# Inclined plane effect and leverage perspectives of stable dentures-an overview

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## Abstract

The stability of complete dentures is of multifactorial origin. The unseating of the complete dentures results in irritation, ulceration of the underlying structures leading to discomfort. The dentist-engineer should take into consideration factors like inclined plane and leverage as they are related to the stability of complete dentures.

The present review was conducted after an extensive literature search of peer reviewed journals, textbooks and extracting information related to the factors influencing stability of complete dentures. This article is a comprehensive compilation on the inclined plane and leverage factors affecting stability of the complete denture.

**Keywords:** Complete denture, Inclined plane, Leverage, Stability.

## Introduction

Complete denture prosthesis is a mechanical device in a biologic environment. To ensure the success of the prosthesis, the dentist must understand the various factors those contribute to its optimal performance.

Consequences of tooth loss create anatomic changes which predispose to difficulties in deriving retention, stability and support with artificial dentures. For a denture to carry out its functions well, it is obvious that it must have good retention, stability and support. These properties are closely interlinked and usually complement each other.

Stability is the quality of a denture to resist displacement by functional stresses and it ensures physiologic comfort to patients. The lack of stability often makes the factors involved in retention and support ineffective[1-8].

In the literature, it has been stated that complete dentures are mechanical devices subjected to the principles of physics (mechanics), which is the inclined plane and lever. These forces will operate whether or not we recognize them. Therefore, it is the responsibility of the Dentist-Engineer to monitor these forces in a controlled way such that the balance or equilibrium exists to enhance complete denture function, stability and comfort [9-11].

Recognition and understanding of these physical factors such as inclined plane and lever and monitoring them by certain modifications in the design of dentures to aid in stability are presented through this article in a systematic manner.

## Literature search

A comprehensive information was gathered (electronic and manual) related to the stability of complete dentures in peer reviewed journals and textbooks. The review was conducted with the search of key words like stability of complete dentures along with related factors, inclined plane and leverages related to stability of complete dentures and criteria for acceptability of dentures by edentulous patients etc in various search engines like Pub Med, MEDLINE etc. Reports published only in English language were preferred for the review.

## Inclined plane

The inclined planes tend to deviate forces and thus produce instability. When the direction of force is at right angles to the support, there is no inclined plane action to wreck stability. In order to prevent such an unstable influence, prosthodontist must appraise following points where incline plane effect prevails.

## Direction of closing force

The effect of inclined plane is determined by the direction of force as related to the supporting surface; the factor of direction of mandible's closing force is fundamental to all our calculations. Lack of feedback signal system with artificial dentures desires for the mandible in function to end its chewing stroke in the most favorable kinesiologic position which is very close to centric relation[1-4].

Centric position is on the arc of closure made by the mandible when it is pivoting about its axis in its most unstrained retruded position. If the teeth don't come together with harmonious intercuspation, when the mandible moves along the centric path of closure, the eventual tooth relationship will be an inclined plane relationship in place of a cusp to fossa relationship [9-11].

An inclined plane relationship cannot be stable. Either the mandible moves forward as in the case of the natural dentition or in the case of complete dentures,

dentures under a continuing and increasing occlusal pressure slide until the proper stable interdigitation of the cusps is adopted. The resultant slide will cause unseating of the dentures along with irritation and ulceration of underlying structures leading to discomfort.

Mandibular closure for functional and parafunctional movements generate multidirectional forces. Therefore, it is advisable to choose and control the occlusal scheme so that resultant forces are as vertical to the foundation as possible[12-28].

## Muscle action on teeth and denture bases

The buccal, labial and lingual surfaces of the denture bases (together with corresponding sides of the teeth-polished surface) can behave as inclined planes either to stabilize or dislodge the dentures according to the design or use made by them.

Proper positioning of teeth in the zone of equilibrium along with contoured polished surfaces of dentures will enable the associated muscles to contact at an angle to push the dentures into place. In other words, form of the denture should follow function [Fig.1][1-9,29-34].

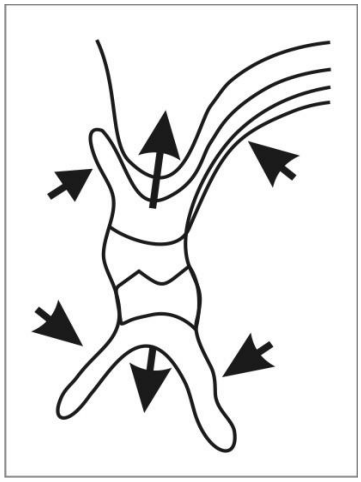

**Fig. 1: Stabilizing effect of properly contoured denture surfaces**

## Effect of Newton's third law

Newton's third law relating to the stability of bodies mentions that "for every force in nature there must be two bodies, one to exert the force and other to resist it and for every action, there is an equal-opposite reaction".

The importance of this in connection with artificial denture construction lies in the fact that the "equal and opposite" reaction requires elimination of all inclined planes when our object is to be ensured of utmost stability.

Formation of possible inclined planes relates to the movement of the denture bases on their supporting structures, which for a given occlusal force varies with the firmness of the ridges. The maxillary denture moves more in a horizontal direction, while the mandibular denture moves more vertically. Because of this movement, the precise interlocking of posterior teeth seems to be disadvantageous as they do not permit the eventual settling of bases[1-4,9-11,14,15].

The control of horizontal force is probably more important than the control of vertical force. It is very difficult to achieve with cusped teeth because of the inclined plane effect of the cusps as they articulate with one another[Fig. 2]. This aspect would call for an accurate programming of an articulator to set the teeth in harmony with the guidance factors of the teeth, the neuromuscular controls and the temporomandibular joint[35-46].

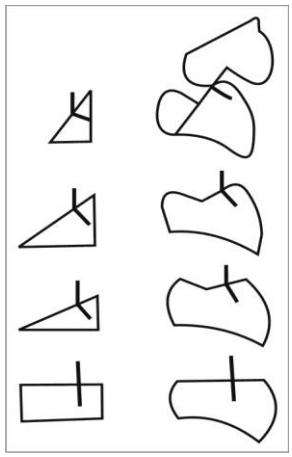

**Fig. 2: Schematic illustration of inclined plane effect with various posterior tooth forms**

## Articular surface of glenoid fossa

The backward facing articular surface of the glenoid fossa may confer to act as an inclined plane along which the mandibular condyle glides posteriorly under upward muscle pull on the mandible. The inclined plane action remains till the condyle meets the resistance of the joint structures which acts as a stop[3,9].

Appropriate condyle-fossa relation can be accomplished through precise recording of vertical and horizontal relations as they are complimentary to each other by means of tracings or very carefully prepared wax recordings which are also helpful even in individuals with habitual centric[Fig. 3][48-51].

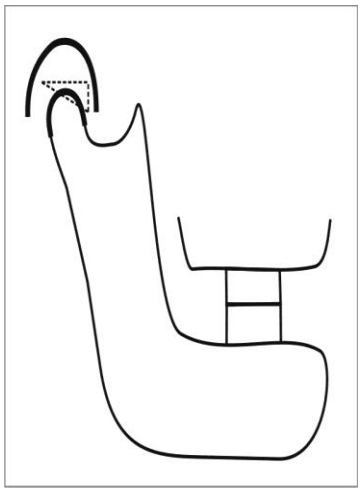

**Fig. 3: Stable condyle –fossa and its relevance to jaw relations**

## Angle of opposing areas of support and occlusal plane

Properly paralleled and positioned occlusal plane will result in an angle between opposing areas of support to direct force at right angles to the support to ensure maximum stability.

A tipped occlusal plane will result in a shunting effect and loss of stability. That is, if the occlusal plane is lower in the molar area, there will be a tendency for the upper denture to be displaced posteriorly and the lower denture to be displaced anteriorly. If the occlusal plane is lower in the incisor area, the shunting effect will be the reversed[Fig. 4][1,3,4,7].

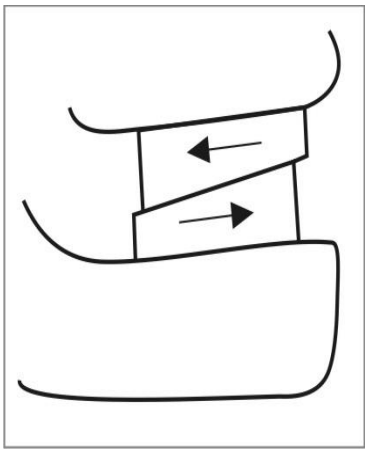

**Fig. 4: Shunting effect from tipped occlusal plane**

Position the occlusal plane midway between maxillary and mandibular ridges will allow the masticatory load to be transmitted through the middle of the ridges without generating any destabilizing forces by achieving synchronous occlusal movement correlating with the movement of condyles[Fig. 5][9-11,19,20,47,52].

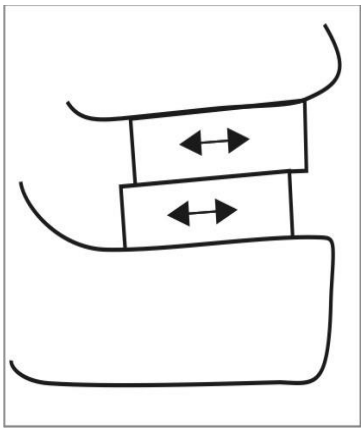

**Fig. 5: Properly divided and positioned occlusal plane**

It should also be ensured that posterior teeth should not be placed too far posteriorly as they come into contact prematurely in the closure path which can pronounce the inclined plane effect.

## Leverage

Leverage means lifting of an object from its base. Lifting of an object from its base is accomplished by lever of any class. Act of chewing with artificial dentures involves a multiple lever system. It is the problem of Prosthodontist to prevent or minimize leverage when its operation would be unfavorable and to establish or increase it when its operation would be beneficial. Basics of lever system and their potential as well as areas of leverage related to complete denture fabrication are explained in a subsequent manner.

## Explanation for potential of lever system

The three classes of levers are well known and are used in many operations. A lever system can potentially magnify the force applied, which can be understood by following explanation.

The length of the lever arm from the fulcrum (f) to the resistance(r) is called the resistance arm. The length of lever from the fulcrum to the point of force applied (e) is called the effort arm. Whenever the effort arm is longer than the resistance arm, the mechanical advantage is in favor of the effort arm.

Areas of leverage related to complete dentures are:

**Anteroposterior point of application of muscle pull on mandible**

Masticatory lever is of third class in nature where condyle is fulcrum, muscle pull is force and food is resistance. Efficiency of lever depends on the ratio between the effort arm and the resistance arm. In the absence of proprioceptive mechanism with complete dentures, our aim should be to balance the ratio to our advantage.

Placing the posteriors (working occlusal units) within the desirable arch position ensures that the forces

of mastication are opposed by center of the bearing area, thus preventing the development of unfavourable leverages which may affect denture stability[Fig. 6][9-15,24,25,37-39,41,46,53].

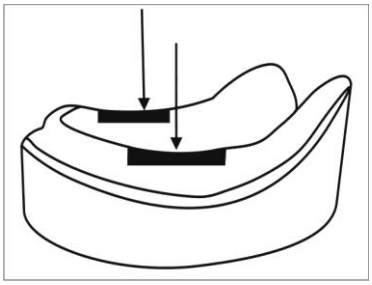

**Fig. 6: Desirable position to place occlusal units**

**Mandibular condyle as fulcrum**

As the mandible pivots around condylar head lying behind occlusal surfaces of teeth, the opposing teeth approach each other more rapidly in the anterior region causing greater forces. Similar forces are observed when food is placed on one side. The condyle on balancing side may be pressed with greater upward force in the fossa than does the condyle on working side. Such forces will lead to greater amount of forces on the side which is subjected along with subsequent shift of bases.

To counteract shift of bases from foundation, it is desirable to choose occlusal scheme with uninterrupted contacts of incising units, working units and balancing units in the dynamics of daily mandibular movements[1,3,9-15,20-24,45,46,52-54].

**Yielding of foundation**

The soft tissues which cover the denture base are neither rigid or nor uniformly yielding. Under intermittent chewing force they transform due to their elastic nature and changes in the volume of contained liquid.

Vertical force applied to a denture base supported by yielding tissue causes the bases to totter when force is not centered on the base transforming it to a lever. Properly positioned working occlusal units reciprocated by contacts of balancing occlusal units on opposing side will minimize this leverage effect[9-11,37].

**Horizontal placement of occlusal surfaces**

It has been mentioned that the denture itself may become a lever because of supporting tissues. Therefore, the more centered the force of occlusion antero-posteriorly, the greater is the stability of the base and more inside (lingual) the teeth are placed in relation to the ridge crest, greater is the balance[9-11,20,37-39,45,54].

**Distance of occlusal areas from the support**

Unfavorable ridges exhibiting severe resorption patterns may contribute to the compromised stability due to poor-base-residual ridge relationship.

In locating the occlusal plane, proper care must be taken to see to it that there is a appropriate distribution of the available inter-alveolar space. If the space is improperly divided, besides producing unsatisfactory aesthetics, unfavorable leverages will result as the distance from the occlusal surfaces to the supporting ridge is too great.

Instability is directly related to the distance of the occlusal surface from the bearing area or to express it another way, the resultant rotational movement or instability of the denture increases as the distance of the occlusal surface from the bearing area increases, for a given occlusal force.

A larger inter ridge distance creates a longer lever arm through which the force created by inclines of cusps. This force can be minimized by using progressively flatter teeth as the inter ridge distance increases. Functional lever balance can be achieved by favorable tooth to ridge crest position.

No single occlusal tooth form provides the optimum masticatory efficiency and control of non-vertical forces for all types of ridges and the various inter ridge distances and relationship[1,3-11,20,35,37,44,54].

## Discussion

Stable and retentive complete dentures enhance patient satisfaction. The appropriate design of the various surfaces contributes to the stability and retention by resisting displacing forces.

The stability and retention of complete dentures can be compromised by displacing forces, which are created during mastication, swallowing and parafunctional habits. Throughout these functions, the maxillary and mandibular teeth come into contact and unfavorable displacing forces can overwhelm the retention and stability of dentures causing discomfort from trauma to the underlying mucosa. Factors enhancing denture displacing forces therefore reduce patient satisfaction.

The denture stability is the resistance to lateral and anteroposterior movements during the exposure to the masticatory forces. The factors that contribute to denture stability are the relationship of the denture base to the underlying tissue, the relationship of the external surface with border to the surrounding orofacial musculature and the form of the occlusal surfaces.Nature of occlusal contacts become critical as they generate force and significantly influence denture base-tissue relationship[1-8].

Force management in complete dentures can be achieved with an understanding of basic biomechanical principles (inclined plane and leverages),because while the dentures can be considered as chewing appliances for edentulous patients and an intelligent application of forces would enhance the functions successfully on long term basis[9-11].

Search for ideal denture occlusion has been going on for almost two centuries in an effort to find the tooth form which provides maximum stability and masticatory

efficiency without compromising the health of underlying structures.

The design of an occlusion while rehabilitating an edentulous patient is different from that of the dentate individual. While both are concerned with the final act of intermaxillary closure, the absence of direct attachment between the dentures and the patient's neuromuscular control system along with the topography and architecture of remaining residual ridge tissues, relationships and chewing patterns would necessitate a different set of guidelines for good occlusal construction.

The occlusal surface of the artificial denture encounters the masticatory forces. These forces are transmitted through the denture base which is in close contact with foundation consisting of hard and soft tissues.

There are different occlusal scheme proponents such as bilateral balanced occlusion, lingualized occlusion, neutrocentric occlusion and monoplane occlusion. The basic guidelines for all these occlusal schemes centered on preservation of the remaining foundational tissues and overcoming different destabilizing forces. This increases stability and support qualities of the artificial denture by controlling the amount and direction of forces reaching the underlying residual ridge.

Accepted principles for occlusal schemes are

a. Complete denture patients must make initial and complete occlusal contact while in centric relation. This is called centric occlusion,
b. All anterior and posterior denture teeth inclines and surfaces as a" unit" during excursive movements,
c. any prematurity preventing the movements described in principles a and/or b must be eliminated,
d. Significant discussion of the posterior teeth when patient protrudes is contraindicated,and
e. Anterior teeth contact contraindicated in centric occlusion.

Selection and programming of an articulator to set the teeth (anatomic/non-anatomic with balancing ramps) in harmony with the guidance factors of the teeth, patient's neuromuscular control and the temporo-mandibular joints would enable all the complete denture wearers with stable dentures.

All the areas of the posterior teeth that are buccal to the ridge crest if kept out of occlusal contact for centric and working mandibular positions, lingualizes the occlusion and prevents tipping of denture bases[9-28,35-54].

Depending on the type and shape of occlusal surface, the masticatory forces are transmitted to the basal tissues differently. Furthermore, unlocking the cusps mesiodistally to permit gradual settling of bases, buccolingual cusp height reduction and selection of tooth form according to ridge resistance and inter ridge distance to control horizontal force, centering the occlusal table anteroposteriorly and positioning of tooth in relation to ridge crest are to be considered to enhance stability.

The controversy about occlusal concept cannot be resolved because of three reasons[40]:

a. Much knowledge is based upon empirical rather than scientific information,
b. The tolerance of the oral organ or the upper and lower physiologic limits are so broad that because if a certain concept fails in one specific mouth, it does not mean that it would fail in all mouths,and
c. The tremendous variable factors of the individual dentist and the standards by which he evaluates his completed restorations.

To date, none of the occlusal schemes is scientifically proven to be the best, but there are no valid reasons to suggest that sound basic principles are of little concern and any dentist should use the philosophy that works best in his own hands and at the same time does the most good, or better yet, the least harm to the patient in a given clinical situation.

## Conclusion

Every edentulous patient is unique. Edentulism has great impact on a patient's life style and quality. Treatment of edentulism with complete dentures is still employed widely because of its relative inexpensiveness and simplicity.

Success of complete denture treatment depends greatly on clear understanding of the possibilities and the limitations of various factors. It is apparent that the application of sound biomechanical basic principles is the most important factor to the success of the denture.

As stability can be more interpreted as" tooth borne" providing an occlusion with removable Prosthesis with reduced impact of destabilizing forces would justify and/or enhance its role.

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