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Determinants of occlusal morphology: A review

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Abstract
Occlusal morphology plays a fundamental role in maintaining functional harmony, esthetics, and longevity of the masticatory system. Its determinants are influenced by anatomic, functional, and biomechanical factors that govern tooth form, cusp height, fossae depth, and occlusal contacts. A proper understanding of these determinants is essential for restorative dentistry, orthodontics, and prosthodontics, as they directly affect occlusal stability, mandibular movements, and patient comfort. This review discusses the major determinants of occlusal morphology, their interrelationship, and clinical implications in restorative and prosthodontic practice.

Keywords: Esthetics, determinants, laterotrusive, mediotrusive

Introduction
Similar to other body systems, the masticatory apparatus undergoes continual modifications due to aging, functional stress, physiological wear, and pathological conditions. Occlusion, being a dynamic phenomenon, may adapt favorably to these influences or result in significant dysfunction [1].

The masticatory system, like other human systems, undergoes adaptation, wear, stress, aging, and disease-induced alterations. Occlusion is a dynamic process that can result in either adaptive adaptation or catastrophic dysfunction [2].

According to Beyren, features of occlusion are

- An optimal occlusion should provide multiple stable centric contacts in maximum intercuspation, regardless of the specific maxillomandibular relationship.
- Whenever feasible, occlusal forces should be directed along the long axis of posterior teeth to promote uniform distribution of stresses in the supporting alveolar structures Allow for flexibility within the occlusal contacts retrusive range to prevent the mandible from being forced into a border position during centric occlusion.
- Allow multidirectional freedom of occlusal contacts, enabling group function in lateral movements and anterior guidance in protrusion, thereby supporting favorable force distribution across functional activities.
- Maintain an appropriate vertical occlusion dimension [3].

Additionally, Dawson (1974) put out his ideas for attaining the perfect occlusion

- For functional stability, each tooth must contact harmoniously when the condyles are seated in their most physiologically stable position.
- The anterior guidance should harmonize with the envelope of functional border movements.
- Protrusive mandibular movements should ideally result in disclusion of all posterior teeth, leaving guidance primarily to the anterior segment.
- On the balancing side, posterior teeth should not contact, and on the working side, there should be no posterior interferences with either the condylar boundary motions or the anterior guidance [4].

Determinants of occlusal Morphology

The mandible's motion is regulated by two main structures: The temporomandibular joints (posterior controlling factors) and the anterior teeth (anterior controlling factors). The occlusal anatomy of teeth must harmonize with these controls so that during mandibular movements, the Although they pass near one another, the rear teeth do not make contact Since the posterior teeth lie between the TMJs and anterior teeth, their occlusal form is influenced by both structures to maintain proper function and harmony.

Posterior Controlling Factors (Condylar Guidance)

When the mandible moves forward from centric relation, the condyle travels downward along the articular eminence, with the steepness of this slope influencing the angulation of the pathway. A steeper eminence produces a steeper vertical path, while a flatter one produces a shallower path. This movement angle is called the condylar guidance angle, which is generally greater during lateral movement due to the fossa's medial wall being steeper than its anterior surface. The temporomandibular joints act as in healthy individuals, condylar guidance and posterior regulating elements of mandibular movement are regarded as permanent, unchangeable variables [5].

Anterior Controlling Factors (Anterior Guidance)

The slope of the lingual surfaces of anterior teeth dictates the vertical component of mandibular movement, where a steeper overlap creates a steeper trajectory and a shallower overlap results in minimal guidance. Unlike condylar guidance, anterior guidance is a variable factor that can be altered by dental treatments, tooth wear, habits, or pathology [5].

Vertical Determinants of Occlusal Morphology

The vertical determinants of occlusal morphology are factors that affect cusp heights and fossa depths. Three elements govern a cusp's length and how far it reaches into the depth of an opposing fossa:

- Anterior guidance, or the anterior regulating element of mandibular movement
- Condylar guidance, the posterior regulating element of mandibular movement
- The cusp's proximity to these governing elements

Posterior centric cusps are designed to maintain intercuspal contact while allowing smooth separation during eccentric mandibular movements. In order to achieve this, they need to be sufficiently long to make contact in the intercuspal position without becoming too lengthy to do so during eccentric motions [6].

Cusp Height and Condylar Guidance (Angle of the Eminence)

The condyle lowers along the articular eminence as the mandible protrudes. The steepness of the prominence determines its fall with respect to a horizontal reference plane. The condyle must migrate inferiorly as it shifts anteriorly in proportion to the steepness of the eminence. The condyle, mandible, and mandibular teeth migrate more vertically as a result.

The condyle in Figure 1 deviates at a 45-degree angle from a horizontal reference plane. The anterior guidance is depicted at an equal angle to make vision easier. Cuspal inclination must be less than 45 degrees to prevent premolar A and premolar B from making eccentric contact during a protrusive movement (Figure 1A,B) [6].

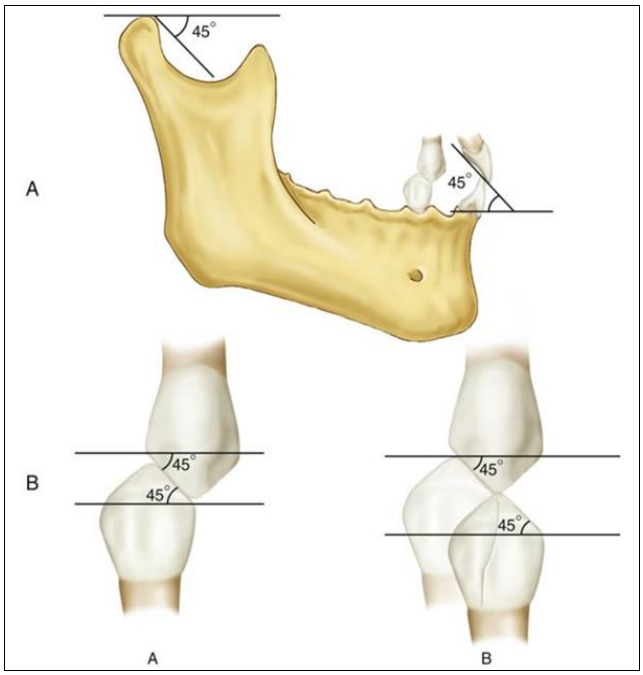

Fig 1: A-B The mandible moves at a 45-degree angle away from the reference plane due to the identical posterior and anterior regulating mechanisms. B, Premolar A must have cuspal inclines of less than 45 degrees in order to disocclude from premolar B during a protrusive action.

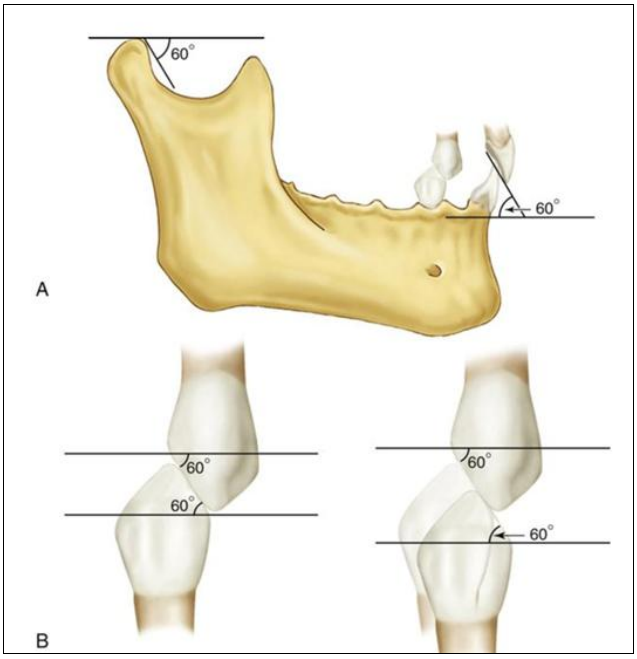

Fig 2: A-B The mandible deviates from the reference plane at a 60-degree angle due to equal posterior and anterior regulating variables. B, Premolar A must have cuspal inclines of less than 60 degrees in order to disocclude from premolar B during a protrusive action. Therefore, steeper posterior cusps are made possible by steeper anterior and posterior regulating elements.

Anterior Guidance's Impact on Cusp Height

The connection between the mandibular and maxillary anterior teeth determines anterior guidance. It is made up of the anterior teeth's horizontal and vertical overlaps. Some combinations of vertical and horizontal overlap appear to demonstrate its impact on mandibular mobility and, consequently, the occlusal form of posterior teeth in Fig 3 [7].

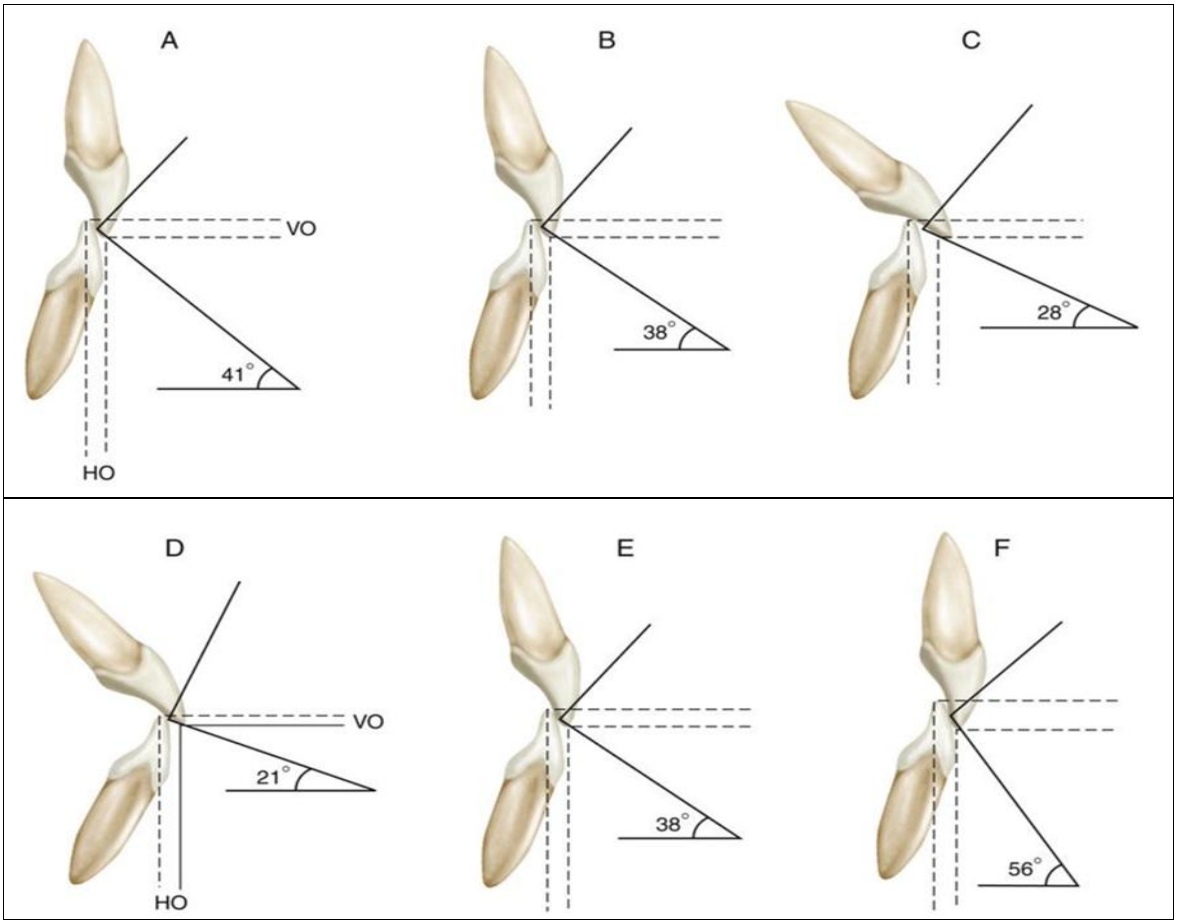

Fig 3: Differences in the horizontal and vertical overlap change the anterior guiding angle. In A-C, the vertical overlap (VO) stays constant while the horizontal overlap (HO) fluctuates. The anterior guidance angle lowers as HO rises. D-F: In this case, the HO stays constant while the VO fluctuates. The anterior guidance angle rises with increasing VO

Effect of cusp height on occlusion plane

The plane of occlusion, formed by the maxillary anterior incisal edge and maxillary posteriors cusps, affects cusp steepness. Depending on how tooth movement of lower arch is compared to occlusal plane, the angle appears different than when measured against the horizontal. A plane more parallel to the eminence requires shorter posterior cusps, while a plane at a steeper angle allows for longer cusps to prevent contact during movement [7].

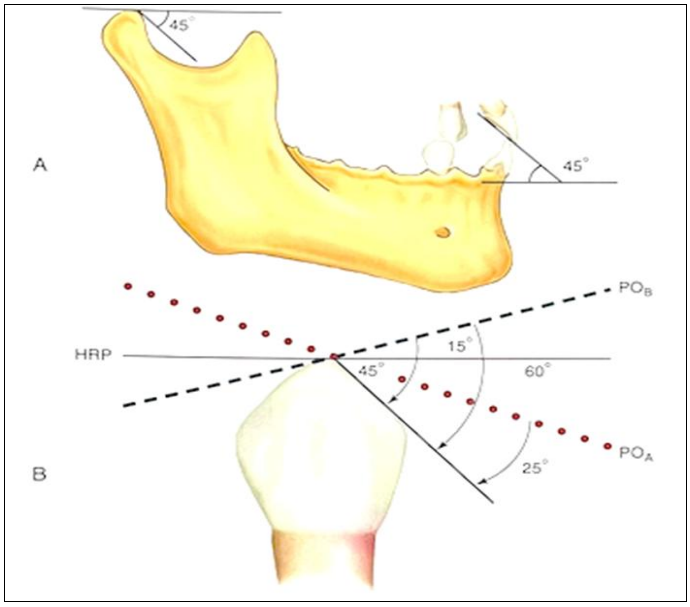

Fig 4: A 45-degree mandibular displacement from the horizontal reference plane (HRP) is produced by the anterior and posterior regulating variables. B. From the reference plane, the tooth travels at a 45-degree angle. The tooth will only deviate from the reference plane by 25 degrees, though, if one plane of occlusion (PO) is inclined. For the cusp to disocclude during protrusive movement, it must be somewhat flat. There is a substantially larger difference between the angle at which the tooth travels during a protrusive movement and another plane ofocclusion (POg) (45 + 15 = 60 degrees). This makes it possible for posterior cusps to be steeper and higher

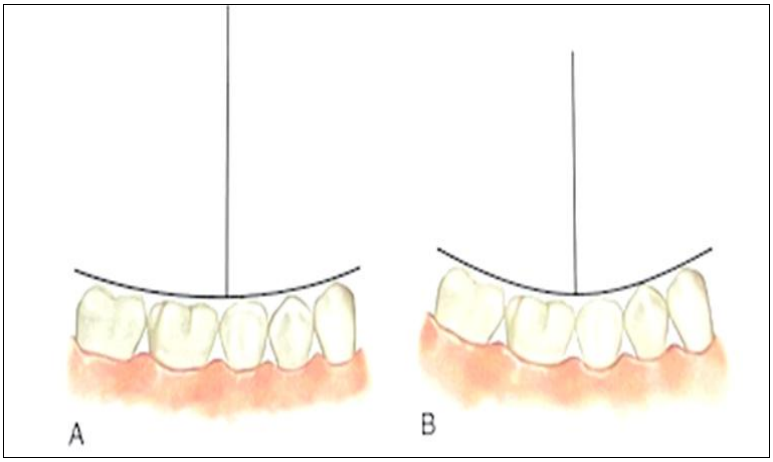

Fig 6: Curve of spee. A flatter plane of occlusion results from a longer radius. B. A more acute plane of occlusion results from a shorter radius

The impact of the spee curve on the height of the cusp

The curve of Spee represents an anteroposterior curvature beginning at the mandibular canine and following the buccal cusp tips of the posterior teeth, with its radius influencing occlusal morphology. A shorter radius produces a sharper curve, increasing the angle at which mandibular teeth separate from maxillary teeth, thus influencing cusp height. The orientation of the curve relative to the horizontal plane also affects cusp morphology:

- When the curve's radius is perpendicular (90°) to the horizontal plane, premolars (mesial) can have longer cusps, while molars (distal) require shorter cusps (In Fig 6A).
- When the curve is rotated forward (radius at ~60°), all posterior cusps, both premolars and molars, must be shorter. (In Fig 6B).
- When the curve is rotated posteriorly, posterior teeth, especially molars, can have longer cusps.

Thus, the curvature and orientation of the curve of Spee act as vertical determinants of posterior cusp height in harmony with mandibular movement [7].

Horizontal Determinants of Occlusal Morphology-

Horizontal determinants of occlusal morphology affect the direction of ridges and grooves on occlusal surfaces and, consequently, cusp placement during eccentric movements. Each central cusp creates laterotrusive and mediotrusive channels on its opposite tooth. Representing arcs of rotation around the working condyle. The angles of these pathways vary according to their relationship with surrounding anatomic structures [8].

Table 1: Vertical determinants of occlusal Morphology (cusp height and Fossa Depth) [9]

Factors	Conditions	Effects
Condylar guidance	The steeper the guidance	The taller the posterior cusps
Anterior guidance	The greater the vertical overlap	The taller the posterior cusps
	The greater the horizontal overlap	The shorter the posterior cusps
Plane of occlusion	The more parallel the plane to condylar guidance	The shorter the posterior cusps
Curve of Spee	The more acute the curve	The shorter most of the posterior cusps
Lateral translation movement	The greater the movement	The shorter the posterior cusps
	The more superior the movement of the rotating condyle	The shorter the posterior cusps
	The greater the immediate side shift	The shorter the posterior cusps

Table 2: Horizontal determinants of occlusal Morphology (Ridge and groove Direction) [10]

Factors	Conditions	Effects
Distance from rotating condyle	Greater the distance	Wider the angle between laterotrusive and mediotrusive pathways
Distance from midsagittal plane	Greater the distance	Wider the angle between laterotrusive and mediotrusive pathways
Lateral translation movement	Greater the movement	Wider the angle between laterotrusive and mediotrusive pathways
Intercondylar distance	Greater the distance	Smaller the angle between laterotrusive and mediotrusive pathways

Clinical Significance

- **Restorative Dentistry:** Proper replication of cusp form prevents occlusal interferences and ensures long-term success of restorations.
- **Prosthodontics:** Balanced occlusion in complete dentures depends heavily on understanding occlusal determinants.
- **TMJ Health:** Prevents undue stress and reduces the risk of temporomandibular disorders (TMD).
- **Orthodontics**
  - Establishing functional anterior guidance and posterior disclusion.
  - Controlling vertical dimension and curve of Spee.
  - Preventing occlusal interferences and TMD.
  - Ensuring stable intercuspation and long-term treatment stability.
  - Guiding appliance design and finishing for functionally harmonious occlusion.

Conclusion

Determinants of occlusal morphology are multifactorial, involving both anterior guidance and posterior guidance, along with occlusal plane and functional movements of the mandible. A thorough understanding of these determinants ensures harmony between restorations, natural dentition, and

mandibular function. Clinicians must consider these principles during diagnosis, treatment planning, and execution to achieve stable, functional, and esthetically pleasing outcomes

Conflict of Interest
Not available

Financial Support
Not available

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