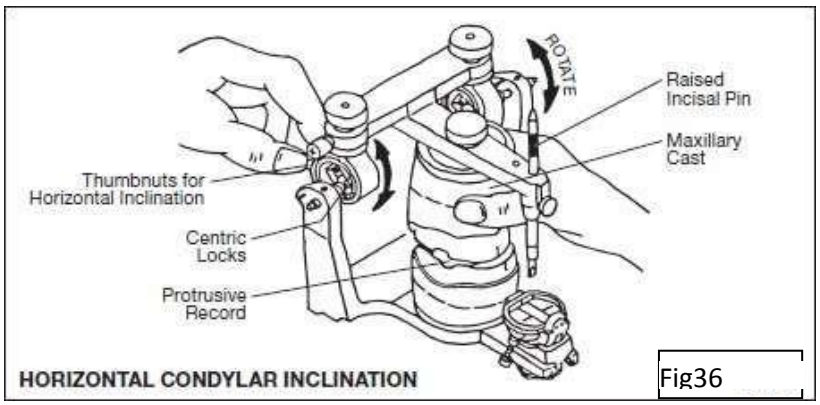
**MOUNTING MANDIBULAR CAST, Figure 35:**

14. Invert the Articulator and swing the Lower Member back to the bench.
    Apply a thin coating of petroleum jelly to all surfaces of the Lower Member that may be contactedby the gypsum material.Firmly attach a Mounting Plate to the Lower Member.
15. Securely seat the mandibular cast in the bite rim and lute together with sticky wax. The centric interocclusal relation record is then carefully seated between the indexed occlusalsurfaces of the upper and lower occlusal rims. Temporarily spot tack the occlusal rims in thiscentric position.
16. A mix of stone is placed on the wetted mounting surface of the lower cast. The Lower Member is then swung over to embed the Mounting Plate into the stone and to bring the Incisal Pin into contact with the Incisal Guide.Complete the mounting with a spatula and finger, making certain that the Centric Locks havebeen secured.




**ADJUSTMENT OF HORIZONTAL CONDYLAR GUIDANCE, Figure 36:**

17. Upon complete set of the mount, the Articulator is placed into an upright position. Carefully cut the tacking at the occlusal surface and remove the centric interocclusal relationrecord.




18. Loosen the Centric Locks and the Thumbnuts for horizontal inclination of the CondylarGuidances.Raise the Incisal Pin to remove the possibility of mechanical interference with the IncisalGuide.Whenever Centric Locks are loosened, the Condyle Retainers MUST be pushed outward toblock the Track, barring accidental removal of the Upper Member.As a matter of habit, leave the Condyle Retainer closed except as necessary for required removalof Upper Member.
19. Seat the protrusive interocclusal relation record onto the lower occlusal rim. Carefully guide the Upper Member into protrusion, lightly engaging the upper rim into the imprint ofthe protrusive relation record.Grasp the upper cast to maintain a tactile feel of the casts at the protrusive record .

20. Rotate the Right and Left guidances back and forth to accurately seat the upper and lowerrims into the protrusive relation record. Observe that the rims seat without rocking in or deforming the record and tighten the Thumbnutsfor horizontal inclination. The protrusive relation record is then removed.

**ADJUSTMENT OF LATERAL CONDYLAR GUIDANCE (BENNETT ANGLE), HANAU FORMULA,Figure 37:**

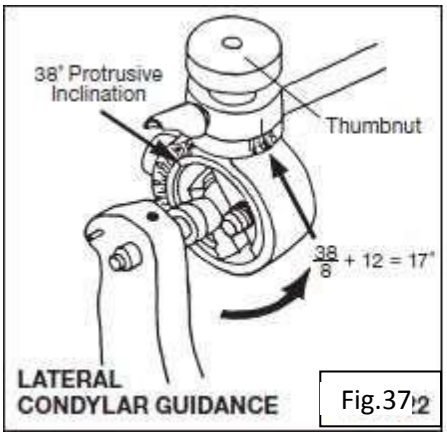


Fig.37.2

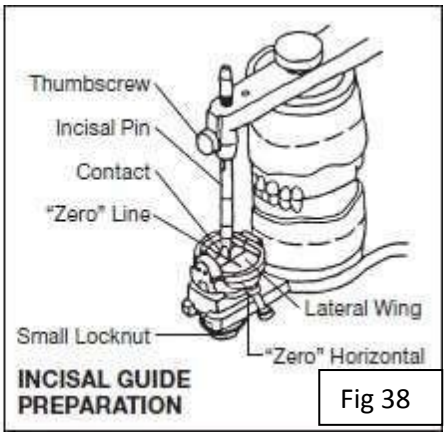


Fig 38

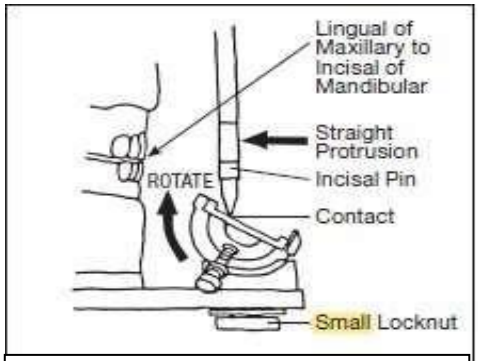
21. The classic HANAU™ Formula, L = H/8 + 12 may be used for adjusting the lateral condylar guidance. In this formula, -H is the Horizontal Condylar (Protrusive) Inclination and -L is the calculated lateral Condylar Guidance (Bennett Angle).

EXAMPLE: The right protrusive inclination of 38 degrees is divided by 8 and is accepted as5, to which 12 is added, totaling 17. The right Condylar Guidance is then adjusted to a 17degree lateral indication at the calibration on the Upper Member and is locked by the

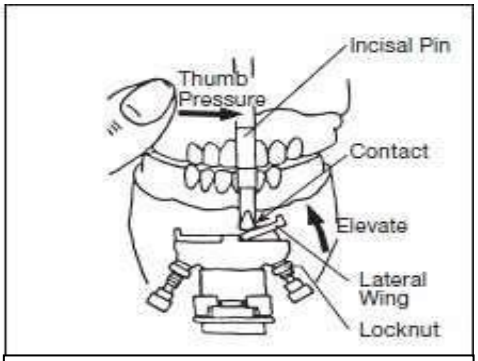
Thumbnut.The same method is used for adjustment of the left lateral – dividing the protrusiveinclination by 8 and adding 12 – then setting the left Condylar Guidance to the computedangle.

**ARRANGEMENT OF ANTERIOR TEETH**

22. The six upper and six lower teeth are set up in the arrangement dictated by the patient‘sesthetic and phonetic requirements




Protrusive fig.39




Right lateral fig. 40

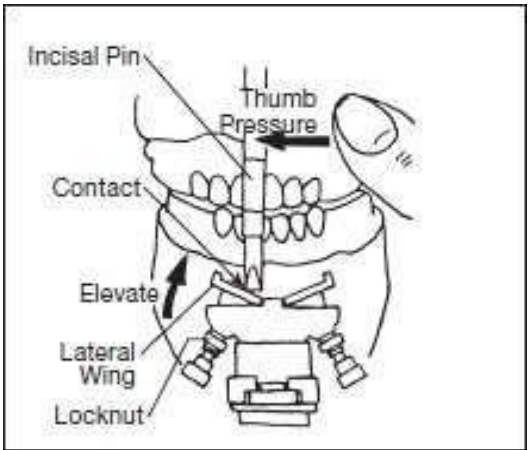
**INCISAL GUIDE PREPARATION, Figure 38:**

23. Lock the Articulator into centric. The occlusal rims are then seated onto their casts at theestablished vertical and centric relation.

24. Lower the Incisal Pin into contact with the- zero horizontal Incisal Guide, the chisel endof the Pin resting crosswise on the center table and lock in position by the Thumbscrew.Verify or correct at this time, the alignment of the Incisal Pin chisel end with the -zeroindicating line on the Lateral Wings. Slightly loosen the small Locknut for protrusion and disengage the Centric Locks.

**ADJUSTMENT OF INCISAL GUIDE, Figures 39 thru 40:**

25. Gently guide the upper cast into a straight protrusion. The lingual edges of the upper central incisors are brought into contact with the incisal edges of the lower incisors.fig.39 The Incisal Guide is then rotated antero posteriorly to make contact with the Incisal Pin, tightening the small Locknut to maintain the angulation.




Left lateralfig.41

26. The upper cast is then guided into a right lateral cuspid to cuspid guidance relation by thumb pressure at the right side of the upper cast to assure the Bennett Shift, Figure 40. The Lateral Wing is then elevated to contact the corner of the Incisal Pin and the Locknut is tightened to maintain this adjustment.
27. Apply thumb pressure at the left side of the upper cast and guide it into a left lateral cuspid to cuspid excursion, Figure 41. Adjust the remaining Lateral Wing to contact the Incisal Pin and secure the adjustment by tightening the Locknut.

**ARRANGEMENT OF POSTERIOR TEETH**

28. The remaining teeth are set into centric occlusion and checked in working, balancing andprotrusive excursions.Left lateral fig.41

    The Incisal Pin acts as the vertical stop and must remain in contact with the Incisal Guide surfacesfrom centric throughout all excursive movements.
29. The waxed occlusal rims may then be tried in the patient for esthetics, occlusal functionand perhaps correction.

    The articulation is completed and the gingival and palatal is waxed.

    Reseat the completed occlusal rims onto their master casts. Seal the rims to the casts to preservethe tissue surface from plaster or stone seepage during the flasking procedure.

**ARRANGEMENT OF ANATOMIC TYPE ARTIFICIAL TEETH INTO BALANCED OCCLUSION**

**HANAU'S LAWS OF ARTICULATION**

Hanau prepared a scientific summary of the possible influence which certain variations ofeach of five of the above named factors would have on an established tooth arrangement, andhe termed his statements the Laws of Articulation. His statements were also assembled into acondensed form in the Hanau Quint .

The Laws of Articulation were prepared primarily for use in connection with the occlusions of artificial teeth, and they were based upon the premise that the occluding verticaldimension had already been established and was, therefore, a fixed factor (no longeralterable) at the time of artificial tooth arrangement.

Laws of Articulation are also applicable to the occlusions of natural teeth, but when so applied we must include the vertical dimension factor in our considerations

because, as withprocessed dentures, any change in vertical dimension has an effect upon all other factors,especially that of incisal guidance.

As they are written, the Laws of Articulation apply to anteroposterior occlusions, but they may be applied to lateral occlusions as well. This is done by considering the working side asincisal guidance, the balancing side as posterior teeth, and the condylar guidance indicationon the balancing side as the condylar guidance.

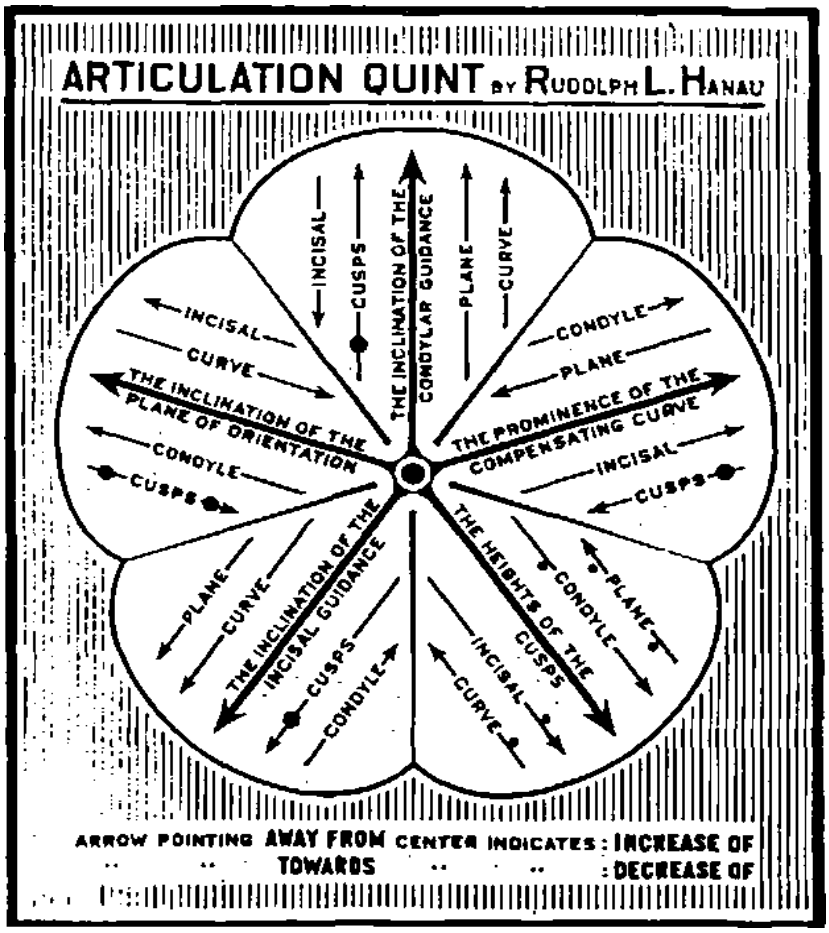
To study and interpret Hanau's Laws of Articulation as they are written and as they appearin the Quint, one should first have before him an ideal setup in wax in an adjustablearticulator. By changing any one factor, such as making the condylar indications steeper orflatter, the effect upon the previously established ideal setup may be noted. In other words,certain errors may be brought about in an ideal setup by arbitrarily changing a single factor,and when we know what change was made we may refer to the Quint to find out what to doto restore the practice setup to balanced occlusion under the new conditions.

Such a roundabout procedure may be excellent for studying the influence which any singlefactor may have upon the other factors, but it constitutes an impractical and confusingapproach to the solution of specific tooth arrangement problems.

Further confusion arises from the fact that the Quint suggests the changing of factors which have become fixed factors and are therefore no longer alterable at the time of artificialtooth arrangement. As an example: An absence of contact in the posterior region in aprotrusive cast relation in the articulator could be corrected by flattening the condylar inclination in the articulator, and the Quint suggests this change as a possibility. Of coursethis should never be done, because condylar inclinations in the articulator result from jawrelation records made on the patient, and this is not an alterable factor at the time ofposterior tooth arrangement.

There are other confusing features encountered when we follow the Quint verbatim. Manydentists consider incisal guidance a fixed factor after the upper and lower anterior teeth havebeen arranged to meet the requirements of the patient. The anterior part of the plane oforientation also becomes a fixed factor as soon as the upper anterior teeth have been finallyarranged. Thus it may be seen that, at the time of posterior tooth arrangement, we no longerhave five variable factors to deal with, but only two and one-half factors. These are: cuspheight, compensating curves, and the posterior limits, only, of the plane of orientation.Nevertheless, the Laws of Articulation are statements of geometric facts which, so far as themechanics of

artificial tooth arrangement into balanced occlusion is concerned, cover theentire group of influencing factors after the occluding vertical dimension has been established. . There are many factors involved in the arrangement of artificial teeth into balanced occlusion which are not contained in the Laws of Articulation, and I will list but few under the heading of general statement.

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To understand the Hanau Quint one should have before him an ideal setup of artificial teeth in the articulator. After changing any one single factor that throws the setup out of idealbalanced occlusion, one may refer to the Quint to find out what to do to bring the setup backinto balanced occlusion. Example: Increase the condylar setting by 10 degrees. The setup willnow show an absence of contact in the posterior region when the casts are in the protrusiverelation. It may be corrected by increasing the prominence of the anteroposteriorcompensating curve, by decreasing the incisal guidance, by raising the plane of orientation inthe posterior region, or by increasing cusp height toward the posterior region. Such aroundabout procedure would not be a

practical aid in arranging teeth into balanced occlusion,but it is an excellent method of studying the influence of any one factor on the other factors.

## GENERAL STATEMENTS[88]

There are different methods of arranging posterior teeth into balanced occlusion, but regardless ofthe method used, much effort and practice will be necessary before consistently good results maybe expected.

1. The amount of horizontal overjet (horizontal overlap) is established in the anterior tooth arrangement. The maxillary and mandibular anterior teeth should not make contact when the jawsare closed in centric relation. There should be not less than 2 mm of horizontal overjet in denturesfor patients with normal ridge relations. Horizontal overjet should be accepted as the result ofpositioning the upper anterior teeth where they will produce thbest possible esthetic effects forthe patient and of positioning the lower anterior teeth over the crest of the remaining ridge, or atleast within the labial border of the lower denture. For some .patients this will result in a veryextensive horizontal overjet, but their appearance is improved, and stability of the lower dentureis increased over that which results when the upper anterior teeth are set too far lingually andwhen the lower anterior teeth are set too far labially. For several patients a horizontal overjet of atleast 0.5 inch has produced most satisfactory results.
2. Steep cusps and prominent compensating curves are usually detrimental to complete denturestability because they result in unnecessary horizontal forces being directed onto the denturebases.
3. Steep condylar guidances, steep incisal guidances, and combinations of them suggest prominent compensating curves with steep anteroposterior and lateral cusp height (steep slopes ofthe cusps). Condylar guidances must be accepted as recorded, but incisal guidance inclinationsmay and should be kept as flat as practicable.
4. The upper premolars should be positioned so as to present a normal dental arch outline, i.e.,with practically a straight line from the canines to the mesiobuccal cusp of the upper first molar,thus contributing to esthetics. In other words, the buccal vestibule should be in evidence when thepatient smiles. A common error is to continue the curved alignment of the anterior teeth into thebuccal vestibule.

5. The lower first premolars must be positioned buccally to the crest of the lower ridge occasionally in order to occlude correctly with the upper premolars.
6. When it is found necessary to grind artificial teeth at the gingival end, care should be used topreserve as much of the buccal side of the ridge lap as possible, even though the tooth materialrepresenting the buccal surface may then be very thin. Both the upper and lower premolars shouldpresent buccal surfaces of sufficient length to place the gingival finishing line in harmony withthat of the canines. Short premolars are detrimental to esthetics and should not be used. It is oftenadvantageous to use longer premolars than those accompanying the molars selected. Thebaseplate underlying the occlusion rim should be scraped very thin before any grinding is done onthe gingival end of the tooth.
7. Before cusp inclines are altered by grinding, the inclinations of the long axes of the opposingteeth should be rotated about their centric occlusion contact in an attempt to establish the desiredbalancing contacts. Grinding is not objectionable provided the desired occlusions cannot beaccomplished otherwise.
8. Artificial posterior teeth which are to occlude with natural teeth should be carefully selected inorder that they will be of the correct mesiodistal and buccolingual width.
9. After artificial teeth have been satisfactorily arranged, the final waxing should be done in amanner which will provide the trial dentures with the desired buccal, labial, and lingual contourswithout destroying the occlusions already established. Overwaxing is very common error, andtoo many dentures have an appearance similar to that of a patient with diseased gingivae thathave swollen to such an extent that the gingivae cover at least one half of the crowns of the teeth.The wax on the buccal and labial surfaces of the teeth should be carved away sufficiently toexpose a slight amount of the collars of the artificial teeth. This produces a more naturalappearance and increases the retention of the teeth in the mold during the flasking, packing, processing procedures.
10. The final forming of the wax in the palatal areas of upper dentures should be done by thedentist during final try-in of the trial dentures and should never be altered by the technician afterthe trial denture has been delivered to him for flasking and processing. The form of thepalatal surface of upper dentures, especially the anterior part, is a vital factor in phonetics.It may be correctly

determined by certain tests made by the dentist with the trial dentures inthe patient's mouth.

11. Before final waxing, the temporary denture bases should be sealed to their respective casts with wax while the teeth are in centric occlusion on the articulator. The casts, with theirmounting rings attached, should then be removed from the articulator and all necessary waxadded to the trial dentures. At no time should the setup be occluded in the articulator until allwax has cooled to room temperature. When the trial dentures are occluded during the finalwaxing they will always be out of contact after the wax has cooled because of the shrinkageof the wax. Final carving of the wax should be done only after it has cooled to roomtemperature. Trial dentures should be maintained at room temperature throughout all flaskingprocedures to prevent the loss of the ideal occlusions established in the articulator.

## BALANCING RAMPS IN PROSTHETIC OCCLUSION[89]

Balanced occlusion is one of the neglected steps in the construction of complete dentures. However, it is essential to their success. The average patient learns to use dentures with comparative ease and comfort when the occlusion is balanced. Balanced occlusion makes possible the greatest possible use of masticating power so that food may be properly prepared fordigestion.

Teeth which are not arranged in balanced occlusion are merely arranged for the opening andclosing mandibular movements. Dentures with this type of occlusion generally destroy theefficient masticating movements habitual to the patient. This is true especially when teeth withhigh cusps are used on the dentures. Patients with dentures that have unbalanced occlusion loseall definite control of the jaw movements and, consequently, many find it quite difficult to usesuch dentures. The fact that some patients do learn to use them is a tribute to the marvelousadaptive powers of the human being rather than to the skill of the dentist.

Balancing ramps built in the region of the retromolar pads of the mandibular denture have greatly simplified the procedure of balancing the occlusion (Fig.42). This applies especiallywhen posterior teeth with zero degree cusps are employed and when the vertical overlap of theanterior teeth is considerable (Fig. 43). When attempting to balance the occlusion of suchdentures, one usually has the alternative of sacrificing

the balanced occlusion or denyingpleasing esthetics to the patient. If esthetics is considered more important, the posterior teeth willnot contact in protrusive positions of the mandible, and this lack of posterior tooth contact willcause a tipping of the dentures (Fig. 44).

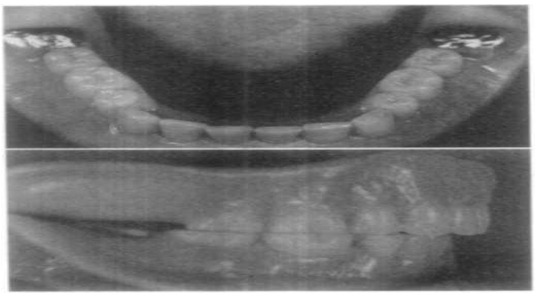


Fig42 & Fig 43

Fig.42—Balancing ramps constructed distal to the last molar on the mandibular denture simplifythe problem of obtaining balancing contacts in protrusive and lateral jaw movements. Fig. 43—Dentures without balancing ramps and with zero degree posterior teeth. There is considerable vertical and horizontal overlap of the anterior teethThe occlusion can be balanced very easily in mandibular protrusive excursions whenbalancing ramps are used, regardless of the vertical or horizontal overlap of the anterior teeth. As the mandible begins to move into a protrusive excursion, the distal marginal ridges of the occlusalsurfaces of the most posterior maxillary teeth, usually the second molars, begin to ascend the balancing ramps. Then, when the incisal edges of the opposing anterior teeth are in contact, thedistal marginal ridges of the second molars of the upper denture are resting on the most distalportion of the balancing ramps (Fig. 44). The incisors, in protrusive position, are balanced by themaxillary molars against the ramps. The same balancing ramps are made broad enough so that they will balance the dentures in lateral excursions of the mandible. The distobuccal margins of the occlusal surfaces of the maxillary second molars glide along the ramps on the balancing side.

Consequently, the patient can glide from centric occlusion to protrusive occlusion and from left to right lateral occlusions without the discomfort of inter-cuspal interferences, diminished retention,tissue irritation, and clicking teeth.

## RAMP CONSTRUCTION

The method of constructing balancing ramps is quite simple. The length, width, and height ofthe ramps are determined while the occlusion is being balanced. During this procedure, the rampsare built up in wax as far distally and buccally as the last molar of the upper denture will travel inprotrusive and lateral excursions. Two millimetres of wax are added to the distal and buccalsurfaces of the ramps to allow for polishing and trimming. Then, the dentures are processed inacrylic resin and polished (Fig. 45). When the completed dentures are tried in the patient's mouth,an interocclusal centric relation record is made, and the dentures are remounted on the articulator.

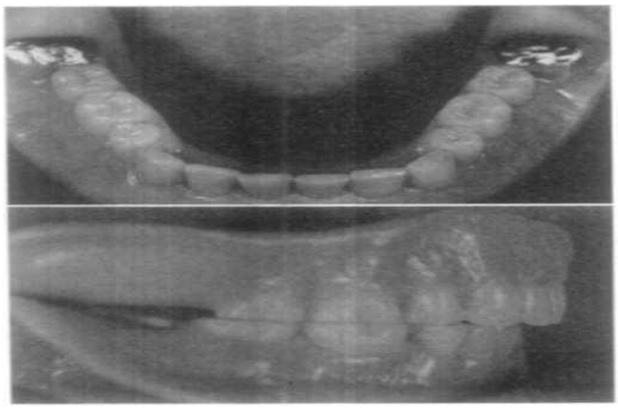


Fig 44 and 45

Fig. 44.—there is no balancing contact on the posterior teeth when the anterior teeth are brought edge-to-edge and when a balancing ramp is not constructed.

Fig. 45—the distal ridge of the maxillary last molar contacts the balancing ramp when the anteriorteeth are brought edge-to-edge.

The final grinding, to refine the balanced occlusion, is done on the articulator. When this isaccomplished, occlusal cavities are prepared in the ramps. About 1 mm. of plastic is preserved atthe border of the ramps (Fig. 46). These two cavities are then filled with silver amalgam, andwhen the amalgam begins its initial set, the articulator is moved from centric position toprotrusive position and back, and then from centric position to the left and right lateral positions.These movements are repeated until the upper tooth cuts a path for itself in the amalgam (Fig.47). The amalgam is allowed to set for 24 hours, and then it can be polished slightly but withoutcreating any heat.

At the insertion of the dentures, a final check of the occlusion in all excursions of the mandible is made. After the patient has worn the dentures for a few weeks, they may or maynot settle into the tissues. If settling occurs, the occlusion will no longer be

balanced as it was when the dentures were inserted. Therefore, it would be necessary to remount the dentures onthe articulator and rebalance the occlusion.

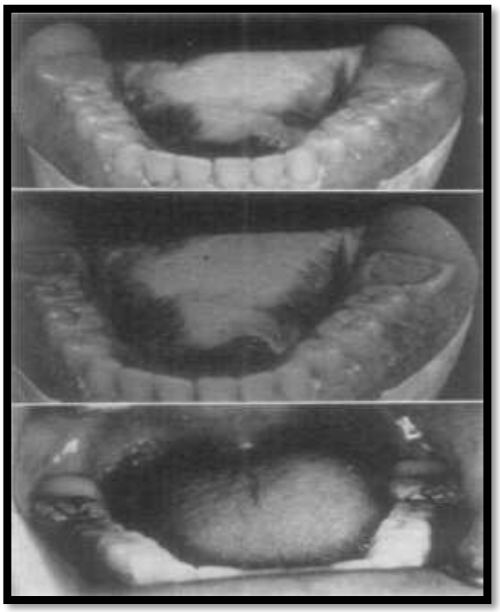


Fig. 45.—The balancing ramps are constructed of wax with a slight excess of height at the time the occlusion is balanced and are processed in acrylic resin along with the denture. Fig.46.—Occlusal cavities are prepared in the ramps. Note that they extend far enough buccally to permit balancing contacts during lateral mandibular excursions. Fig. 47.—The shiny streaks in the amalgam ramps represent the paths followed by the upper last molars during protrusive and lateral jaw movements.

## CONSTRUCTION OF FULL DENTURES WITH BALANCED FUNCTIONAL OCCLUSION[90]

As described BY FRED S. MEYER, D.D

1. Make accurate stone casts from good impressions. Score the bases of the casts, and adaptrigid baseplates to these casts.
2. Construct hard wax occlusion rims on the baseplates. These occlusion rims should be aboutone-half inch wide on the occlusal surfaces.
3. Determine vertical dimension: Place the lower occlusion rim in the mouth. Trim the anterior part of the lower occlusion rim to the desired height of the lower anterior teeth andthe posterior part of the occlusion rim to two-thirds of the height of the retromolar pad. Thisestablishes the occlusal height of the lower teeth. The trimming of the upper wax occlusionrim is determined by esthetics

and the free-way space. The upper occlusion rim should occlude approximately with the lower occlusion rim. Approximate balance of the hard waxocclusion rims is obtained by having the patient make lateral and protrusive jaw movementsas wax is added to one rim, and removed from the other, until an approximate curve is made.

When the occlusion rims maintain a good contact in all these movements, the approximateocclusal plane will have been established. Mark the median line on the occlusion rims, andwith a pair of locked dividers make indentations in the median line so the vertical dimensioncan be checked later.

4. Generate the primary occlusal path in soft wax: A. Shorten the vertical dimension of each hard wax occlusion rim 2 mm. being careful to maintain the approximate curve. This is done by making indentations about one-quarter inchapart with a hot 2 mm. chisel (Fig. 48), and trimming the wax to the depth of the indentations. Add 3 mm. of soft counter wax to each occlusion rim and cover the occlusal surfaces of the counter wax with 0.001 tin foil (Fig. 49). Lubricate the tin foiled surfaces with petroleum jelly.

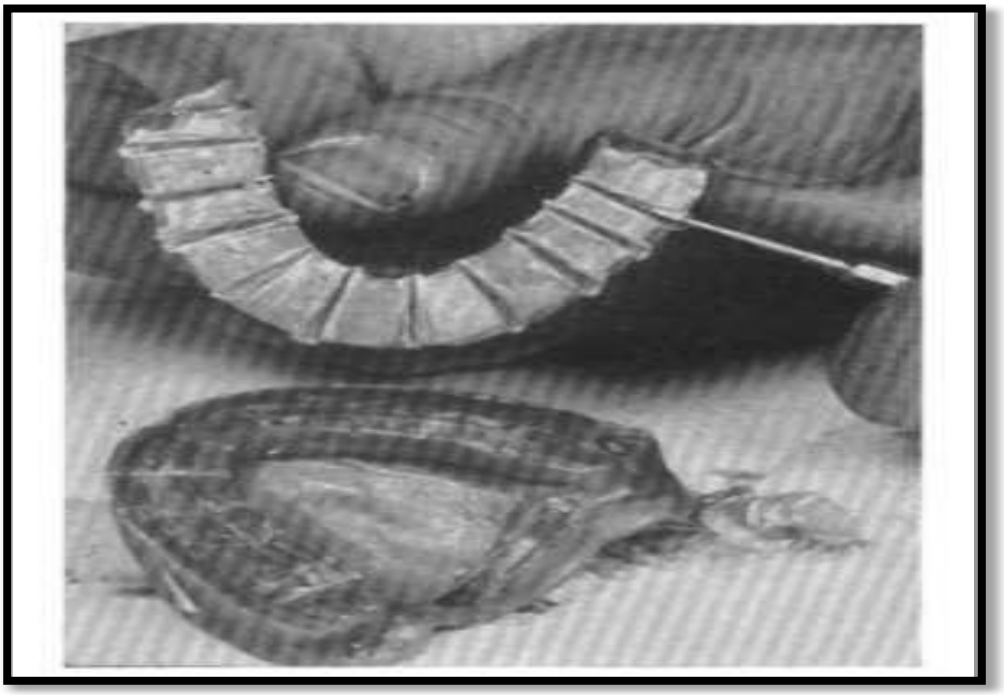
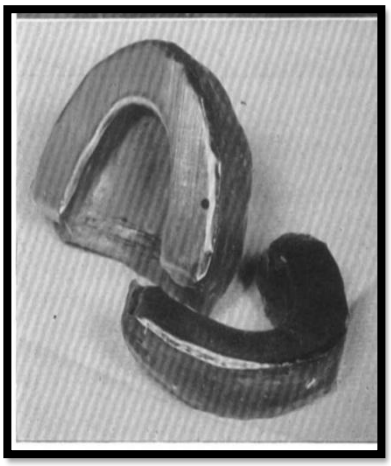


Fig.48 and fig 49

Removing 2 mm. from hard wax occlusion rims.

B. Return the occlusion rims to the mouth. By lateral and protrusive jaw movements



and slight pressure, the primary path is generated until the vertical dimension is reestablished (as determined by the locked dividers).

Fig 50

5. Establish the approximate centric relation:

A. Remove the lower occlusion rim from the mouth, and trim enough wax from. the labialsurface so that the upper rim will protrude over the lower, and re-mark the median line on thelower, and return it to the mouth.

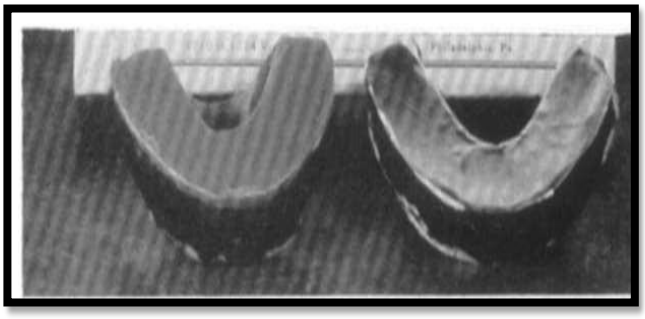
B. Have the patient close in the most retruded position. With a pointed instrument, make anindentation in the upper occlusion rim just above the medianline marked on the lower rim.Have the patient make various jaw movements, and if he comes to rest at this point each time,this is his approximate centric relation. The wax rims are stapled together, and a face-bowtransfer is made to an articulator that permits no lateral movements.

6. A reproduction of the primary wax path is made in stone:

A. A baseplate is adapted to cover the entire upper surface of the lower cast, excluding undercuts. The upper wax primary path is boxed-in in the palate, and closed into a mixture ofstone poured on the new lower baseplate to the established vertical dimension.(Fig. 50)opening the articulator, trim, and mark lines on the stone primary path above the crest of theposterior ridges. The lines serve as guides for setting up the posterior teeth. It is not necessary toset the teeth on the lines. C. To locate crest of ridge lines on the primary stonestone path fromthe cast. Place a straight edge over the crest of the (posterior ridge. Mark the distal end and the anterior part of the cast under

the straight edge. Replace the stone primary path, align thestraight edge with the marks, and draw the lines on the stone path.

7. Set the upper anterior teeth for esthetics. Small portions of the anterior part of



the primary stone path may be removed in order to set the anterior teeth parts or useprimary stone pain may be removed in order to set the anterior as desired.major cusps of theposterior teeth must touch the primary stone path (Fig. 51). Grind cusps if necessary.Posterior teeth should be set so that medial grooves and pits are in a straight line.

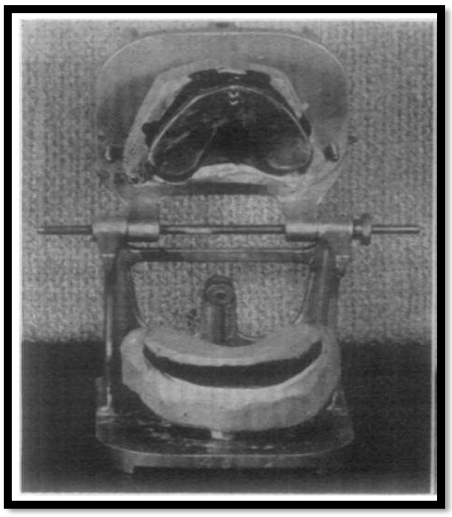


fig 51

fig 52

8. Set thelower teeth to the upper teeth, and try the wax dentures in the mouth
9. Process the upper denture.

10. Remount the upper denture on the articulator before removing it from the cast, ancl correctit to the stone primary path. Paint the stone path with Prussian blue, and spot grind the teethuntil all major cusps touch the stone path.
11. Preparation for cusp and sulci analysis:

    4. Mount a black modeling compound rim on another lower baseplate.

R. Soften the occlusal surface of the compound, and close the upper teeth into the compound tothe vertical dimension recorded by the articulator.pits, sulci, and marginal ridges, and leave atable on each side of these impressions to carry a soft cuspal wax later (Fig. 53). Mark themedian line in the compound.

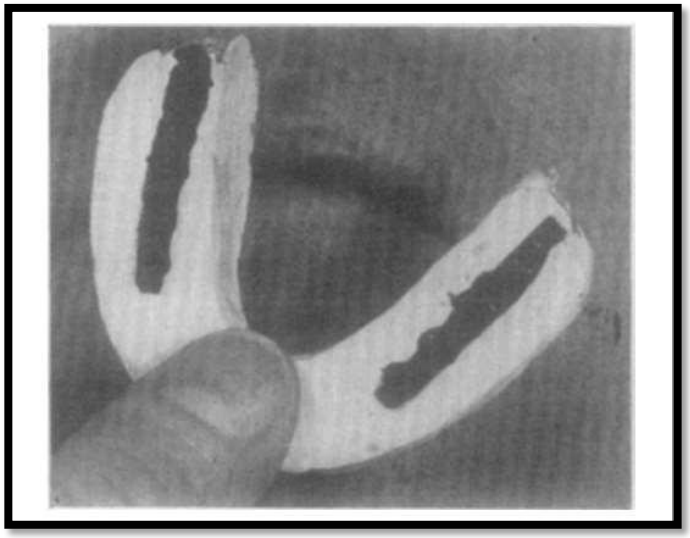


Fig .53

12. Remove the upper denture from the cast, trim and polish it, and place it in the mouth.
13. Cusp and sulci analysis: Soften the modeling compound ridges slightly, and have the patient close into centric relation with the median line marking a guide. The ridge on one side willprobably register more than the other side.

    A slight amount of compound should be added to the side with the lesser registration, and whilethe compound is still soft, have the patient close into centric relation a second time. If all of thecusp and sulci registrations are sharply defined, the pressure is even on both sides. Remove thecompound, rim from the mouth and trim the excess compound as before. Replace the rim in themouth. The patient is asked to slide the jaw to the lateral positions. All buccal cusps on theworking side, and all lingual cusps on the balancing side should, touch the ridges in thecompound simultaneously. If a cusp does not

touch, deepen the sulcus or groove:if a cusp donot touch or marginal ridge of that tooth, add a bit of compound to the ridge, and have the b patient close into centric relation, thus the ridge is heightened at this point. The step is repeated, if necessary, until all cusps touch.When this is accomplish the cusp ant sulci analysis will becomplete.

14. Generate the cuspal path : Add cuspal tracing wax to the compound tables (on both sides ofthe compound ridges) to a height a little above the compoundridges. Also add cuspalwax tothe anterior portion of the compound rim. Place the compound rim in the mouth, and have the patient close in centric relation, then make lateral and protrusive movements from centric position to the height of the compound ridges. The compound ridges must show plainly and even through the cuspal wax, and there should be a smooth, even tracing of the cusps in thewax (Fig. 54). It should be emphasized that after a movement is made from centric position,the patient should open his mouth and close again in centric position before the nextmovement is made. The wax will tear if movements are made both ways.

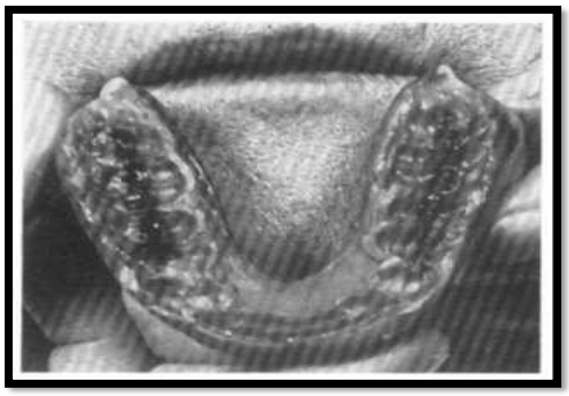


Fig .54

15. Make a counterpart of the cuspal wax path in stone : Return the cuspal wax path to thelower cast on the articulator. Pour the cuspal path in stone, attach it to the upper arm of thearticulator. Separate the cuspal wax path from the stone cuspal path by opening the articulator,and trim away the excess ,stone(Fig. 55)
16. Reset the lower teeth to the stone cuspal path. Process the lower denture. Return the processed lower denture to the articulator before removing it from the cast. Paint the stonecuspal path with Prussian blue, and correct the lower denture by

spot grinding the teeth tofit the stone cuspal path (Fig. 56). Remove the lower denture from the cast and trim and polishit.

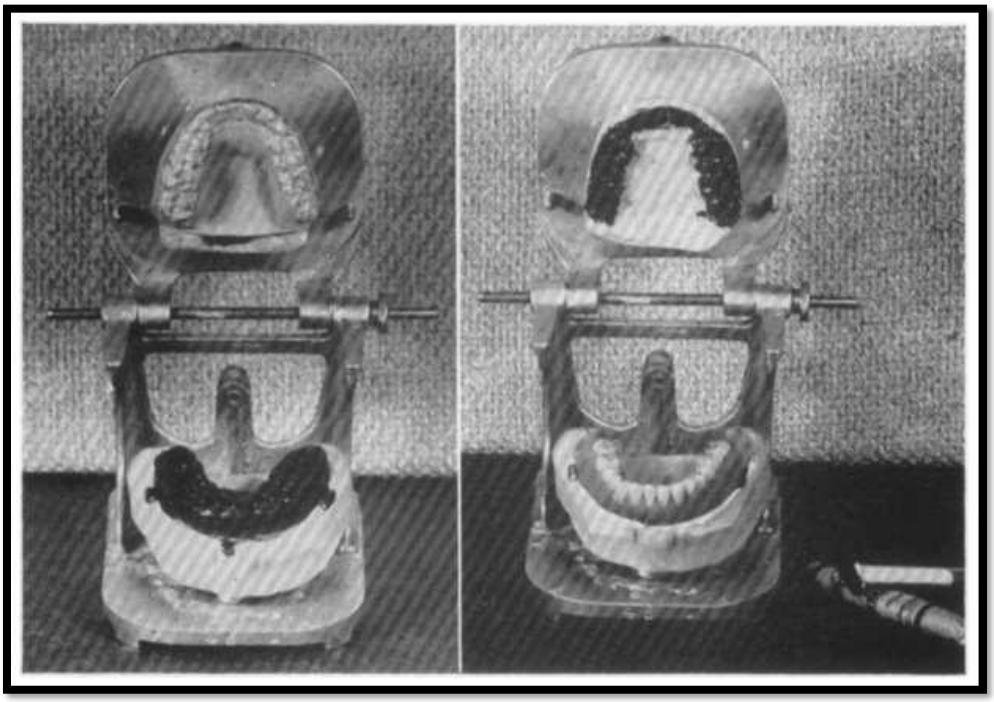


Fig. 55 and 56

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## CONSTRUCTION OF FUNCTIONAL OCCLUSION IN COMPLETE DENTURES

Meyer suggested a generated-path technique for obtaining functional occlusions in complete dentures[91]. Even though this technique proved to be satisfactory, this article will suggest amodification to his technique.

**PROCEDURE**

1. Make primary and secondary impressions and casts in the usual manner.
2. Fabricate permanent bases in acrylic resin.
3. Add wax occlusion rims to the permanent bases.
4. Establish the plane of occlusion and occlusal vertical dimension in the patient's mouth.
5. Record the centric relation with interocclusal wax.
6. Obtain a face-bow record, and transfer the casts and records to an articulator.
7. Set the upper teeth according to the established plane of occlusion (Fig. 57).
8. Attach an extraoral tracing device to the upper and lower bases (Fig. 58).

The tracer and central bearing plates should not interfere with the tooth arrangement (Fig. 59)

9. Make a needle point tracing (Fig. 60), and transfer the recorded centric relation record tothe articulator (Fig. 61)
10. Cover the maxillary teeth with a wax occlusion rim. Maintain the proper height by makingthe wax rim only to the level of the cusps of the teeth (Fig. 62)
11. Make a lower cold-curing acrylic resin occlusion rim to fit and contact the occlusal surface of the upper wax rim (Fig. 63)
12. Remove the wax from around the upper teeth. The tips of the cusps will now contact thelower acrylic resin occlusion rim (Fig.64)
13. Raise the central bearing stud of the tracer device to increase the occlusal vertical dimension 1 mm. in the articulator (Fig.65)
14. Add a layer of blue inlay wax on the lower acrylic resin rim (Fig. 66)
15. Warm the blue inlay wax, and close the articulator until the incisal pin touches the incisaltable.
16. Return the upper set-up and the lower wax rim to the patient's mouth.
17. Instruct the patient to close his jaw in lateral position(Fig 67) and to slide the lower waxrim to the centric relation position (fig 68)
18. Repeat above step for the right and left lateral excursions. Always start the movement from the eccentric position, and move the jaw to the centric relation position until the generated path shows the acrylic resin rim through the blue inlay wax. The desired occlusalvertical dimension is retained in this manner (Fig 69)
19. Box the generated path (Fig 70)
20. Remove the upper mounting from the articulator.
21. Pour Vel-Mix* stone into the generated path, and attach this stone record to the upper member of the articulator (Fig. 71).
22. Remove the wax and tracing device from the lower member of the articulator (Fig 72)
23. Increase the occlusal vertical dimension in the articulator by 2 mm.
24. Arrange the lower teeth to occlude with the upper teeth on the articulator (Fig 73).
25. Remove the upper set-up from the articulator, and reattach the stone record of the generated path (Fig. 74).

26. Grind the lower posterior teeth to the level of the established occlusal vertical dimensionand to the centric occlusion originally established (Fig. 75).
27. Return the upper set-up of teeth on its cast to the articulator (Fig. 76).
28. Wax, process, and finish the dentures in the usual manner.

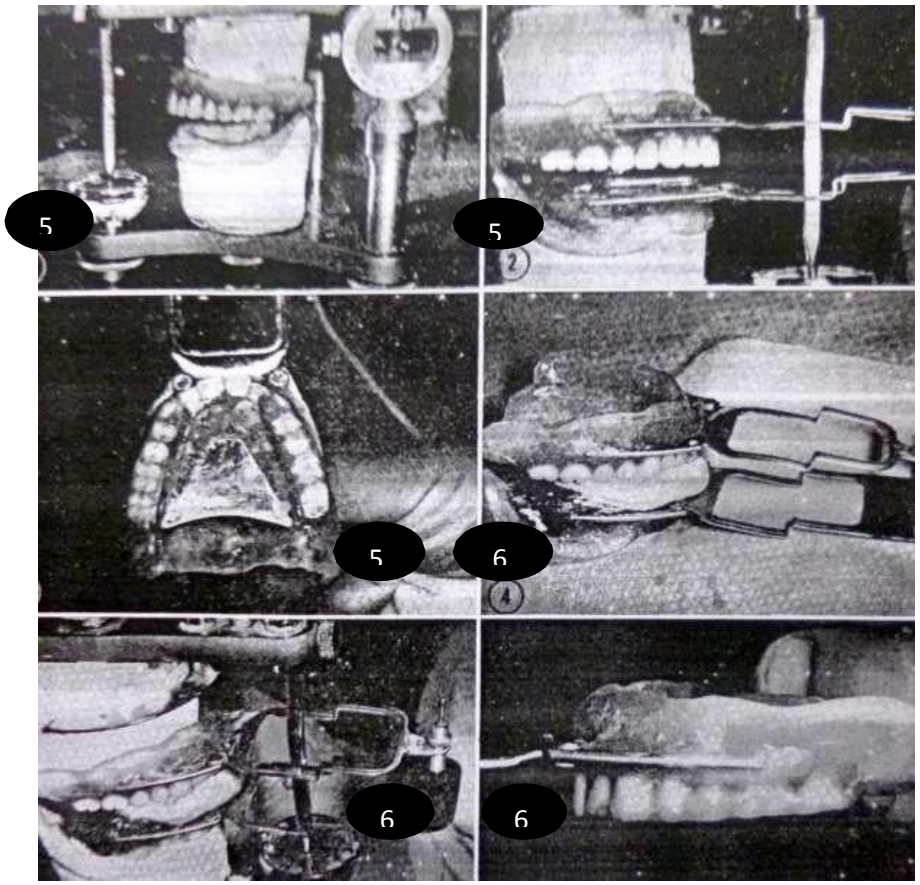


Fig.57. The upper teeth establish the plane of occlusion.

Fig. 58. An extraoral tracing device is mounted on the upper and lower base

Fig. 59. The upper plate is positioned so it will not interfere with the upper teeth.

Fig. 60. The centric relation record is attached to the tracing assembly.

Fig. 61. The centric relation record is transferred to the articulator.

Fig. 62. The maxillary teeth are covered with wax to the level of the tips of the cusps andthe occlusal surface of the wax rim

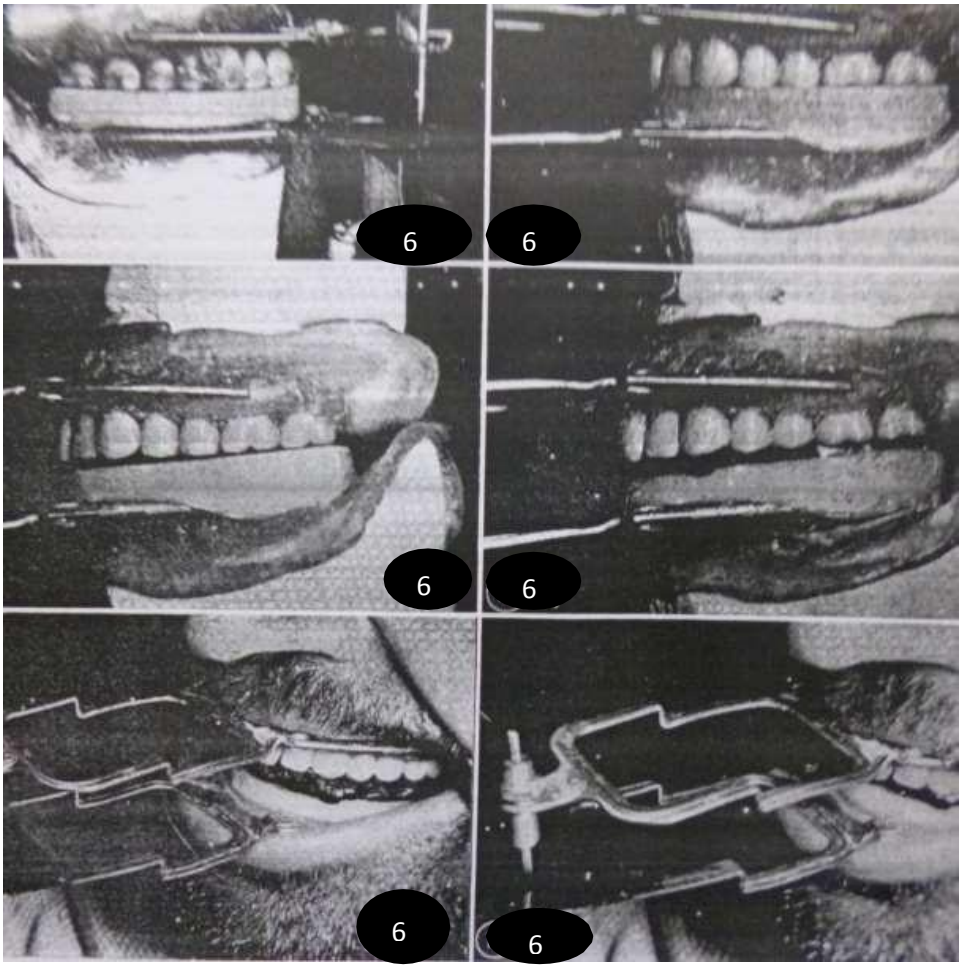



Fig. 63. Cold-curing acrylic resin is built up on the lower baseplate to contact the cusp tips ofthe upper teeth.

Fig. 64. The lower acrylic resin rim is trimmed so the tips of cusps of the maxillary teeth just makecontact.

Fig. 65.Vertical dimension increased 1 mm. on the articulator to allow for addition of wax. Fig. 10. Blue inlay wax is added to the lower resin rim.

Fig. 66 The patient is closing the teeth into the blue wax with his mandible in an eccentric position ready to glide into centric relation.

Fig. 67. The termination of the gliding movement from an eccentric to the centric relation position

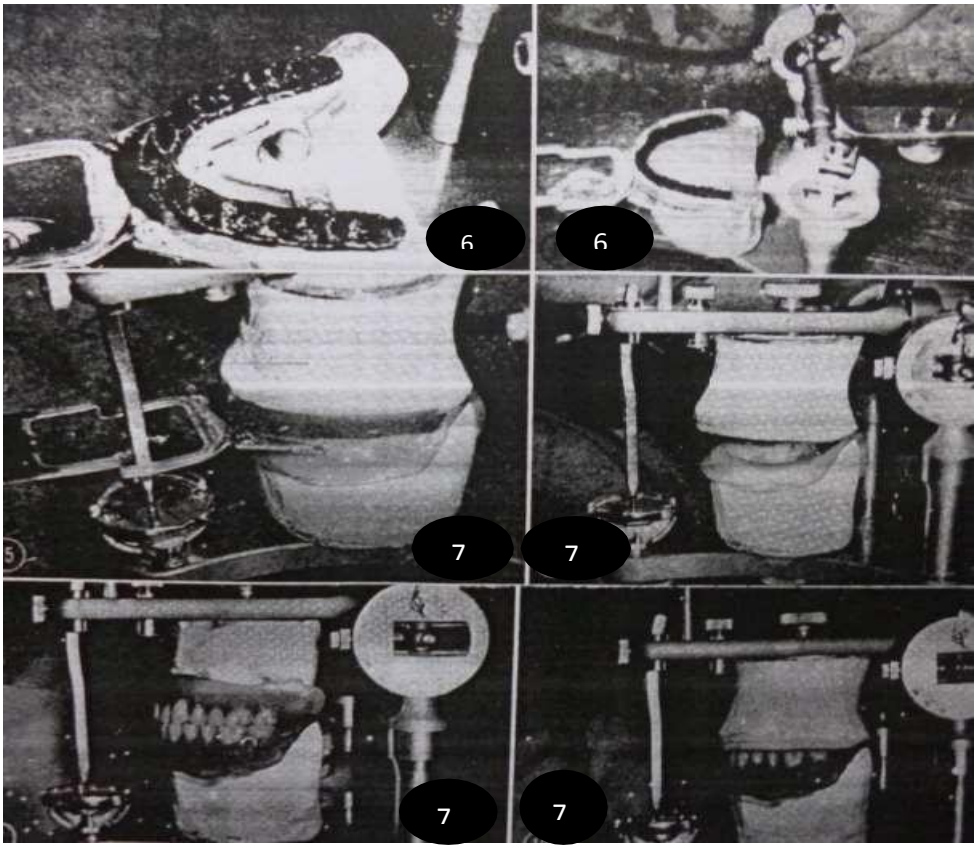


Fig. 68.The completed wax generated path. Note the vertical stops of acrylic resin showingthrough the wax to maintain the correct occlusal vertical dimension.

Fig. 69.. The boxed generated path attached to the lower member of the articulator.

Fig. 70. The Vel Mix stone is poured into the generated path in the wax and attached to theupper member of the articulator.

Fig. 71. The wax generated path is removed, and the articulator is opened 2 mm. by movingthe incisal guide down.

]Fig. 72. The lower teeth are arranged to occlude with the teeth on the original upper set up.

Fig. 73. The stone record of the generated stone path is replaced in the upper member of thearticulator

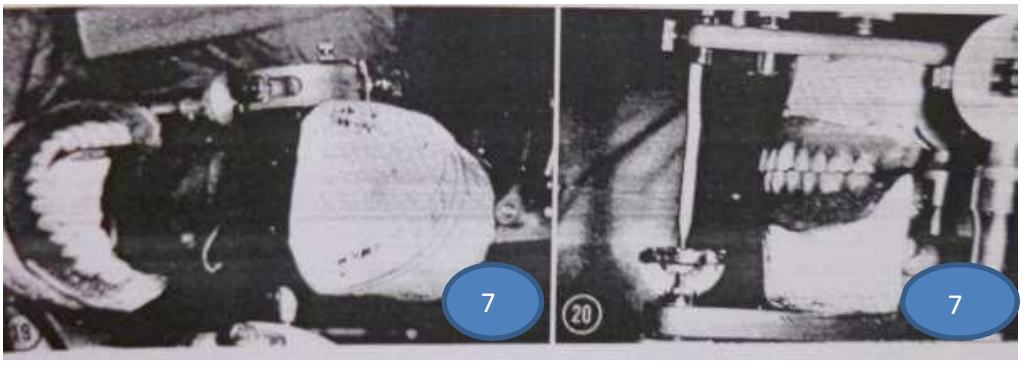



Fig. 74. The lower teeth are arranged and ground to fit the generated path at the original occlusalvertical dimension.

Fig. 75. The upper tooth arrangement is returned to the articulator and made ready for finishing inthe usual manner.

## ERRORS IN OCCLUSION DISCOVERED WHEN TRIAL DENTURES ARE EXAMINED IN THE PATIENT'S MOUTH

Desired occlusions should always be established on trial dentures, in the articulator, beforethey are taken to the patient's mouth for checking. Regardless of the intended care used in allprevious steps of the denture construction procedure, it sometimes happens that theocclusions of the trial dentures are not the same in the mouth as in the articulator. Toofrequently this difference is immediately attributed to faulty jaw relation records, but this mayor may not be true.

Many kinds of errors produce results that are equivalent to faulty jaw relation records.

Errors occurring during jaw relation record making could result from: (1) ill-fitting or warpedbaseplates, (2) wax or other debris under one or both bases while making the record, (3)failure to properly assemble the upper or lower occlusion rim in the jaw relation record, and(4) unobserved interference of the posterior ends of the bases during record making in themouth.

Errors occurring when mounting the casts and adjusting the articulator could result from:

(1) warped bases which did not serve as accurate indexes for seating the casts, (2) debris onthe casts or under the bases, (3) distal ends of the casts making contact, thus preventing thecasts from seating all the way into their respective bases, (4) the upper and lower members ofthe articulator not being in "centric relation" (i.e., with the condylar balls against their stopsin the Hanau Model H) when the lower cast was attached to the articulator according to thecentric jaw relation record, (5) the stem of

the face-bow fork sagging from too much pressurewhen the upper cast is being attached to the articulator, (6) failure to properly seat andmaintain the casts in their respective bases when attaching them to the articulator, (7) thefailure of the condylar elements to move freely in their respective housings, thus interferingwith their accurate adjustment by means of the protrusive jaw relation record, and (8) wornand loose condylar elements in the articulator. (Worn condylar elements should be replacedwith new ones.)These errors, singly or in combination, may produce results which are the equivalent of

faulty jaw relation records, and I will refer to them as "or its equivalent" in the following list.

The list will include the most common occlusal errors which may be encountered during thefinal try-in, together with the probable causes and suggestions for their correction. It is best tocheck all "equivalent" causes before assuming that a faulty jaw relation record was made.

**An increase or decrease of vertical dimension of occlusion from that originally established on the patient**

Cause:

This could result only from failure to have the lower end of the anterior pin in contact with the platform of the anterior guide at the time the mandibular cast was mounted in the articulator and locking it in this position, or from will ful or accidental change of the verticaldimension on the articulator before the teeth were arranged.

To correct:

If the change was accidental after mounting the mandibular cast in the articulator, reestablishthe desired occluding vertical dimension on the patient, return to the articulator, and firmlylock the anterior pin in its correct position and rearrange the teeth.

If the change resulted from failure to maintain the anterior pin in contact with the anterior

guide platfqrm at the time of mounting the mandibular cast, make a new centric jaw relationrecord, remount the mandibular cast, and reset the teeth to the proper occluding verticaldimension.

**Faulty centric occlusion when the jaws are closed in centric relation**

Cause:

A faulty centric jaw relation record "or its equivalent."

To correct:

First check all features listed as "equivalent." Make a new centric jaw relation record on thepatient and remount the mandibular cast. (The setup should now show the same errors in thearticulator as it did in the mouth.) Make a new protrusive jaw relation record and readjust thecondylar elements of the articulator. Rearrange the teeth into proper occlusions." Neverbother to check the eccentric occlusions if the centric occlusion is in error, because they willall be in error.

**Absence of contact in the posterior region in protrusive jaw relation**

Cause:

The condylar indications on the articulator are flatter than the condyle paths of the patient.This is probably due to a faulty protrusive jaw relation record "or its equivalent."

To correct:

Make a new protrusive jaw relation record on the patient and readjust the condylar elementsof the articulator. The setup should now show the same error in the articulator as it did whentried in the mouth. Rearrange the teeth as follows:

1. Increase cusp height progressively toward the posterior,
2. Increase the prominence of the anteroposterior compensating curve, or
3. Raise the plane of orientation in the posterior region.

**Premature contact in the posterior region in protrusive jaw relation**

Cause:

The patient's condyle path is flatter than the condylar guidance in the articulator. This is probably due to a faulty protrusive jaw relation record "or its equivalent."

To correct:

Make a new protrusive jaw relation record on the patient and readjust the condylar elements of the articulator. The same error in occlusion should now appear in the articulator. Rearrange the teeth as follows:

1. Decrease the cusp height progressively toward the posterior,
2. Decrease the prominence of the anteroposterior compensating curve,
3. Lower the plane of orientation in the posterior region, or

4. As a last resort, increase the anteroposterior inclination of incisal guidance by raising the level of the lower anterior teeth and adjusting the anterior guide to harmonize with the newlyestablished incisal guidance.

## LATERAL OCCLUSIONS

The Laws of Articulation apply to lateral occlusions as well as protrusive occlusions. The application is accomplished by considering the working side as being incisal guidance, thenbalancing side as being the posterior teeth, and the condyle on the balancing side as condylarguidance. Familiarity with this fact greatly simplifies the correction of malocclusions ofnatural teeth as well as those of artificial teeth.

### Absence of contact on the balancing side

The absence of contact on the balancing side is often misinterpreted as being premature contact on the working side.

Cause:

The condylar indication on the articulator is too flat, probably due to a faulty protrusive jawrelation record "or its equivalent."

To correct:

Make a new protrusive jaw relation record on the patient and readjust the condylar guidances of the articulator. The same error in occlusion should now appear in the articulator. Rearrange the teeth as follows:

1. Increase the lateral cusp height on the balancing side,
2. Increase the prominence of the lateral compensating curve on that side, or
3. Raise the plane of orientation in the posterior region on that side.

### Premature contact on the balancing side

Cause:

The condylar guidance inclination in the articulator is steeper than the condyle path inclination of the patient, probably due to a faulty protrusive jaw relation record "or its equivalent." To correct:

Make a new protrusive jaw relation record on the patient. Readjust the condyle guidance elements of the articulator. The same error in occlusion should now appear in the articulator.

Rearrange the teeth as follows:

1. Decrease the lateral cusp height on the balancing side,

2. Decrease the prominence of the lateral compensating curve on that side, or

3. If the error is slight, set the condylar guidance inclination 5 degrees flatter and spot-grindthe teeth on that side. Then return the condylar guidance to its original setting.

**Premature contact on the working side**

Unless all of the anterior teeth and the posterior teeth on the balancing side are out of contact, the error has been probably misinterpreted and should be diagnosed as an absence ofcontact on the balancing side and treated as such.

If it is a true premature (interceptive occlusal) contact on the working side, the anterior pinwill not be in contact with the anterior guide, and the anterior teeth will not be I contact.

Tocorrect:

Rearrange the teeth on the working side as follows:

1. Increase the prominence of the lateral compensating curve on that side or

2. Grind the teeth on the working side to decrease the lateral cusp height.

**Correcting Occlusal Disharmony**

There are many acceptable intraoral methods for correcting occlusal disharmony. However, the intraoral methods are more accurate if the uneven contacting of the teeth hasbeen first corrected with laboratory remount and patient remount procedures. Some of theintraoral methods follow.

**Articulating paper**

Articulating paper alone will not give as accurate an indication of premature contacts as some other methods. The resiliency of the supporting tissues allows the denture to shift; therefore, the paper markings are frequently false and misleading. The denture base can movefrom the basal seat causing the teeth in the opposing side of the arch to contact prematurelyand produce an incorrect marking. To place articulating paper on one side of the arch mayinduce the patient to close to or away from that side. Articulating paper should be placed onboth arches, a procedure sometimes difficult to do accurately

Some operators use one type of central-bearing device, the correlator, to correct occlusion in the mouth. The central-bearing pin works on a spring. As the patient closes his mouth, thepin in the mandibular mounting contacts a metal plate in the vault of the maxillary denture.Thus, by holding the maxillary denture up and the mandibular denture down, the pin creates atension before the teeth contact. If a premature contact is made by one tooth, the denture donot shift because the spring holds the other tooth apart. The interceptive occlusal contacts arelocated with articulating ribbon. The central bearing device can be mounted on denture inthree to four minutes and will serve to disprove the theory that occlusion can be corrected byhaving the patient closing down on a piece of articulating paper alone.Another type of central bearing device, the coble device, has a central bearing pin without aspring. Like the correlator, it requires careful control of the patient throughout the procedure.(Fig 77)

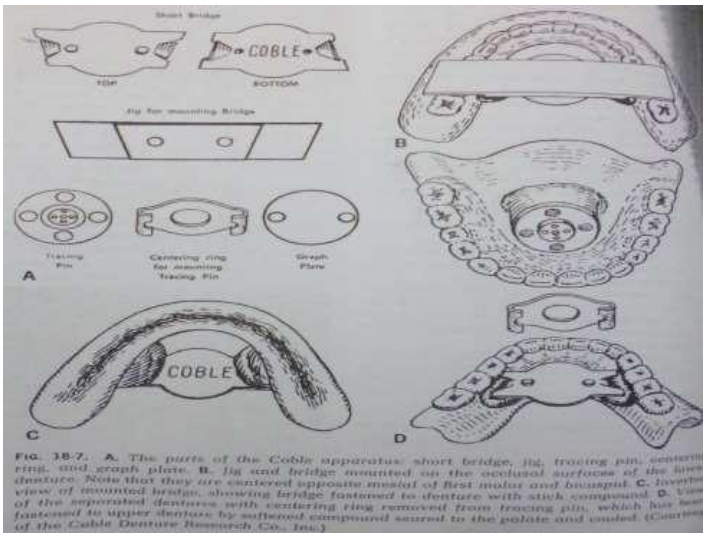



FIG. 18-7. A. The parts of the Coble apparatus: short bridge, jig, tracing pin, centering ring, and graph plate. B. Jig and bridge mounted on the occlusal surfaces of the lower denture. Note that they are centered opposite mesial of first molar and bicuspid. C. Inverted view of mounted bridge, showing bridge fastened to denture with stick compound. D. View of the separated dentures with centering ring removed from tracing pin, which has been fastened to upper denture by softened compound seated to the palate and sealed. (Courtesy of the Coble Denture Research Co., Inc.)

**Occlusal wax**

Adhesive green wax is placed on the occlusal surface of mandibular denture. Points of penetration that occurs upon closing with the jaws in centric relation may be marked with alead pencil and relived where indicated . With this method one may also locate points of interference during functional movements. One disadvantage of this method is that shiftingof the denture over the resilient tissue in eccentric jaw positions will give false marking. Thisis an excellent method for correcting occlusion in the centric position.

## REMOUNT PROCEDURE

Errors in occlusal relationships of teeth on complete dentures are caused by various factors. Thy include changes in the condition of the temporomandibular joints, unstable trial bases forinterarch relationship record, incorrect use of face-bow, transfer of casts into the articulator,inaccurately defined vertical and horizontal relation, irregular arrangement of the posteriorteeth, use of excessive pressure during pressing of acrylic resin into the flask, inadequatelyclosed flasks during polymerisation, as well as overheating of the finished dentures by finalpolishing. All the mentioned factors result from an error by the dentist or dental technician inthe course of fabrication of complete dentures. Occlusal errors can also result from inevitabledimensional changes in the denture material during and after polymerisation (contractions)and from wearing of the finished dentures in the mouth (expansion of the acrylic resin due towater absorption)

### Purpose of a remount procedure[93]

Physical, biologic, and prosthetic factors determine the functional quality of completedentures.The denture base, mucosa under the denture base, and saliva enable retention byadhesion, cohesion, and atmospheric pressure.

Biologic factors are dependent on neuromuscular balance and the content and amount of saliva.The residual ridge can, to a certain extent, mechanically hold the denture base on the denturefoundation as well asmovable parts of the mucosa and muscles that have a favorable effect onthe stabilization of complete dentures.

Prosthetic factors include the arrangement and occlusal contacts of denture teeth. Therefore thecontrol and correction of occlusal contacts during denture fabrication, polymerization of thedenture base, and subsequent patient care are very important.

According to Suzuki et al, the occlusal forces, area, and number and position of occlusal contact points were significantly larger in an adjusted group than in a nonadjusted group ofcomplete dentures.Remounting of complete dentures on preliminary casts should be avoided. Preliminary casts areinadequate because they are usually damaged, and the insertion of complete dentures is difficultbecause of dimensional changes. Alternatively, denture bases can be attached to the articulatorwith a putty material, although fabrication of stone transfer casts is a simple

and preciseprocedure. Check record mounting blocks can be used for faster mounting of dentures in thearticulator.

Determination of interarch relationships is possible with the centric relation record by means of a supporting pin, but this narrows the lingual area, prohibits muscle function, andincreases the vertical relation by 5 to 10 mm. The functional record raises the bite by about 0.5mm, and it is the most common procedure. Aiming at uniformity and simultaneity of the bite inthe area of distal teeth, this procedure has proven clinically reliable.The most often applied occlusal concept is balanced occlusion. In the occlusal

treatment of edentulous patients, preference is more often given to the lingualized occlusalconcept, which is achieved by a specific tooth form, and it is logical and less complicated thanbalanced occlusion. It has been established that both balanced and lingualized Occlusal schemesrequire less force to be exerted during mastication, and therefore the denture-bearing tissues aresubjected to lower forces than with the monoplane (nonbalanced) occlusion.Gausch was one of the first to report a positive experience in the application of thecanine/anterior guided occlusion on complete dentures. Later, other authors reported successfulperformance with this prosthetic treatment. According to Gutowsk and Peroz et al, theadvantage of canine/ anterior guided occlusion is its simplicity, because anteroposterior andbilaterally balanced occlusal schemes are difficult to achieve. Esthetics and stability ofcomplete dentures during eccentric movements are better and the occurrence of parafunctions isreduced. Less muscle activity is found in complete denture wearers with anterior/ canine guided occlusion than in those with balanced occlusion.Remounting should definitely be performed after polymerization of denture bases and beforecomplete dentures are given to the patient. However, the best timing of remounting afteroptimal incorporation of the denture into the patient's mouth is uncertain.

According to Lauritzen,this should be done after 8 to 10 days of the patient wearing the complete denture, and Dapprich and Oidtman recommend it be performed after 2 weeks. Utzemphasized the different extent of occlusal changes in complete dentures and recommendedremounting between the first and the third week of wearing.

Gutowski recommended remounting after 1 to 3 days of wearing and again after 1 week. Theocclusal aspect of complete dentures plays a role in achieving uniform distribution of masticatory forces and improved retention and stabilization of denture bases. The occlusion ofcomplete dentures should satisfy the dynamic

interrelationships of stabilization including freedom in centric occlusion, centric relation, and the individual arrangement of denture teeth.Although many factors influence patient satisfaction with complete dentures-for example, denture quality, oral health, the patient-clinician relationship, the patient's opinion about dentures, the patient's personality, and psychosocial factors-it has been reported thatmasticatory efficacy and satisfaction are more important than occlusion for patients withcompletedentures. Occlusion varies constantly depending on muscle tonus, remodelling of the supporting structures,tooth wear, and mental health. A follow- up of patients with complete dentures established that, in half of them, occlusion was not stable, and in some of them, a new maximal intercuspal occlusion was determined clinically.

The consequences of undesirable changes in occlusal relations include resorption of the edentulous jaw and abrasion of denture teeth. Remounting can help reduce and prevent changesin occlusion and improve denture comfort, as well as the efficacy of Occlusal rehabilitation of edentulous patients.Remounting of complete denturesand control of occlusal contacts can also be performed after denture relining, although noconsiderable dimensional changes in complete dentures have been observed.

The success of prosthetic treatment in edentulous patients is determined by acceptable functionof complete dentures. Pressure points should be eliminated in two or three visits, which canhelp heal any lesions on the denture foundation. A remount procedure, which can be repeatedseveral times, also helps. If the process of denture base adjustment on the denture foundation isnot completed, a remount procedure should be performed again after 2 to 6 weeks. It isadvisable to carry out a functional control of dentures once a year. Recall is necessary every 1to 2 years of denture wearing, together with remounting, relining of denture bases, andreplacement of the dentures with new ones after 7 years of wearing.

**Fabrication of remount casts and transfer of dentures in the articulator**

The remount procedure starts with preparation of dentures for fabrication of remount casts.The dentures are dried and undercuts in the denture base and lingual area are filled with hardsilicone . Remount casts are made from hard stone. As soon as the stone is hardened, thesilicone is taken off the dentures and the dentures are placed on the casts with high precision.The transfer of the upper denture, according to the horizontal plane of reference, is performedby anatomic face-bow, which is

satisfactory with respect to accuracy and practicality ofapplication. As opposed to split casts, some articulators have a system with a magnetic disk(e.g. in the SAM 2 articulator the control system SAM Axiosplit). The remount cast with theupper denture is positioned on the mounting table and bonded with stone to the uppermounting stand of the articulator.

**Determination of the horizontal interarch relationship**

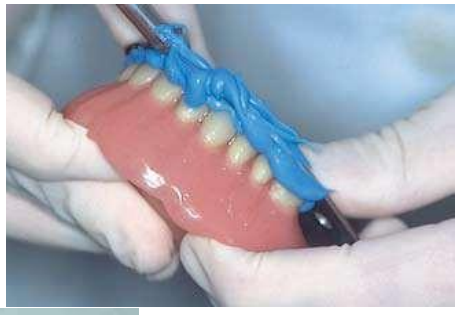
A habitual and physiologic occlusion is an important factor of adjusted relations in the masticatory system. By loss of all teeth the patient loses habitual occlusion . The horizontaland vertical interarch relationships are reconstructed at fabrication of the upper and lowercomplete denture. In maximum intercuspation of artificial teeth the condyles of the lower jawmust be in the centric, i.e. physiologic position within the temporomandibular joint socket.Centric relation, i.e. horizontal interarch relationship is determined once again by a remountprocedure. The functional position of the terminal hinge axis is determined by functionalrecord by means of aluminium wax and zinc oxide paste. Vertical interarch relationship ispreserved during registration. Points are made with a permanent marker on the labial surfacesof the upper and lower central incisor, and the distance between them is recorded by slidingcallipers in maximum intercuspation. Finger rests for the operator (made from compound thermoplastic impression material), which are placed in the premolar and molar area, enable recording. In this way a steady seat of the lower denture on the denture foundation isachieved .

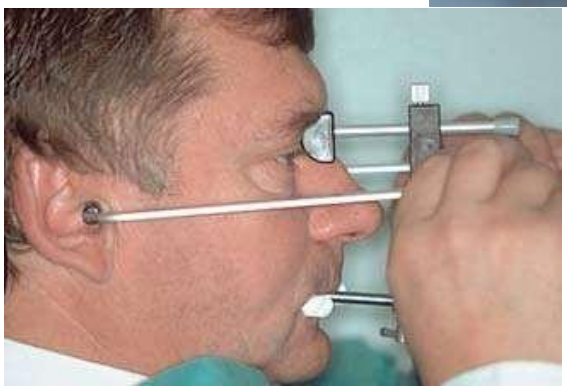
The dentures are dried and a 1 mm thick layer of aluminium wax is applied to the outer and inner surfaces of distal teeth in order to prevent intrusion of saliva. With the dentures prepared in this way, the patient first practices guidance of the lower jaw into centric relation until he touches the wax layer. The lower denture with the wax layer is immersed in the waterbath at 52°C for 20 seconds and placed on the denture foundation. The patient closes themouth gently, as he has practised, and by means of antagonist tooth contact the operator checks the recorded distance between the control points, which must be the same or increasedby the space between the teeth not exceeding 0.2 - 0.5 mm. The lower den-ture is removedfrom the mouth, all wax impressions chilled in water are trimmed off with a scalpel and theprocedure is repeated. The patient in an upright position touches the upper dental arch slowlyand simultaneously without the operator's aid. The dentures are removed from the mouth,

the impressions are chilled in water, and their depth and uniformity are checked. Only caninesand cusps of lateral teeth can make impressions. The procedure is repeated if uneven pressure creates impressions of different depths. The upper teeth on the denture must perfectly slipinto the respective impressions on the lower denture. Zinc oxide eugenol paste is applied intothe impressions with a thin brush and a definite record of the interarch relationship is made.

The dentures connected with the record are mounted on the casts fastened by warm glue (Pattex). In the mounting table of the articulator the lower cast is attached with stone to thelower mounting stand of the articulator. A record check is repeated by elimination of impressions, and a check in the articulator is performed by means of split casts.

**Clinical remounting**[94]





Preparation for transfer of complete dentures in an articulator with afacebow begins with attaching the maxillarycomplete denture to the transfer tray with a bite registration materialTransfer of the occlusal surfacein relation to the axis orbital plane isachieved by placement of a facebow in the transverse horizontal plane ofthe mandible and a point on the inferior border of the right and leftbonyorbit (orbitale) and on the maxillary complete denture attached withscrews, which is placed on the edentulous jaw. The patient assists in the procedure so that he or she holds the anterior

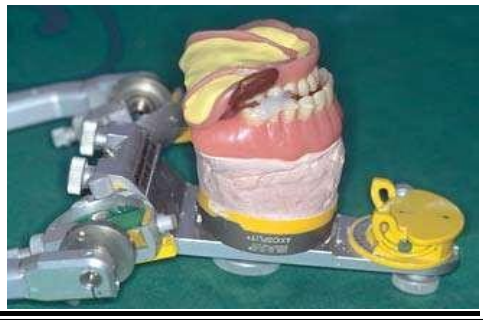
part of the facebow with the hands and fixes the denture on the denture foundation by biting into cotton pellets.

The maxillary denture is removed from the mouth together with the facebow and is mounted onthe upper portion of the articulator (SAM 3). The undercuts of the denture base are filled withfirm silicone.

Mounting of the maxillary complete denture in the SAM 3 articulator with a hard stone accomplishes simultaneous fabrication of a transfer cast for remounting.

The centric record of the horizontal interarch relationship is performed by bimanual stabilization of the mandibular complete denture and unforced mandibular guidance into centric relation. The patient bites gently with the complete dentures into an impression compound .

The mandibular complete denture with finger rests and a record of the occlusal surfaces of posterior teeth made of a thermoplastic compound. Impressions in the record are chilledin water and reduced with a scalpel. The procedure of making a centric record isrepeated.



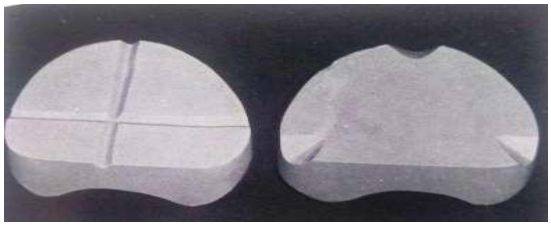
Dentures attached to the centric record are carefully removed from the patient's mouth. The maxillary denture is mounted on the upper transfer cast in the articulator. The mandibular denture is attached to the maxillary denture by means of the centric record. After the undercuts of the denture base are filled with firm silicone, the transfer cast is fabricated, and the mandibular denture is mounted on the lower part of the articulator.

**Lab remounting**

Purpose:

1. To correct errors in processing
2. To return dentures to the correct vertical dimension
3. To restore centric and bilateral balanced occlusion

After processing, but before the removal of the dentures from their casts, they are returned tothe articulator. This is accomplished by using split-cast mounting techniques, which allow easylocation and removal of the cast from its mounting plaster on the articulator.



Split Cast mounting technique:

**1.**procedure for placing indexed casts on an articulator to facilitate their removal and replacement on the instrument;

2.the procedure of checking the ability of an articulator to receive or be adjusted to a maxillomandibular relation record.Splitcast mounting is carried out in the laboratory, by notching the base of the cast andapplying separating medium just before articulating the casts. The cast is easily separatedfrom themounting plaster and is flasked after the try-in. The cast can be removed from the flask andreattached to the

mounting plaster using cyanoacrylate glue. After remounting ,check the incisal pin and incisal table contact (1-3mm)Check contactsbetween heals of the casts and dentures.Place articulating paper ,and gently tap. After thecentric check eccentric and protrusive contacts,adjust these contacts by selective teeth .grinding.

**Advantages :**

1. It reduces patient participation
2. It permits the dentist to see better what he /she is doing
3. It provides stable bas ,eliminating the resilient tissues
4. Absence of saliva makes markings more accurate

**Elimination of deflective occlusal contacts in the articulator**

Correction of occlusal relationships starts with mounting of dentures on the casts in the articulator and marking of the relation between fossae and cusps on the buccal and oral surfaces of the posterior teeth from the cusp tip to the tooth equator by a permanent marker .The final correction of possible occlusal disharmony on dentures is carried out by the processof selective grinding. Selective grinding preserves the desired tooth form and types ofocclusion . Occlusal contacts in the retruded contact position are marked with thinarticulating paper. The process of marking and grinding is repeated until bilateral,simultaneous and uniform contacts of all lateral teeth, optionally also of canines, areobtained. A sufficient number of anteroposterior and buccolingualstabilising tooth contacts isneeded. Every deflective contact is trimmed with a bur in order to preserve the toothmorphology . Incisors must be outside occlusion. It is important that the incisal pin alwayscontacts the incisal table

simultaneously with mutual tooth contacts. The next step iselimination of deflective occlusal contacts at straight protrusive movement.The border occlusion of the anteriors is transferred into the articulator by means ofprotrusive interocclusal bite, and this position is maintained by means of a protrusive screwand contact between the incisal pin and the anterior guidance holder. Only incisors produce asimultaneous and uniform contact.Deflective contacts are ground with a bur on the palatal side of the occlusion rim due toaesthetic reasons . Then the upper mounting stand of the articulator is moved gradually for 1mm towards the retruded contact position, where also canines should make contact, and ifcontacts between incisors are not possible, they should be made also on the first premolars

(protrusive group contacts). Control of the right and left tooth guided lateral movement canbe initiated if the articulator is programmed (e.g. setting of Bennett angle in the SAM

articulator by means of setting the red SAM extension at 10° on both sides). It is started withthe right lateral movement. The upper part of the articulator is moved towards left wherebythe condylar ball on the working side touches the rear wall of the housing. It is necessary toproduce contacts on canines by selective grinding, i.e. on premolars on the working side.

Deflective contacts are eliminated by grinding of excursive contacts (of the part beside thecusp), and the ones nearer to the fossae are preserved, because this is the place of contacts inthe retruded contact position. Each contact on the free or balancing side is eliminated. Thesame correction is carried out also on the left side.

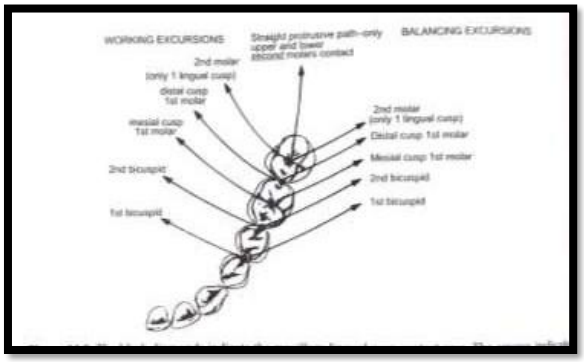
**SELECTIVE GRINDING PROCEDURES**

The final correction of possible occlusal disharmony on dentures is carried out with the procedure of selective grinding. Each occlusal error is corrected by grinding of specific toothsurfaces, which preserves the desired tooth form and type of occlusion.The disability of thebasal seat mucosa must be corrected when the teeth are altered by selective grindingprocedures. Hanau describes this factor as Realeff, derived from resiliency and like effect, andpointed out that denture built on the Hanau articulator model H articulate in the mouth with acomponent of over protrusion within a range. He describes the effect by saying that the teethhave a tendency to find premature contacts of the distal inclines of the lower cusps with themesial inclines of the upper cusps.

On denture teeth, occlusal errors can include errors in centric occlusion, errors during protrusivemovements, and errors on the working and nonworking (balancing) side.

**Selective grinding for static centric contacts**

Once the initial balance is achieved during the setup of the maxillary posteriors, the completeocclusion must be refined by selective grinding. First remove the incisal guide pin so that theteeth are holding the proper occluding vertical dimension. A length of thin articulating paper isplaced on the posterior teeth, and the articulator is gently tapped several times in centricocclusion. If marks show on lower cusps inclines, gently grind the inclines to eliminatedeflective contacts.If there are any upper lingual cusp out of contact, the nonoccludingmaxillary teeth are repositioned by moving the lingual cusp down into contact.It is also possibleto selective grind the teeth into a stable centric occlusion. Only the lower central fossae ormarginal ridge should be ground, not the upper lingual cusps. If any significant grinding doneon the lower teeth , the occlual vertical dimension will be reduced and anterior interference willoccur.If the nonoccluding lingual upper cusps are nearly in contact, modest grinding can be done , asit will not significantly close the occlusal vertical dimension. If any upper buccal cusps orinclines are in contact,it should be ground out of contact. Only upper lingual cups,shouldarticulate with lower posteriors.the final result after several tapping and spot grinding should bestable contact with all upper lingual cups in the common lower central fossae.




The black diamonds indicate the maxillary lingual cusp contact area. The arrows indicate the paths of the maxillary lingual cusps in balancing, working and protrusive excursion.

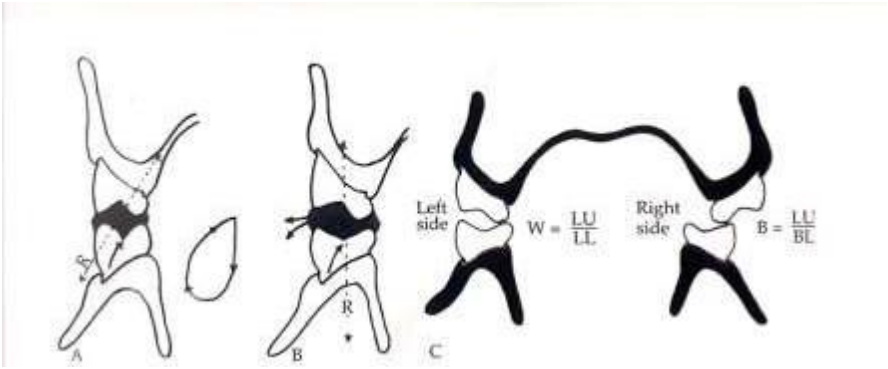
**Selective grinding for working and balancing contact**

When the mandible moves in the left, this becomes the working side. The upper left lingualcusps should contact the lower left lingual cups.The right side is then the balcing side, and theupper lingual usps should contact the lower buccal cusps.Only one lateral excursion should be checked at a time. After the working and balancing contactfor left lateral excursion have been equilibrated, then check the right lateral excursion.

Place a strip of thin articulating paper between the posterior teeth bilaterally. While keeping gentle pressure on the maxillary member of articulator, move it to the right. This duplicates aleft lateral excursion. Ideally, in this occlusal scheme there should be five working cusp contact,and no upper cusps contact.

When functioning as balancing contact , upper lingual cusps ride lower buccal (lingual-facinginclines) cusp inclines diagonally.When acting as working cusps, upper lingual cusps pass between modified triangular ridges ofthe lower lingual cusps that run either to the marginal of lower ridge or to groove between thecusps of the lower molars. Do not grind the upper lingual cusps.There may also be upper buccal cusps contact on the working side. This is usually the result of inadequate buccal cusps rise made during the setup.Do not grind the lower buccal cusps. There should be no upper buccal cusp contact in anyexcursion.As the premature inclines and high cusps are selectively ground until there is simultaneouscontact of working and balancing cusps, the cusp rise is gradually reduced. This may create anterior interference on the working side,which must be eliminated .usually, there is sufficient vertical overlap to allow for a simple solution by grinding.Thelingual of upper anterior incisaledges and labial of lower anterior are grounded to eliminate any interference that developswhile selectively grinding to balanced occlusion.

Grinding of anterior teeth should always be conservative so that esthetic value of anterior teethis not disturbed. When it is apparent that selective grinding to balance the occlusion will cause anterior interference , the upper posterior teeth should reset to open the vertical dimension enough to clear the anterior teeth after balancing for eccentric excursions. The finished dentureshould be smooth gliding lateral excursion with ten simultaneous working and balancing contact. Now equilibrate the right side with opposite lateral excursion in the same manner.




**Selective grinding for protrusive balance**

The upper right and left second molar cusp should ride up the distal inclines of the lower rightand left second molar with enough rise to clear the anteriors. There should be n interferencebetween the buccal cusp of upper teeth and any of the lower buccal cusps. The movement itselfmust be smooth and devoid of any washboard effect.If anterior interference occurs,either moveor grind the lower offending anteriors tooth slightly or increase the distal incline on the lowersecond molar by increasing the compensatory curve**.**

The intercuspalrelationshipbetween the fossae andthe cusps of the complete denture teeth is indicatedwith apermanent marker.

Uniform protrusive contacts on the maxillaryanterior teeth are achieved by selective grinding . Deflective contact on the right second premolar(green) during right laterotrusive movement.When the impressions for complete dentures are made and relations of the jaw are recorded,the basal mucosa is at or near an undisplaced position. The casts are related on the articulator with the jaw relation record that was made at centric or terminal relation at the vertical dimension of occlusion. Maximum intercuspation of posterior tooth contact is developed at that given amount of jaw separation. When the dentures are inserted in the patient‘s mouth and the force of jaw closure is exerted on the teeth, the mucosa under themaxillary denture is displaced in a superior direction at the same time the mucosa under themandibular denture is displaced in an inferior direction. When the denture bases follow thistissue displacement, the jaws come closer together and the vertical dimension of jawseparation is changed. As the jaws come closer together, the mandible is slightly moreforward in relation to the maxillae. This change in maxilla-mandibular relation would resultin the distal inclines of the mandibular posterior cusp having tendency to

find prematurecontact with the mesial Inclines of the maxillary cusps. This would occur regardless of articulation upon which the denture was constructed if the jaw relation records were madewith a passive recording material such as plaster, softened wax, or impression compound.

The more displaceable the tissue the more the tendency for premature contact.

The "correction technique" described by Hanau requires multiple remount procedures usingfirst ―unstrained" jaw relation records and then "strained" jaw relation records made with thejaws in terminal relation. An "unstrained" record is recorded with a passive materialnecessitating no undue force that would displace the mucosa. Selective grinding isaccomplished first with this "unstrained" mounting. The mandibular cast is then remountedwith "strained" jaw relation records that are made with a resistant recording materialnecessitating the jaws to be closed with a force that displaces the supporting tissue.

Selective grinding procedures using this technique of remounting will result in an area of Contact between the canines is achieved duringtooth-guided lateral movement without contacts ofdenture teeth on the balancing (nonworking) sidefreedom of occlusion with the jaws are in terminal relation. This area of freedom of occlusionmay be referred to as long centric or short protrusive occlusion.

**Selective grinding of anatomic teeth**

In the first step, cusp form teeth are altered by selective grinding to obtain balanced occlusion when the jaws are in centric relation. Occlusal balance in a lateral direction is obtained by having all the posterior teeth and the cuspids in contact on the working side andon posterior contact only on the balancing side. In protrusive balance the anterior teeth shouldmake incisal contact at the same time that the tips of the buccal and lingual cusps of theposterior teeth contact.

The techniques are as follows:

1. Adjust the horizontal and lateral condylar inclinations of the articulator to the settings dictated by protrusive inter occlusal maxilla mandibular relation record
2. Release the horizontal condylar elements to allow freedom of the articulator movements in the eccentric positions,
3. Raise the incisal guide pin from the guide table and secure it above the height of the table.
4. Evaluate the areas of tooth contact in the centric and eccentric positions prior to selection of the point or area to be reduced or altered

5. With the condylar elements against the centric relation stops, close the articulator until theposterior teeth are in contact. The anterior teeth should not be in contact .Examine the lingual cusps .The maxillary posterior teeth and the buccal cusps of the mandibular posterior teeth.

   Premature contact appears when the remainder of the teeth fail to make maximum intercuspation. Record the area or areas of premature contact the contacts maybe in varyingamounts and may involve more than one cusp or tooth. These varying situations makenecessary critical evaluations prior to grinding procedures in the centric position; however,further evaluation in the eccentric position is necessary before one starts any grinding.

6. Secure the right condylar element in the centric position and place the lingual cusps of themaxillary posterior teeth in balancing relation with the buccal cusps of the mandibular posterior teeth. This procedure also places the buccal and lingual cusps of maxillary and mandibular posterior teeth and the cuspids in their working position on the opposite side. Theteeth are placed in these positions and not shifted from the centric to the eccentric position withthe teeth in contact. The procedure often results in breaking or chipping teeth.When the teeth on the balancing side are not in the correct relation, the error appears on the either the balancing or working side. If the balancing contact is excessive the working side teeth will notbe in contact. If the working side contact is excessive, the excess prevents contact on thebalancing side.

   If the teeth on the working side are too long, there will be no contact on the balancing side. Ifa single tooth is high on the working side, there will be contact neither on the balancing sidenor on the working side

7. Record the premature contacts.

   Repeat the procedure with the left side as the working side and record the premature contacts.Use articulating tape to mark the areas of premature contact for selective grinding. Whenusing tape, exercise care to prevent the tape from wrinkling or doubling, as this will result in an error in marking. Place the tape on the occlusal surfaces and the incisal edges of all themandibular teeth. When the teeth are brought together, this position assures that the sameforce is exerted on all the teeth.

8. Return the incisal guide pin to the table and use the following grinding procedures to ensure balanced occlusion in the centric and eccentric position.

a. If the cusp is high in centric and eccentric position, reduce the cusp.

b. If the cusp is high in centric and not in the eccentric position, deepen the fossae or the marginal ridges. After all interceptive contacts have been removed in the centric and eccentric positions.

1) Do not reduce the maxillary lingual cusp or mandibular buccal cusp and

2) Do not deepen the fossa or marginal ridge of any tooth.

9. When one wishes to refine the teeth to retain contact when the articulator is being movedto and from centric and eccentric position- balanced gliding occlusion-use the followingselective grinding procedures:

   On the working side reduce the inner inclines of a) the buccal cusps of the maxillary teeth and b) the lingual cusps of the mandibular teeth.

**Selective grinding of non-anatomic teeth**

When non cusp form posterior teeth are used and selective grinding procedures are instituted, the occlusal surfaces of the posterior teeth are altered to make harmonious contacton the right side and the left side when jaws are in centric relation

1. Secure the horizontal condylar elements on the articulator against the centric relation stops.
2. Place articulating tape over the occlusal surfaces and incisal edges of all of the mandibularteeth.
3. Tap the teeth together to record the contacting areas.
4. Using a mounted wheel, grind the occlusal surface of the teeth until simultaneous even contacting areas on the right and left are developed. Do not allow the anterior teeth to makecontact. Develop small areas of contact uniformly dispersed over the occlusal surfaces of the distal of the first bicuspid, the second bicuspid, the first molar.
5. Polish all altered surfaces with wet pumice on a wet rag wheel
6. Exercise care to maintain the occlusion surfaces of the mandibular arch on a plane.
7. When using porcelain teeth in one arch to oppose acrylic resin teeth in the opposite arch,do all grinding of the occlusal surfaces on the acrylic resin teeth.

## STRIPPING METHOD FOR THE OCCLUSAL EQUILIBRATION OF ZERO DEGREE TEETH

Another acceptable technique to refine the occlusion for cuspless, non-anatomic teeth isthe carborundum stripping technique which was originally published by Dr. Gronas in 1970.It, like all procedures in dentistry, if followed correctly, will give excellent results. Theprimary purpose of non-anatomic posterior teeth when set on a flat plane is to eliminatecuspal interferences.

Therefore, it is necessary during the selective grinding procedure in this technique to maintain the previously established flat occlusal scheme. A rotary instrument usually produces irregularities in the flat occlusal surfaces. Waterproof carborundum abrasive paperis the most ideal material to use with this method. A 220 grit paper is used to modifyporcelain teeth and a fine 320 grit paper is used for acrylic resin teeth.

Strips of the abrasive paper should be cut in varying widths to allow for the reduction of individual teeth or to reduce entire quadrants. It should be remember that the flatness of theocclusal surfaces must be maintained throughout the entire grinding procedure.

The technique is as follows:

1. Adjusting for centric occlusion
    a. Locate the premature contacts with articulating ribbon or paper. If there is a grossly tippedtooth which is above the occlusal plane, reduce the tooth with a stone or bur until a flatocclusal plane is obtained.
    b. Check the eccentric movements and if any premature contacts are present in any of the positions, remove them also with a stone or bur before proceeding further with the grinding.
    c. After the procedures in a. and b. have been accomplished, place a carborundum strip of theappropriate width with the abrasive side against the teeth that are to be reduced and gentlyclose the articulator in centric relation.
    d. Apply light pressure to the upper member of the articulator and pull the strip briskly between the teeth. Always pull the strip in the same plane as the flat occlusal surfaces of theteeth in order to avoid rounding of the bucco – occlusal angle of the teeth. Evaluate thevertical dimension of occlusion carefully throughout the procedure, as the rapid reduction ofthe

occlusal surfaces could allow overclosure past the original vertical dimension.

e. Reduction of the contacts with the strips is continued by stripping an equal number of times with the abrasive side alternated up and down until uniform bilateral contacts on theposterior teeth are obtained. By alternating the abrasive side of the paper between the maxillary and mandibular teeth, it will equalize the reduction between the two arches and ensure that the occlusal plane will be kept flat. Finish the reduction with finer grits of sandpaper strips in order to produce a smoother flat surface.

2. Adjusting for the eccentric occlusion

a. Check each eccentric position (working, balancing, protrusive) and remove any prematurecontacts with a flat stone while maintaining a flat occlusal plane.

Following the adjustment of the eccentric positions, the centric occlusion should be again bechecked and any necessary modifications made with the abrasive strips of the appropriatewidth along with ensuring that there is no contacting of the maxillary and mandibular anteriorteeth in that position.

# SUMMARY AND CONCLUSION

## CONCLUSION AND SUMMARY

The present concept of balanced occlusion is based primarily upon geometry and articulator movement. Various groups have set up different geometric ideals as a guide forocclusion of natural and artificial teeth based primarily on the assumption that the instruments used in their studies follow normal mandibular movements. The hinge axis wasdiscussed, and the condyle path was demonstrated to have different degrees of angulationdepending upon the method used to obtain check bites. The central bearing screw attached tothe mandible, and moving on different plates attached to the maxilla, such as flat, convex orconcave, will give different registrations from which different occlusions could be determined.

The value of the hinge axis and adjustable articulators as aids to obtaining a balanced occlusion were questioned. The importance of centric relation was stressed as the only pointin common between functional and nonfunctional movements, and that if centric relation is correctly recorded, most geometric ideals of occlusion will function for the patient. The direction of occlusal forces varies depending upon the plane of projection, but it is never perpendicular in an axial direction to a natural tooth or perpendicular to the occlusal surfacesof a denture. A method to grind the occlusion of natural teeth to eliminate interferences, and a method to set artificial teeth was described to follow the direction of physiologic-wear of natural teeth and to aid in the stabilization of the lower denture.Both artificial cusp and flat cuspless occlusal forms present disadvantages when they areused for complete dentures. Although the objectives of natural occlusion and prosthetic occlusion are the same, the aims of prosthetic occlusion must be achieved by mechanicalmeans. A cuspless occlusal pattern which incorporates the principle of concentric curvaturesof the same radius is suggested as a means of accomplishing the aims of prosthetic, occlusionin complete denture construction. This cuspless occlusal pattern is characterized by a curvedthree-dimensional occlusal surface rather than by a flat, two-dimensional occlusal surface. Itis bio-mechanical and meets with the biologic and mechanical requirements of occlusion incomplete denture construction. A simplified procedure for obtaining balanced occlusion hasbeen described. The teeth are set to fixed lateral and protrusive positions, thereby obtaining proper working, balancing, and centric occlusion.

The mechanical factors which are involved in the arrangement of anatomic type artificial teeth into balanced occlusion have been described. Many of the mechanical

problems encountered during artificial tooth arrangement have been listed, together with suggestionsfor their solution. Hanau's Laws of Articulation have been utilized in a practical manner informulating some of the solutions to tooth arrangement problems when establishing balancedocclusion. Trial dentures which present ideal occlusions in the articulator may not always doso when examined in the patient's mouth. Possible reasons for these differences are listed,and methods for making the necessary corrections are described.The most important reason for providing balanced occlusion is the added retention whichit affords to a denture at times when the stability is threatened. Balancing ramps can be an indispensable factor in obtaining this balanced occlusion.

Occlusion should be smooth running, the importance of occlusion and articulation for maintenance of CD stability has never been underestimated, but overlooked. No matter howgreat amount of initial retention, the impression may demonstrate. Because the occlusion weare going to provide gives more stability which indirectly gives the retention. Balanced occlusion is making a stumbling phrase into a beautiful poem so dentist(prosthodontist) should provide occlusion, which should compatible with the stomatognathicsystem and should provide an efficient mastication and esthetics, without any physiologic abnormality.The preservation of the supporting tissues is a sacred trust that cannot be ignored. The application of the basic concepts discussed will help to keep this trust in the hands of the dental profession.

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