

# **Biomechanics Of Edentulous State**

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# INTRODUCTION

- The edentulous state represents a compromise in the integrity of the masticatory system. It is frequently accompanied by adverse functional and esthetic consequences, which are varyingly perceived by the affected patient.

## **Dental Biomechanics :-**

The relationship between the biologic behaviour of oral structures and the physical influence of a dental restoration {GPT 8}.

- The clinical implications of an edentulous Masticatory system are considered under the following factors:

Modifications in areas of support  
(Natural Dentition vs. Complete denture)

Functional and Parafunctional considerations;

Changes in Morphologic Face height, and TMJ

Cosmetic changes and Adaptive responses

## Modifications in Areas of Support



Natural Dentition



Vs Complete Denture

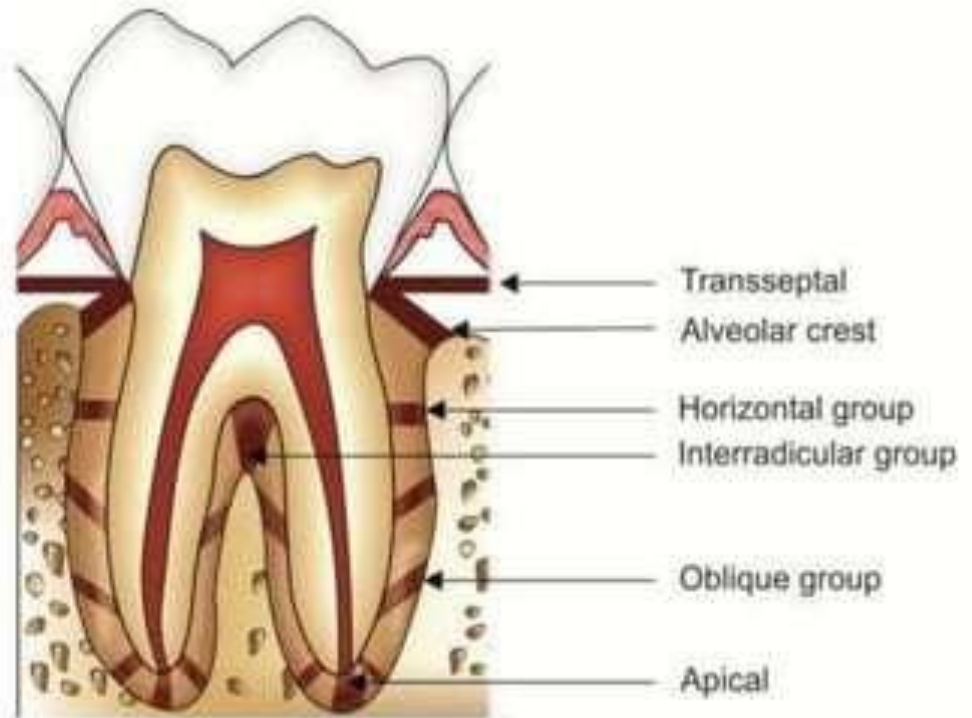
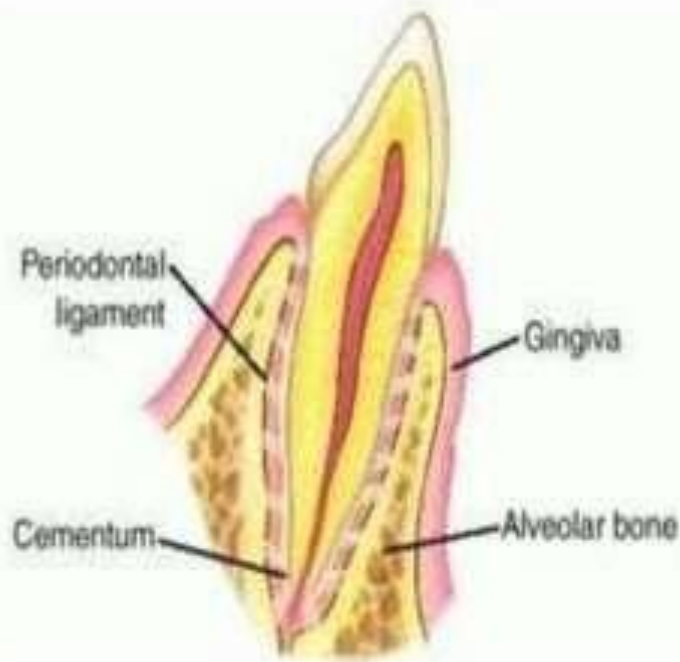
## BIOMECHANICAL SUPPORT FOR NATURAL DENTITION

- The masticatory apparatus is involved in the trituration of food.
- The attachment of teeth in sockets is but one of many important modifications that took place when the earliest mammals were evolving from their reptilian predecessor.
- Teeth function properly only if adequately supported, and this support is provided by the periodontium.





The periodontium attaches the teeth to the bone of the jaws, providing a resilient suspensory apparatus resistant to functional forces



- **The Two Principal Functions Of The Periodontium Are :-**

Support and Positional adjustment of the tooth,

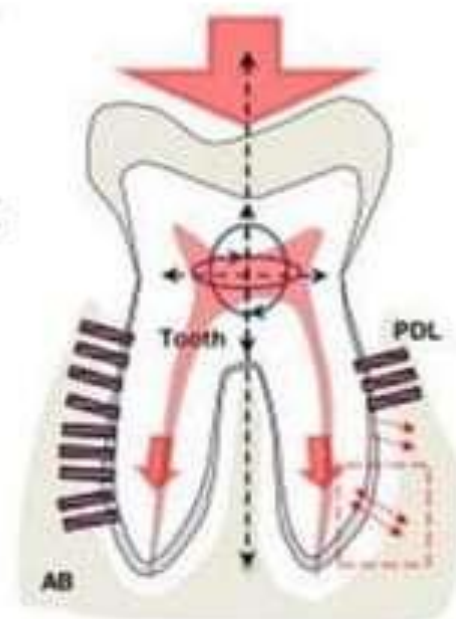
Also Sensory perception

The greatest forces acting on the teeth are normally produced during mastication and deglutition, and they are essentially vertical in direction.

Each thrust is of short duration, and for most people, chewing is restricted to short periods during the day.

Deglutition, on the other hand, occurs about 500 times a day, (POWELL,1963) and tooth contacts during swallowing are usually of longer duration than those occurring during chewing.

Loads of a lower order but longer duration are produced throughout the day by the tongue and circumoral musculature. These forces are predominantly in the horizontal direction.





- It has been calculated that within a 24-hour period the teeth are subjected to the functional forces of mastication and deglutition for a total of some 17.5 minutes.

<b>Chewing</b>	
Actual chewing time per meal	450 sec
Four meals per day	1800 sec
One chewing stroke per sec	1800 strokes
Duration of each stroke	0.3 sec
Total chewing forces per day	540 sec (9 min)
<b>Swallowing</b>	
<b>Meals</b>	
Duration of one deglutition	1 sec
During chewing, three deglutitions per min, one third with occlusal force	30 sec (0.5 min)
<b>Between Meals</b>	
Daytime: 25/hr (16 hr)	400 sec (6.6 min)
Nighttime: 10/hr (8 hr)	80 sec (1.3 min)
<b>Total</b>	1050 sec = 17.5 min

*From Graf H: Bruxism, Dent Clin North Am 13(3):659-665, 1969.*

# BIOMECHANICAL SUPPORT MECHANISMS FOR COMPLETE DENTURES

- The basic challenge in the treatment of edentulous patients lies in the differences between the ways natural teeth and their artificial replacements are supported.



# Mucosal Support & Masticatory Loads

- The mean area of mucosa available for denture support has been calculated to be 22.96 cm<sup>2</sup> in the edentulous maxillae and approximately 12.25 cm<sup>2</sup> in an edentulous mandible.(WATT,1961)
- Hence, area of mucosa available to receive the load from complete dentures is limited when compared with the corresponding areas of support available for natural dentitions.



- The mucosa demonstrates little tolerance or adaptability to denture wearing. This minimal tolerance can still be **reduced further** by the presence of systemic diseases such as **anemia, hypertension, or diabetes, as well as nutritional deficiencies.**
- In fact, any disturbance of the normal metabolic processes may lower the upper limit of mucosal tolerance and initiate inflammation.



- Masticatory loads are much smaller than those that can be produced by conscious effort and are in the region of 44 lb (20 kg) for the natural teeth.(PICTON,1969)
- Maximum forces of 13 to 16 lb (6 to 8 kg) during chewing have been recorded with complete dentures, but the average loads are probably much less than these.
- In fact, maximal bite forces appear to be five to six times less for complete denture wearers than for persons with natural teeth.

# RESIDUAL RIDGE

- The residual ridge consists of denture bearing mucosa, the submucosa and periosteum, and the underlying residual alveolar bone.
- A variety of changes occur in the residual bone after tooth extraction and use of complete dentures.
- When the alveolar process is made edentulous, the alveoli that contained the **roots of the teeth become filled with new bone**, forming the residual alveolar processes. These become the residual ridges and are the foundation for dentures,
- Alveolar bone supporting natural teeth receives tensile loads through a large area of periodontal ligament.



- Whereas the edentulous residual ridge receives vertical, diagonal, and horizontal loads applied by a denture with a surface area much smaller than the total area of the periodontal ligaments of all the natural teeth that had been present
- One of the few firm facts relating to edentulous patients is that wearing dentures is almost invariably accompanied by an undesirable and irreversible bone loss.
- **Two concepts** have been advanced concerning the inevitable loss of residual bone:
  1. Direct consequence of loss of the periodontal structures, variable progressive bone reduction occurs.
  2. Residual bone loss is not a necessary consequence of tooth removal but depends on a series of poorly understood factors.

- Physical factors affecting the denture retention described by (BRILL,1967) are
  1. Maximal extension of the denture base;
  2. Intimate contact of the denture base and its basal seat.
  3. Maximal area of contact between the mucous membrane and denture base
- Muscular factors can be used to increase retention (and stability) of dentures.
- The buccinator, the orbicularis oris , and the intrinsic and extrinsic muscles of the tongue are key muscles.
- Impression techniques the design of the labial, buccal, and lingual polished surfaces of the denture and the form of the dental arch are considered in balancing the forces generated by the tongue and perioral musculature.

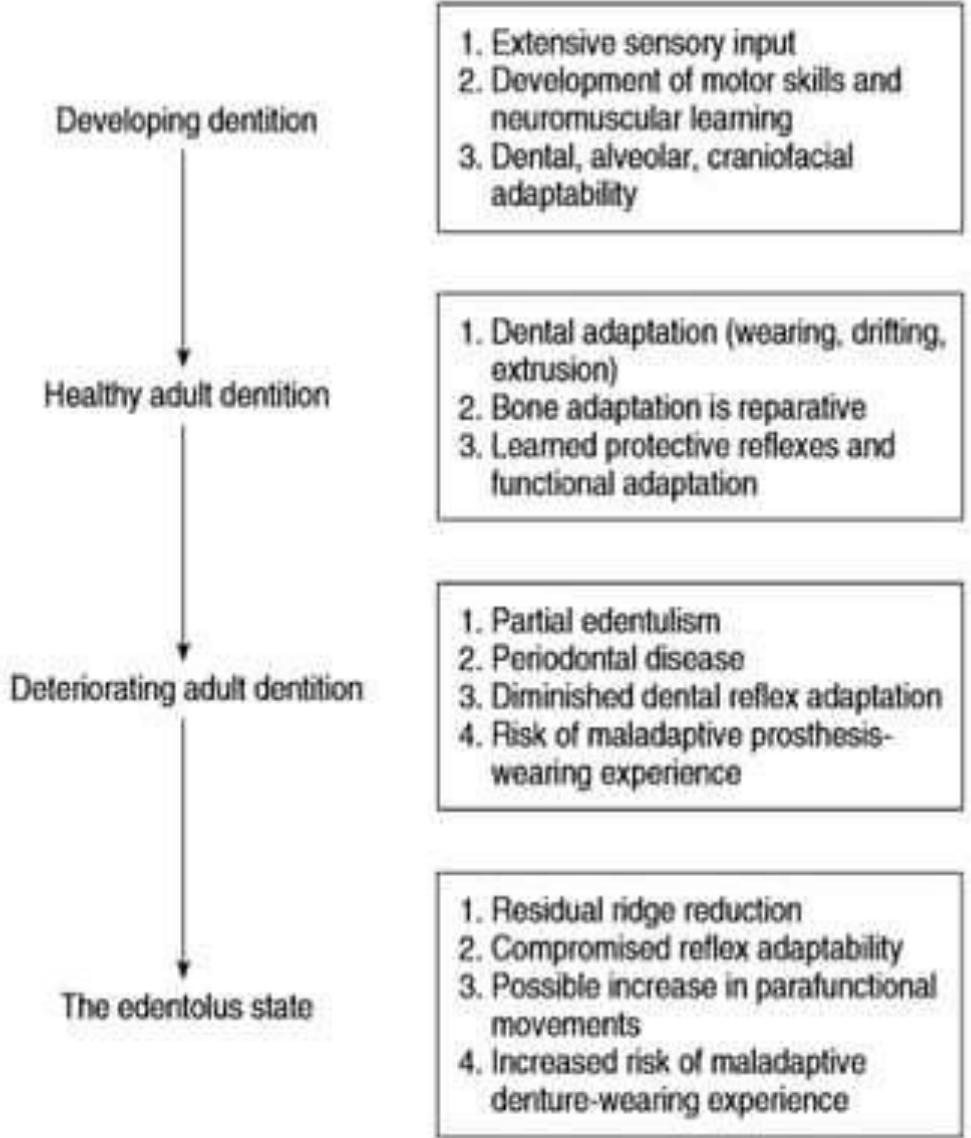
- As the form and size of the denture-supporting tissues (the basal seat) change, the physiologic muscular forces in becomes important for denture retention.
- Following full mouth extractions, the alveolar ridges undergo significant bony changes, with the largest changes seen on the mandibular arch. Studies indicate that the mandibular ridge resorbs approximately four times as much as the maxillary arch.
- The direction of mandibular resorption is downward and outward, while maxillary resorption is upward and inward. The results of this resorptive pattern often force a crossbite of the posterior dentures in order to maintain the dentures over the residual ridges

# **FUNCTIONAL AND PARAFUNCTIONAL CONSIDERATIONS**

# OCCLUSION

- The masticatory system appears to operate best in an environment of continuing functional equilibrium
- Primary components
  - The Dentition
  - The Neuromuscular system
  - The Craniofacial structure
- Complete Denture are designed so that their occlusal surfaces permit both Functional & Para Functional movements of mandible.
- Orofacial & tongue muscles play an important role in retaining and stabilizing complete dentures attained by arranging teeth in “Neutral Zone”

Dentition development is characterized by a period of dental alveolar and craniofacial adaptability, which is also a time when motor skills and neuromuscular learning are developing.





# FUNCTION:MASTICATION & MANDIBULAR MOVEMENTS

- Mastication consists of a rhythmic separation and apposition of the jaws and involves biophysical and biochemical processes, including the use of the lips, teeth, cheeks, tongue, palate, and other oral structures to prepare food for swallowing.
- During masticatory movements, the tongue and cheek muscles play an essential role in keeping the food bolus between the occlusal surfaces of the teeth.
- The maximal bite force in denture wearers is five to six times less than that in dentate subjects.
- Edentulous patients are clearly handicapped in masticatory function, and even clinically satisfactory complete dentures are a poor substitute for natural teeth

- Chewing occur chiefly in the premolar & molar region and both right and left side are used to about the same extent.
  
- The pronounced differences between persons with natural teeth and patients with complete dentures are conspicuous in this functional context:
  - (1) The mucosal mechanism of support as opposed to support by the periodontium
  - (2) The movements of the dentures during mastication.
  - (3) The progressive changes in Maxillo-Mandibular relations.
  - (4) The different physical stimuli to the sensory motor systems.
  
- The denture bearing tissues are constantly exposed to the frictional contact of the overlying denture bases.
  
- Dentures move during mastication because of the dislodging forces of the surrounding musculature.

- These movements manifest themselves as displacing, lifting, sliding, tilting, or rotating of the dentures.
- Furthermore, opposing tooth contacts occur with both natural and artificial teeth during function and parafunction when the patient is both awake and asleep.
- Apparently, tissue displacement beneath the denture base results in tilting of the dentures and tooth contacts on the non chewing side.
- In addition, occlusal pressure on the dentures displaces soft tissues of the basal seat and allows the dentures to move closer to the supporting bone.
- This change of position under pressure induces a change in the relationship of the teeth to each other.

# PARAFUNCTION CONSIDERATION

- Parafunctional habits involving repeated or sustained occlusion of the teeth can be harmful to the teeth or other components of the masticatory system.(RAMFJORD AND ASH,1971)
- Bruxism is common and is a frequent cause of the complaint of soreness of the denture-bearing mucosa.(THOMAS,1968)
- In the denture wearer, parafunctional habits can cause additional loading on the denture-bearing tissues

- The initial discomfort associated with wearing new dentures is known to evoke unusual patterns of behavior in the surrounding musculature.
  - Frequently, the complaint of a sore tongue is related to a habit of thrusting the tongue against the denture.
  - The patient usually is unaware of the causal relationship between the painful tongue and its contact with the teeth.
- Direction , duration and magnitude of forces generated during function and parafunction.

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	<b>Force Generated</b>	
	<b>Direction</b>	<b>Duration and Magnitude</b>
Mastication	Mainly vertical	Intermittent and light Diurnal only
Parafunction	Frequently horizontal as well as vertical	Prolonged, possibly excessive Both diurnal and nocturnal

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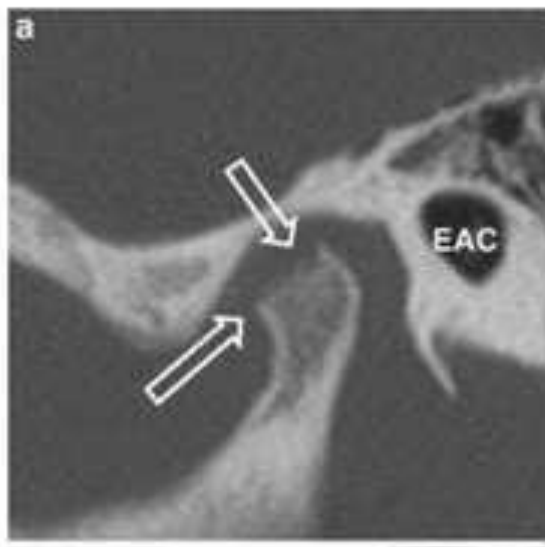
**CHANGES IN MORPHOLOGICAL  
FACE HEIGHT AND THE  
TEMPOROMANDIBULAR JOINTS**





- The terminal stage of skeletal growth is usually accepted as being at 20 to 25 years of age.
- It is also recognized that growth and remodeling of the bony skeleton continue well into adult life and that such growth accounts for dimensional changes in the adult facial skeleton.
- A premature reduction in morphological face height occurs with attrition or abrasion of teeth. This reduction is even more conspicuous in edentulous and complete denture wearing patients.

- Changes in morphological face height or the shapes of the jaw bones due to tooth loss are inevitably transmitted to the TMJs.
- It is not surprising, then, that these articular surfaces undergo a slow but continuous remodeling throughout life.



- Resorption of the residual ridges supporting complete dentures and the consequent reduction in the vertical dimension of occlusion tend to cause a decrease in total face height and a resultant mandibular prognathism.



- Indeed in complete denture wearers, the mean reduction in height of the mandibular process measured in the anterior region may be approximately **four times greater** than that in the corresponding maxillary process

# Occlusion



- The occlusion of complete dentures is designed to harmonize with the primitive and unconditioned reflex of the patient's unconscious swallow.
- Tooth contacts and mandibular bracing against the maxillae occur during swallowing by complete denture patients.
- This suggests that complete denture occlusions must be compatible with the forces developed during deglutition to prevent disharmonious occlusal contacts that could cause trauma to the basal seat of dentures

- In the natural dentition, most functional tooth contacts occur in a mandibular position slightly anterior to centric relation, a position referred to as centric occlusion.
- However, in complete denture prosthodontics, the position of planned maximum intercuspation of teeth is established to coincide with the patient's centric relation.
- **Centric relation** at the established vertical dimension **has potential for change.**
- This change is brought about by alterations in denture-supporting tissues and facial height, as well as by morphological changes in the TMJs



# TEMPOROMANDIBULAR JOINT CHANGES

- The basic physiological relationships between condyles, disks, and glenoid fossae appear to be maintained during maximal occlusal contacts and during all movements guided by occlusal elements.
- It is therefore logical that the dentist should seek to maintain or restore these basic physiological relations when treating a patient with complete dentures.

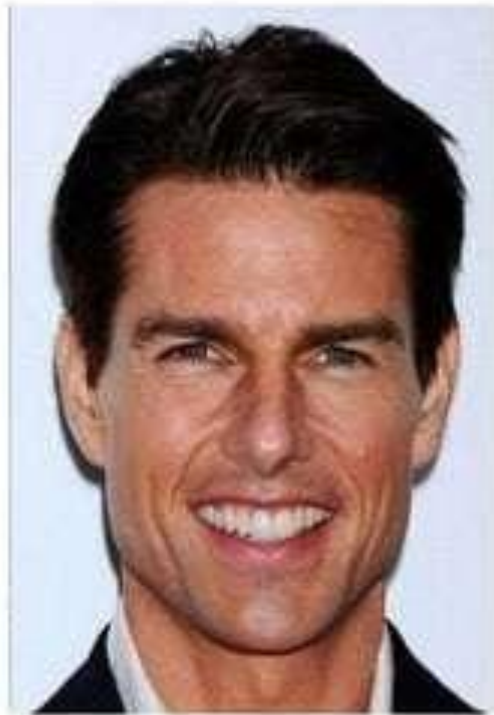
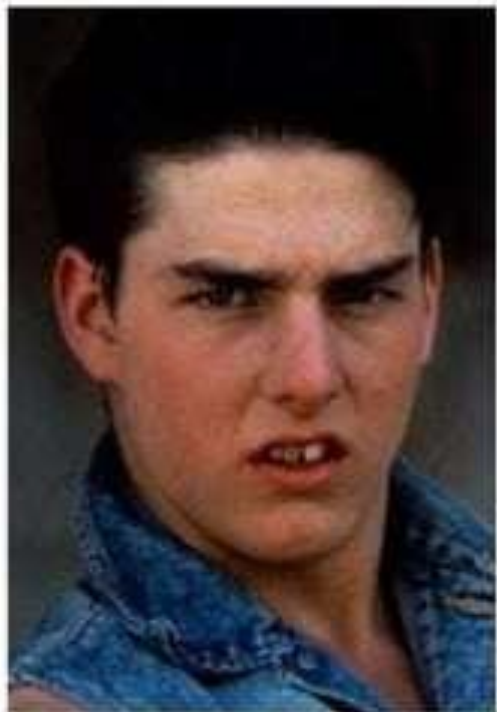




- Researchers have concluded that the passive hinge movement tends to have a constant rotational and reproducible character.
- This reproducibility of the posterior border path is of tremendous practical significance in patients undergoing prosthodontic treatment,
- It also has been reported that impaired dental efficiency resulting from partial tooth loss, inappropriate prosthodontic treatment, or indeed its absence can influence the outcome of temporomandibular disorders (TMDs)

**COSMETIC CHANGES AND  
INDIVIDUAL ADAPTIVE  
RESPONES**

# COSMETIC CHANGES



- Patients seek dental treatment for both functional and aesthetic or cosmetic reasons, and dentists have been successful in restoring or improving many a patient's appearance.

### **Box 1-1 Morphological Changes Associated with the Edentulous State**

Deepening of nasolabial groove  
Loss of labiodental angle  
Decrease in horizontal labial angle  
Narrowing of lips  
Increase in columella-philtral angle  
Prognathic appearance

- Patients should be asked to provide photographs of their pre-edentulous appearance, and relevant details from these photographs should be carefully analysed and discussed with the patient.

# **BEHAVIORAL AND ADAPTIVE RESPONSES**



- The process whereby an edentulous patient can accept and use complete dentures is complex
- That adaptation must take place in the context of the patient's oral, systemic, emotional, and psychological states.
- Emotional factors are known to play a significant role in the etiology of dental problems.
- The patient's ability and willingness to accept and learn to use the dentures ultimately determine the degree of success of clinical treatment.
- Learning means the acquisition of a new activity or change of an existing one.
- The facility for learning and coordination appears to diminish with age.

- Successful management begins with identification of anticipated difficulties before treatment starts and with careful planning to meet specific needs and problems.
- Dentists must train themselves to reassure the patient, to perceive their wishes, and to know how and when to limit the patient's expectations.





- Optimal denture control requires the interpretation of impulses from both exteroceptors and proprioceptors, which are probably affected by the size, shape, position, and mobility of the prostheses and the pressures they generate
- The acceptance of complete dentures is accompanied by a process of habituation, which is defined as a “gradual diminution of responses to continued or repeated stimuli.”
- Storage of information becomes more difficult in older age, which is why patients in this group often have difficulties becoming comfortable with dentures.

- In addition advancing age tends to be accompanied by progressive atrophy of elements in the cerebral cortex and a consequent loss in the facility of coordination
- Patient motivation is also important in dictating the speed at which adaptation to dentures takes place

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# Review Of Literature



# Psychological Aspects of Treating Complete Denture Patients: Their Relation to Prosthodontic Success

Sheldon Winkler, DDS

Journal of Geriatric Psychiatry and Neurology / Vol. 2 / January-March 1989



- Jamieson wrote that

“fitting the personality of the aged patient is often more difficult than fitting the denture to the mouth.”

Success in geriatric dentistry \_ can be the result of building up the patient’s confidence in the dentist, regardless of the quality of the final prosthesis

## Clinical Judgment

Many times, nothing is as important as good clinical judgment in prosthetic diagnosis for the geriatric patient.

Complete dentures should not be constructed if a patient is under extreme physical or mental stress. A patient with advanced degenerative disease is no candidate for complete dentures. Removing possible sources of infection or irritation, such as cariously or periodontally involved teeth or retained roots, is all that is usually necessary.



## The Satisfied Denture Wearer

Geriatric patients satisfied with their old dentures should not be talked into having new dentures constructed. Even if the patients can be convinced that new dentures must be made, the prognosis is extremely poor. They most certainly will object to many of the changes incorporated into new dentures. The only time the patient must be overruled is when severe tissue deterioration has occurred that is directly related to the old dentures.







# Conclusion

- The success of prosthetic treatment is predicated not only on the dentist's manual dexterity but also on the ability to relate to patients and to understand their needs.
- The importance of empathy and correct clinical judgment on the part of the dentist can hardly be overemphasized.



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THANK YOU