

IMPORTANCE of FORCE in ORTHODONTICS



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CONTENT of the LECTURE

1. Sources of Orthodontic Force

a. Sources of Natural Force

b. Sources of Mechanical Force

2. Properties of Orthodontic Force

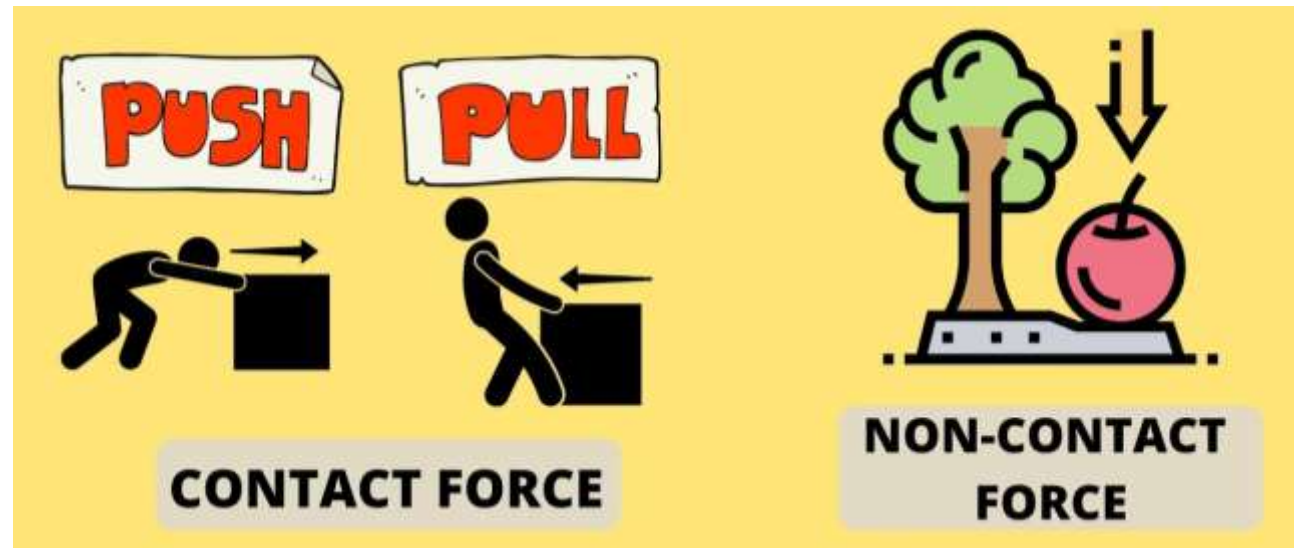
3. Characteristics of Optimal Force



What is FORCE?

In Physics, force is defined as: The push or pull on an object with mass causes it to change its velocity. Force is an external agent capable of changing a body's state of rest or motion.

Simply, it is the effect of one object on another object.



Newton's first law of motion defines the force as;



Every body continues in its state of rest, or of uniform motion in a straight line, unless it is compelled to change that state by FORCES impressed upon it.

Bir cisme dış kuvvet (bileşke kuvvet) etki etmedikçe cisim durgun ise durgun kalacak, hareketli ise sabit hızla doğrusal hareketine devam edecektir.

Ball at rest.

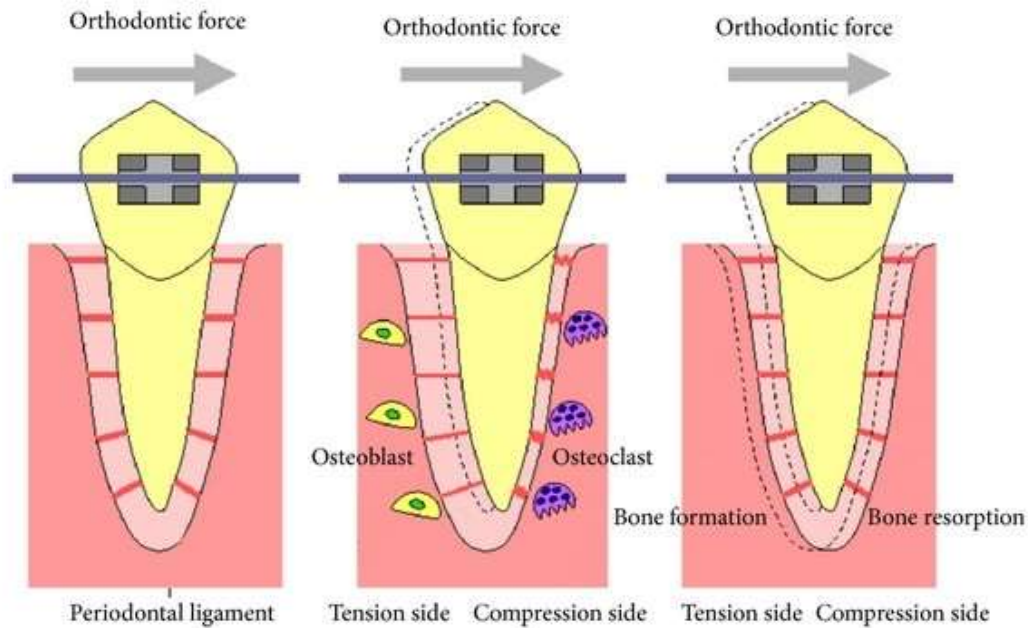
Ball moves only when a force is applied.



Isaac Newton
1643 - 1727

ORTHODONTIC FORCE

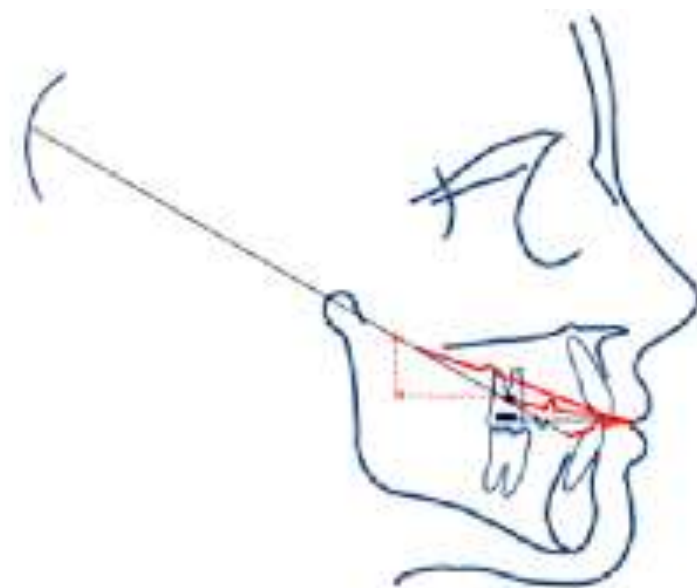
The effect that moves a tooth from one place to another with auxiliary materials such as wires, elastics and screws is called orthodontic force.



ORTHOPEDIC FORCE

The effect that changes the position and form of the maxilla and mandible relative to the cranium with intraoral or extraoral appliances is called orthopedic force.





CONTENT of the LECTURE

1. Sources of Orthodontic Force

a. Sources of natural force

b. Sources of mechanical force

2. Properties of Orthodontic Force

3. Characteristics of Optimal Force



SOURCES OF ORTHODONTIC FORCE

A. Natural (*muscles*)

B. Mechanical (*every kind of orthodontic and orthopedic appliances*)

a. Intraoral

b. Extraoral

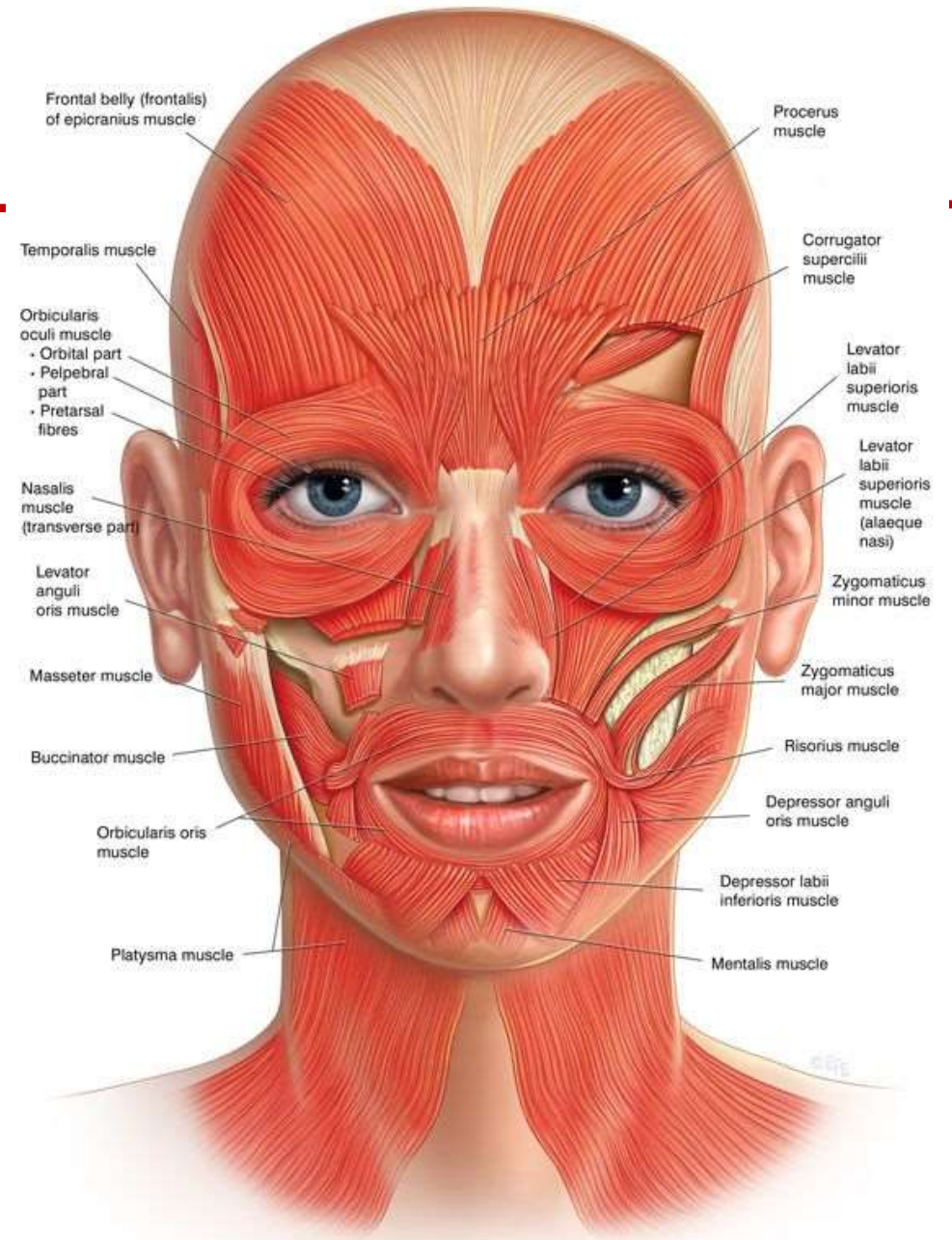
A. Sources of Natural Force

MUSCLES

✓ Masticatory Muscles

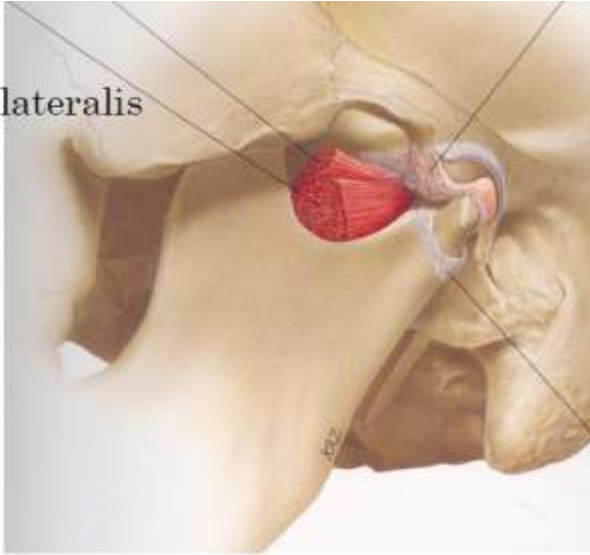
✓ Perioral Muscles

✓ Muscles of Tongue

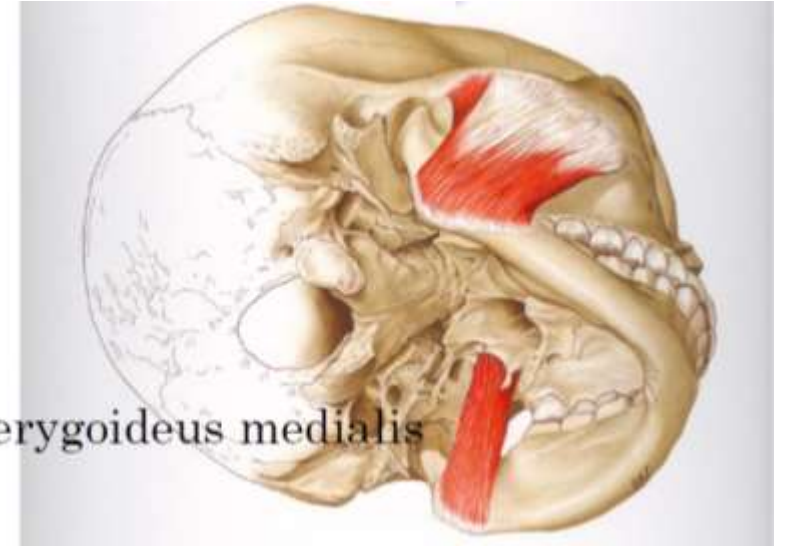


MASTICATORY MUSCLES

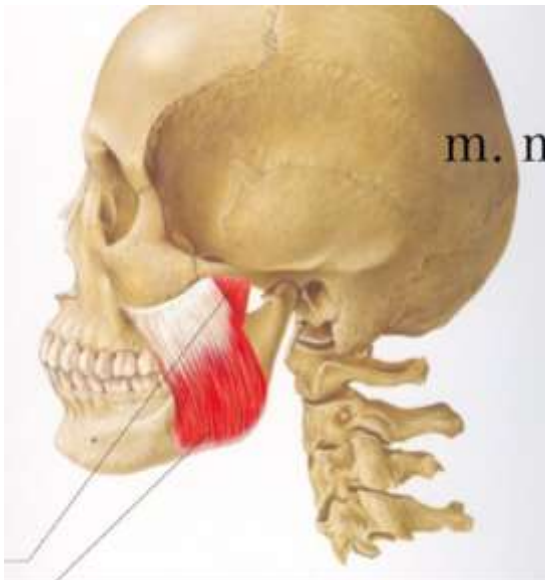
m. pterygoideus lateralis



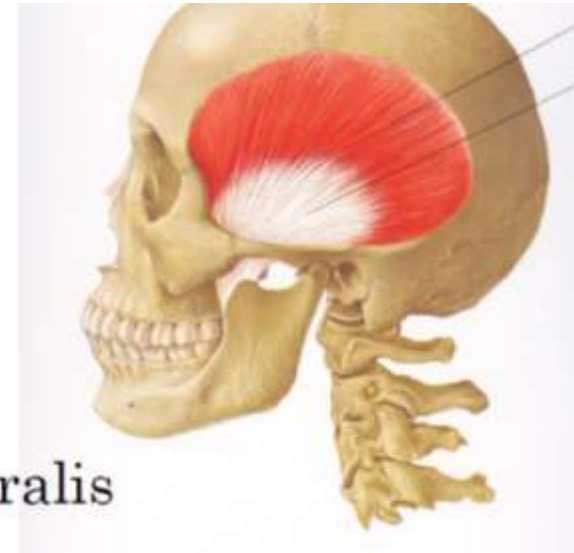
m. pterygoideus medialis



m. massetericus

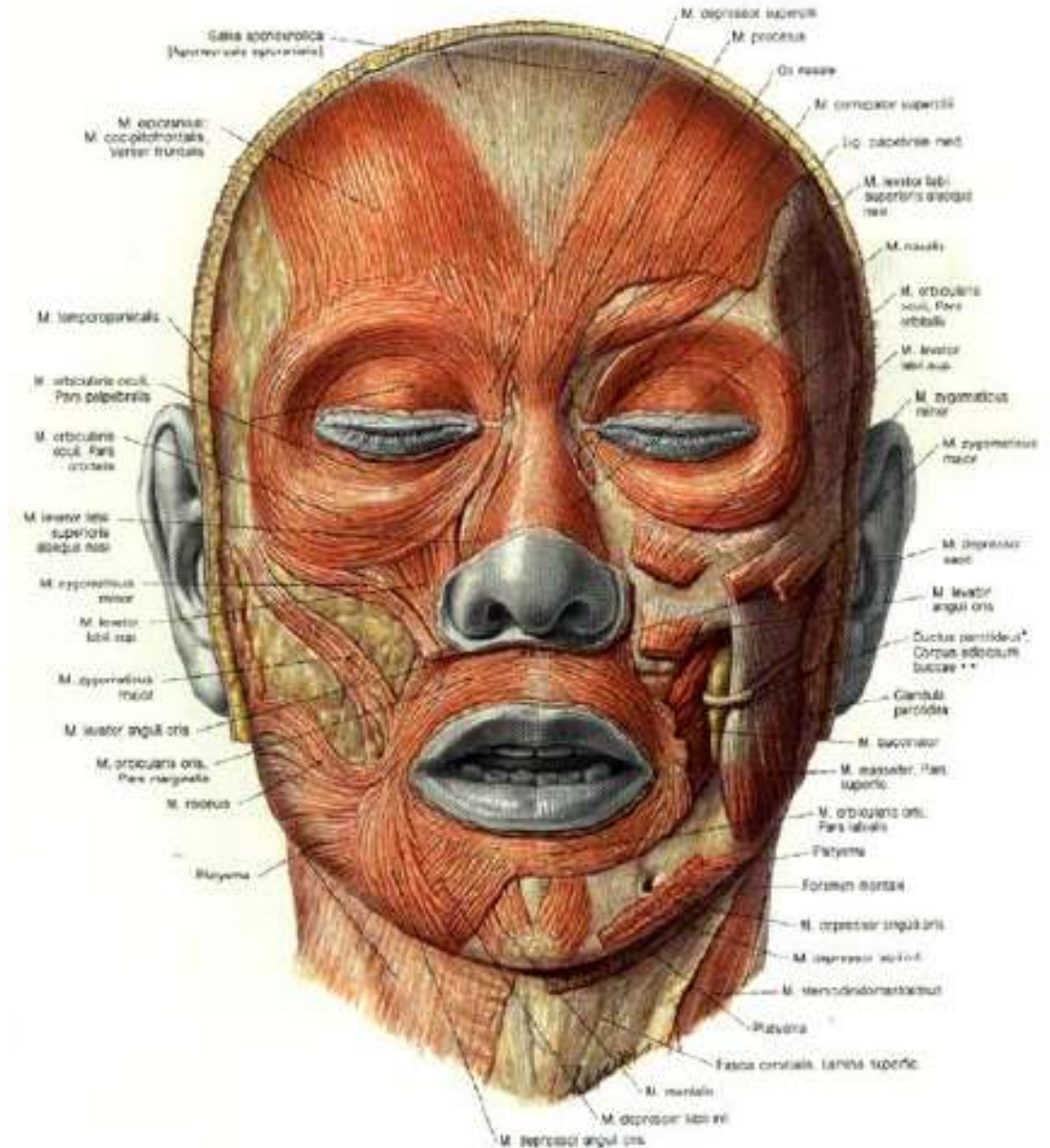


m. temporalis



PERIORAL MUSCLES

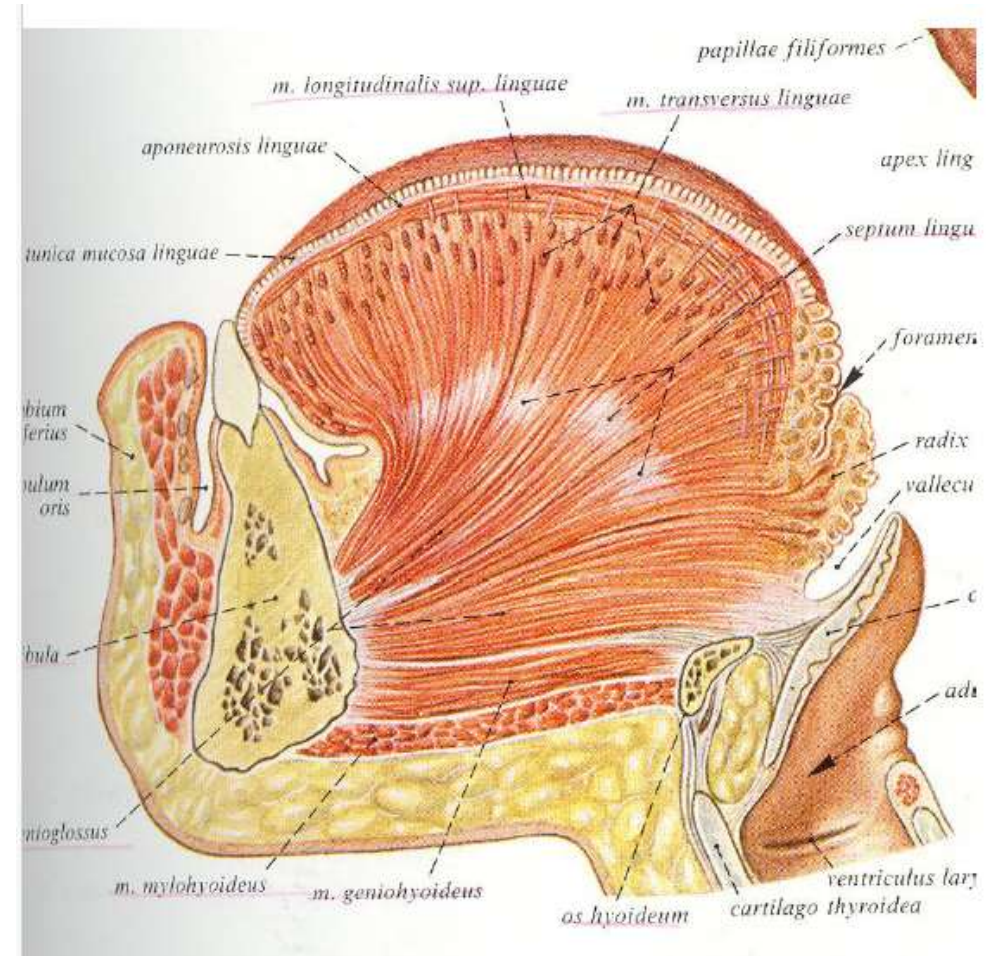
m. orbicularis oris
m. levator labii superior
m. levator anguli oris
m. depressor labii inferior
m. depressor anguli oris
m. zygomaticus major ve minor
m. buccinatorius
m. risorius
m. mentalis
m. platysma



MUSCLES of TONGUE

INNER MUSCLES of TONGUE

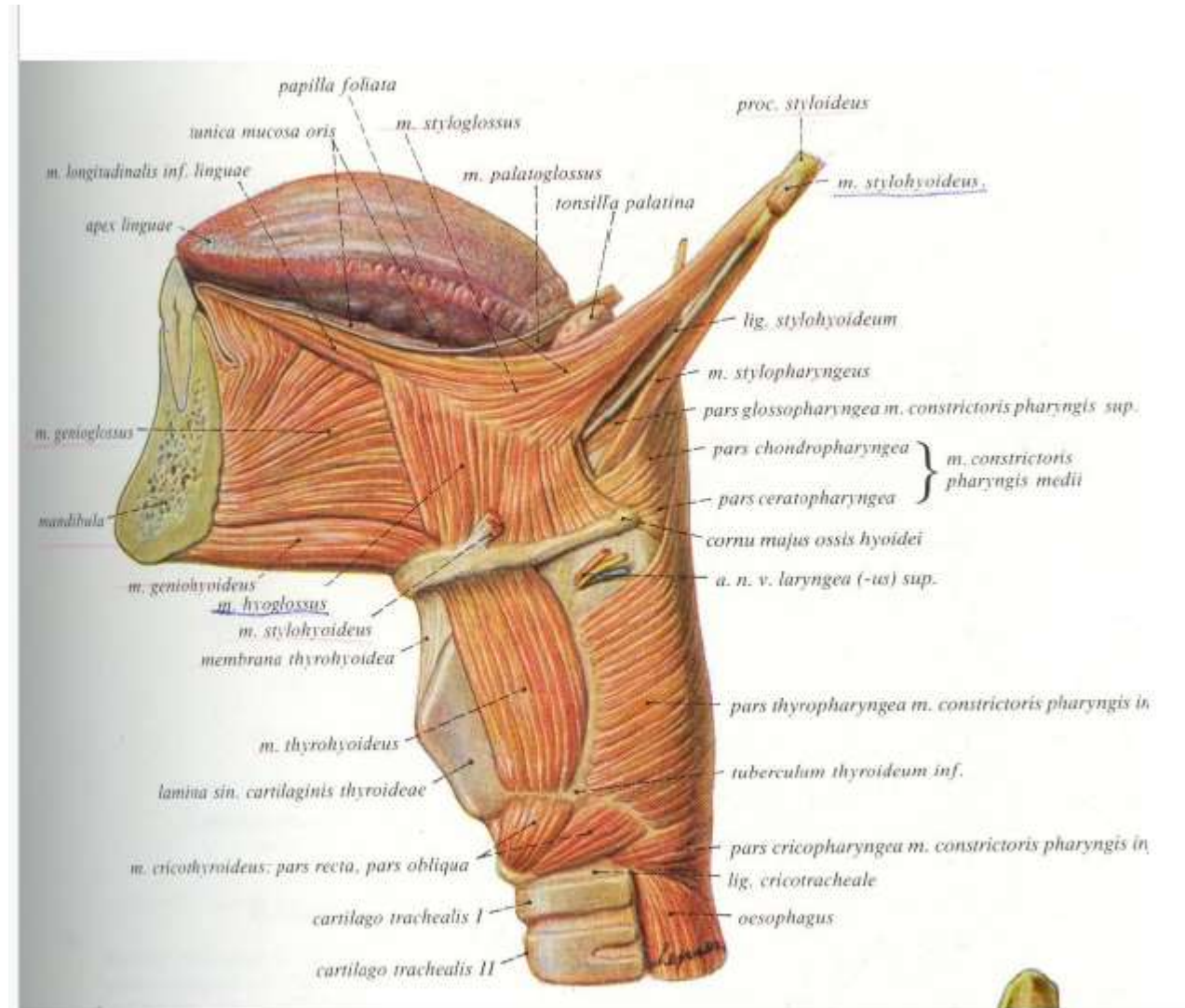
m. longitudinalis inferior
m. longitudinalis superior
m. transversus lingua
m. verticalis lingua



MUSCLES of TONGUE

OUTER MUSCLES of TONGUE

m. genioglossus
m. hyoglossus
m. chondroglossus
m. palatoglossus

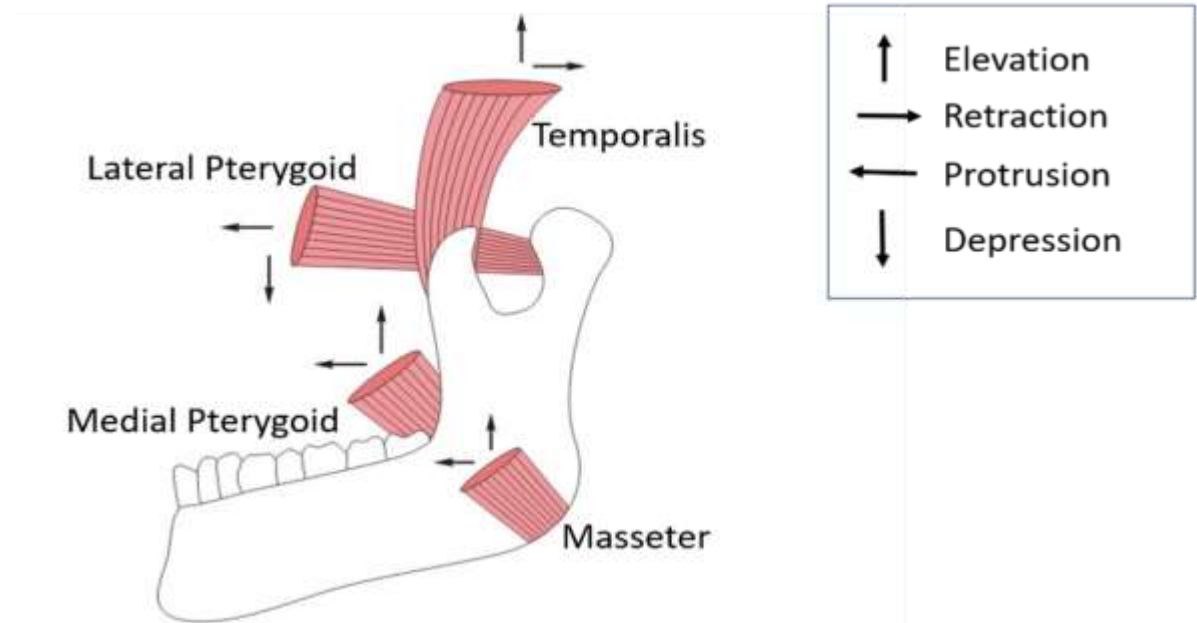


Why the muscles are important for orthodontics?

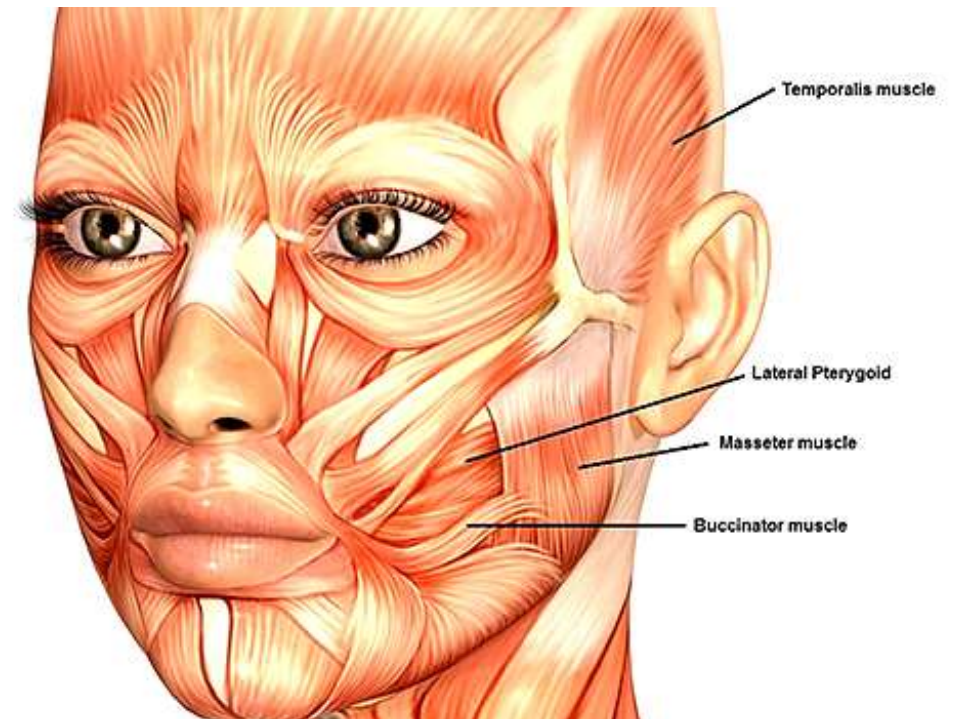
They play a significant role in the etiology of malocclusions.

✓ **Orientation of muscles**

✓ **Activity of muscles**



In Class 1 patients with orthognathic facial profiles all muscles are in a harmony.





Micheal Phelps
Swimmer

High-Angle



Hyperdivergency

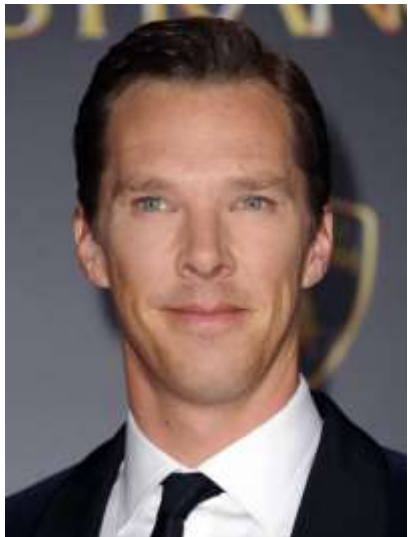
Low-Angle



Hypodivergency



Jackie Kennedy
USA First Lady



Benedict Cumberbatch
Actor



Ed Sheeran
Musician

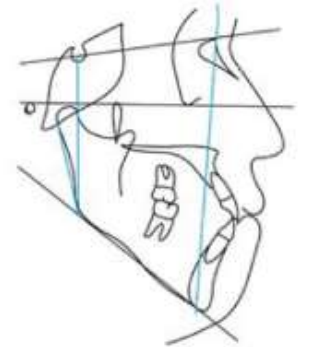
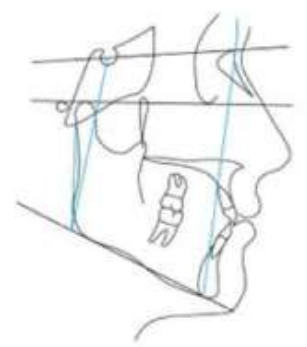
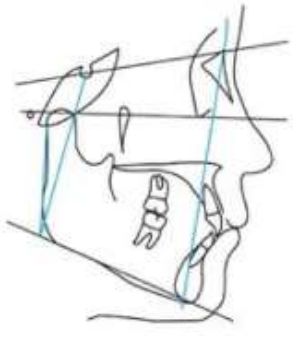
RESEARCH



Correlation of masticatory muscle activity and occlusal function with craniofacial morphology: a prospective cohort study

Yu Jung Yoon¹ · Ju-Young Kang¹ · Kyung-Ho Kim¹ · Jung-Yul Cha¹ · Hyung Joon Ahn² · Yoon Jeong Choi¹

Participants with **hypodivergent** facial profiles may have a greater occlusal function and consequently **greater masticatory muscle efficiency** compared with participants with hyper- and normodivergent profiles.

Hyperdivergent group	Normodivergent group	Hypodivergent group
		
		
Facial height ratio (%)56.9	Facial height ratio (%)66.2	Facial height ratio (%)77.3
Gonial angle (°)129.6	Gonial angle (°)123.7	Gonial angle (°)112.5
Ramus height (mm)40.5	Ramus height (mm)51.3	Ramus height (mm)67.0
Mandibular plane angle (°)42.3	Mandibular plane angle (°)35.7	Mandibular plane angle (°)21.6

Mandibular muscle morphology in children with different vertical facial patterns: A 3-dimensional computed tomography study

Hong Jin Chan,^a Michael Woods,^b and Damien Stella^c
Melbourne and Victoria, Australia

Am J Orthod Dentofacial Orthop 2008;133:10.e1-10.e13

Conclusions: Three-dimensional CT can be used for the assessment of soft- and hard-tissue dentofacial forms. Clinicians should note the potential differences in muscle cross-sectional area, volume, and orientation in subjects with different underlying vertical facial patterns.

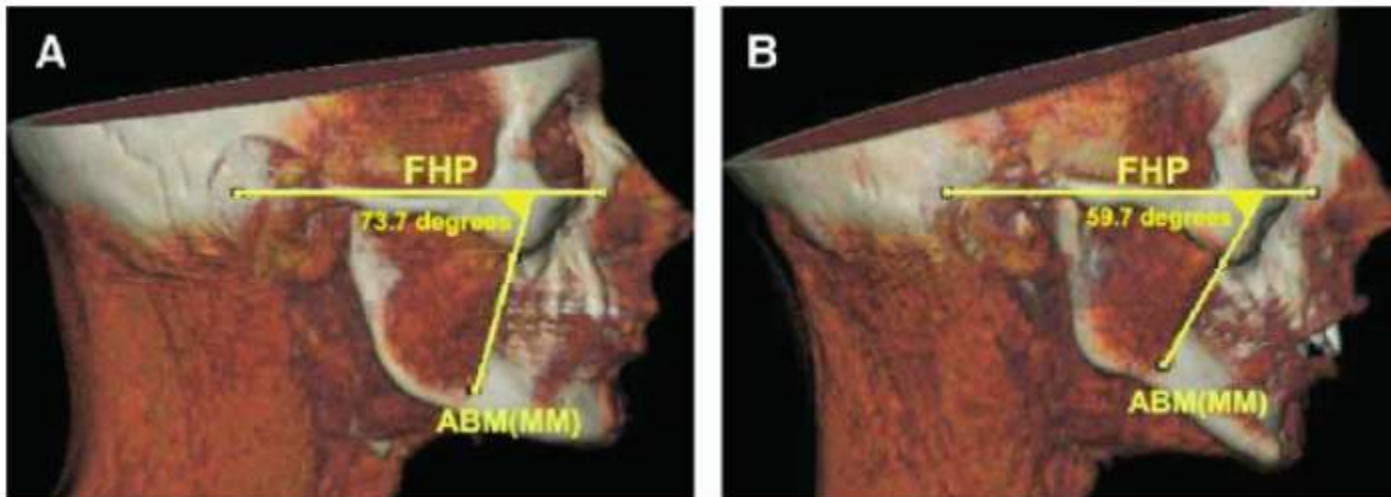
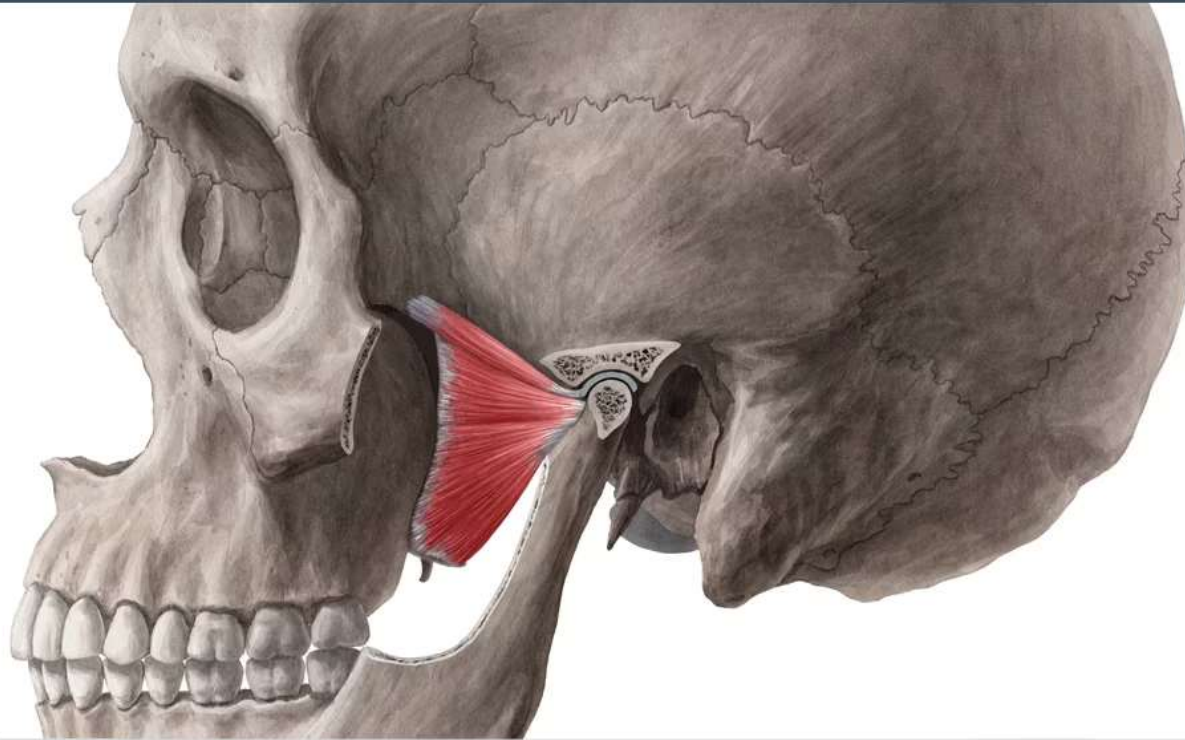


Fig 7. Extremes of underlying vertical facial patterns. A, Brachyfacial; angle between FHP and masseter anterior border is 73.7°; B, dolichofacial; angle between FHP and masseter anterior border is 59.7°.

This figure was uploaded by [Michael G Woods](#)

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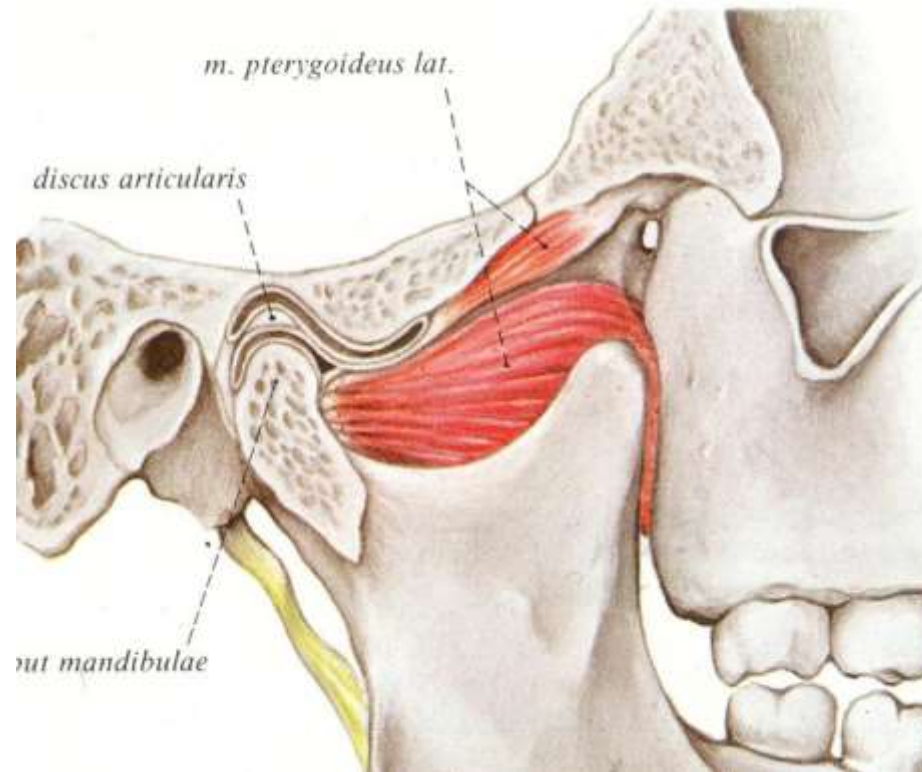
Lateral pterygoid



The **upper head** originates on the infratemporal surface and infratemporal crest of the greater wing of the sphenoid bone. It inserts onto the articular disc and fibrous capsule of the temporomandibular joint.

The **lower head** originates on the lateral surface of the lateral pterygoid plate. It inserts onto the pterygoid fovea at the neck of the condyloid process of the mandible.

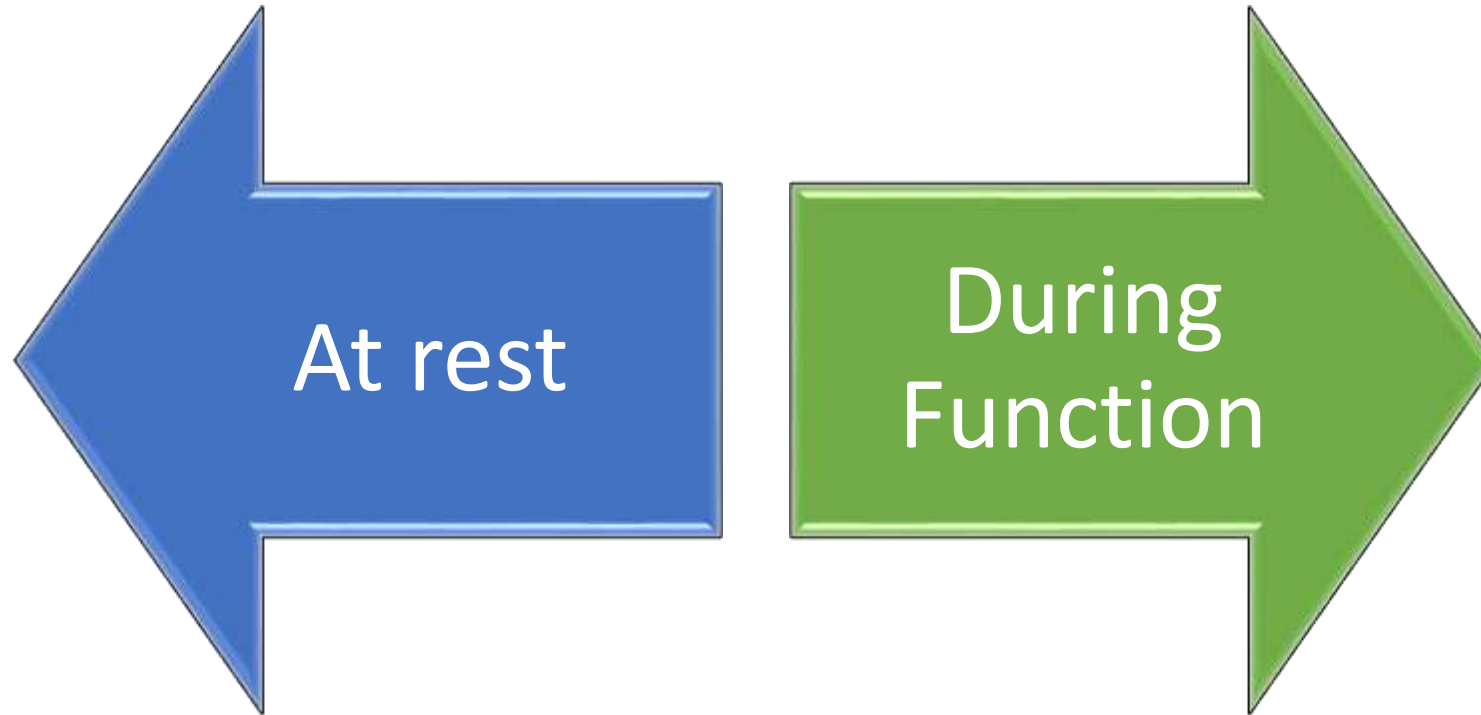
Orientation of Muscles



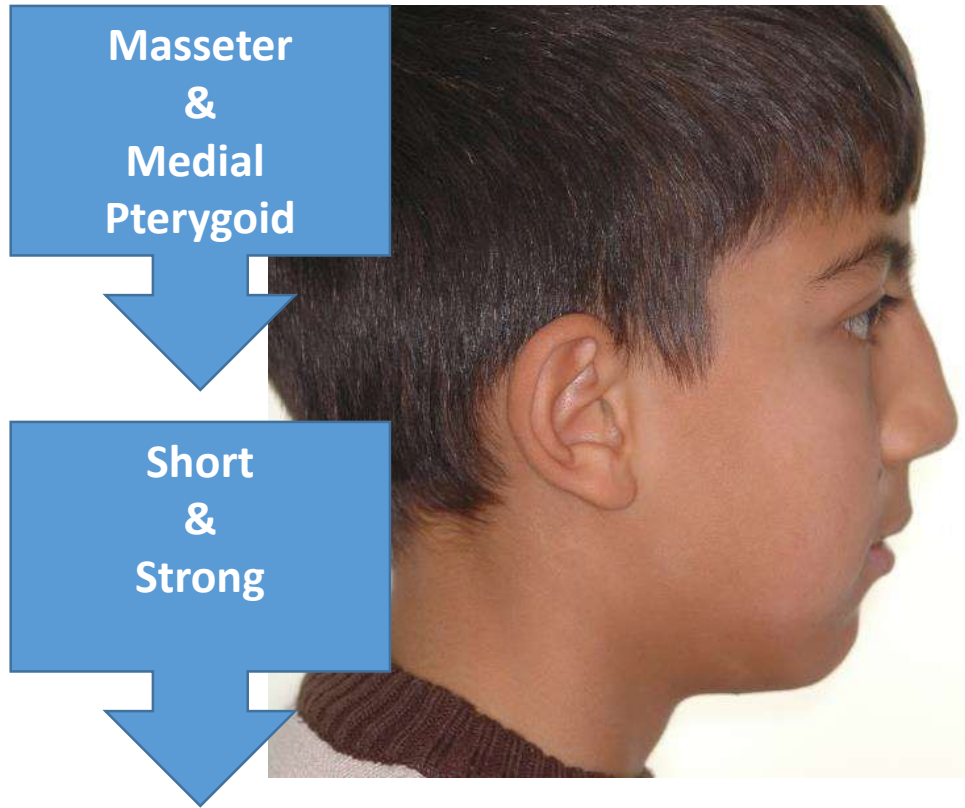
Lateral pterygoid is shorter in patients with **Class 2 anomaly** (mandibular retrognathia) – as the mandible is positioned backwards in relation with the Cranium

Lateral pterygoid muscle is longer in patients with **Class 3 anomaly** (mandibular prognathia) – as the mandible is positioned forward in relation with the Cranium

Activity of Muscles



HYPERDIVERGENCY



Posterior tooth eruption is more

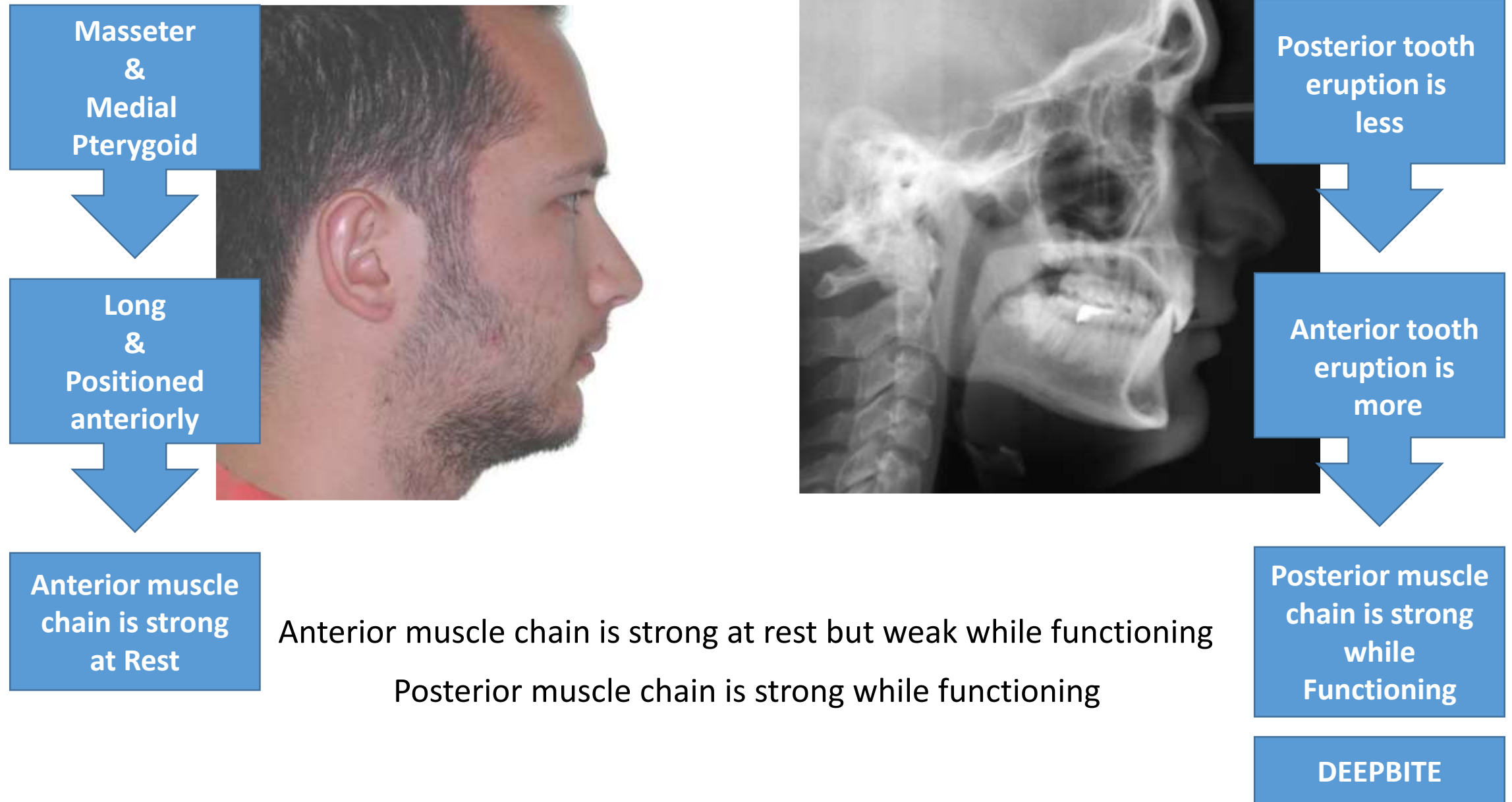
Anterior tooth eruption is less

Anterior muscle chain is strong while functioning

OPENBITE

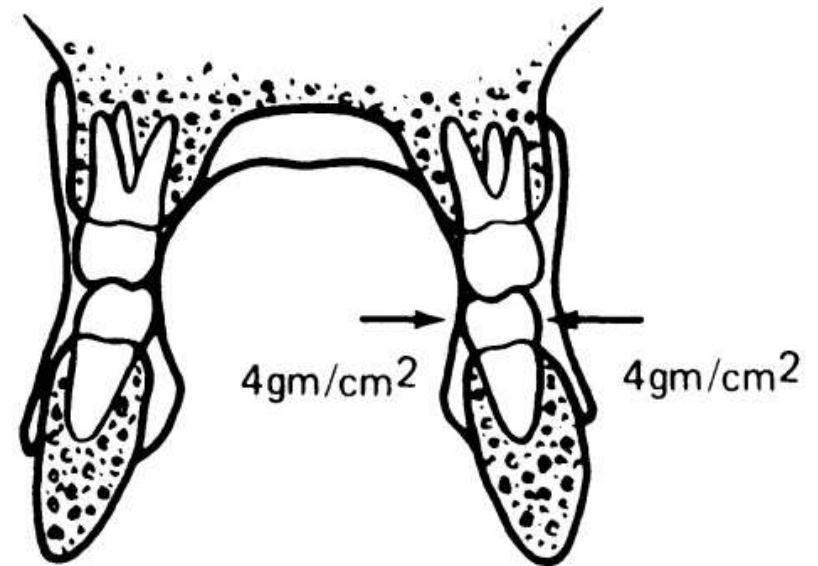
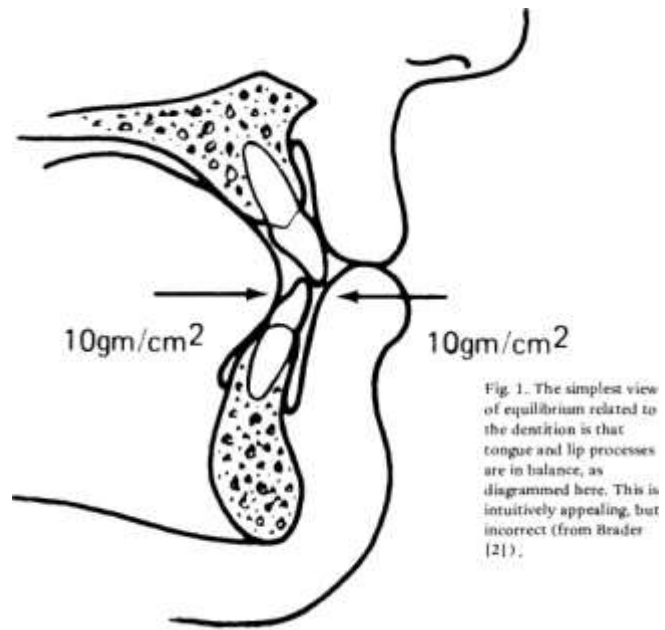
Posterior muscle chain is strong at rest but weak while functioning
Anterior muscle chain is strong while functioning

HYPODIVERGENCY



Muscle Balance Theory

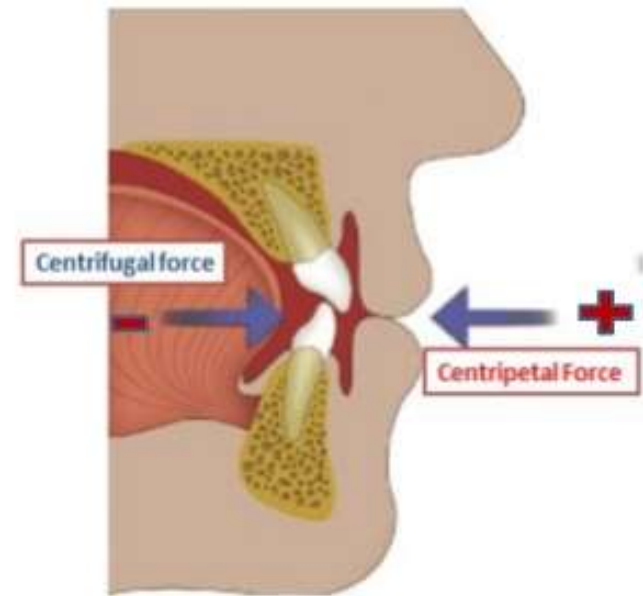
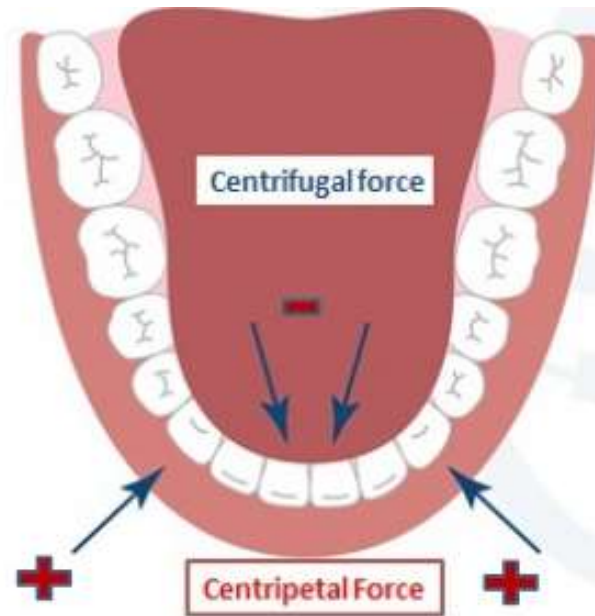
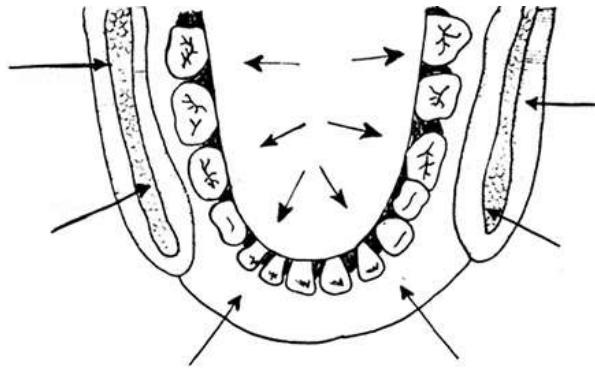
Teeth are surrounded anteriorly by lips outside and tongue inside;
posteriorly by cheek outside and tongue inside



William R. Proffit. Equilibrium Theory Reexamined: To What Extent Do Tongue and Lip Pressures Influence Tooth Position and Thereby the Occlusion? Oral Physiology and Occlusion, 1978.

Muscle Balance Theory

Normally, the muscles on these two sides apply equal force on the teeth from outside to inside and from inside to outside.



Muscle Balance Theory

However, if this balance is disrupted in favor of the tongue, diastema occurs between the teeth.



Muscle Balance Theory

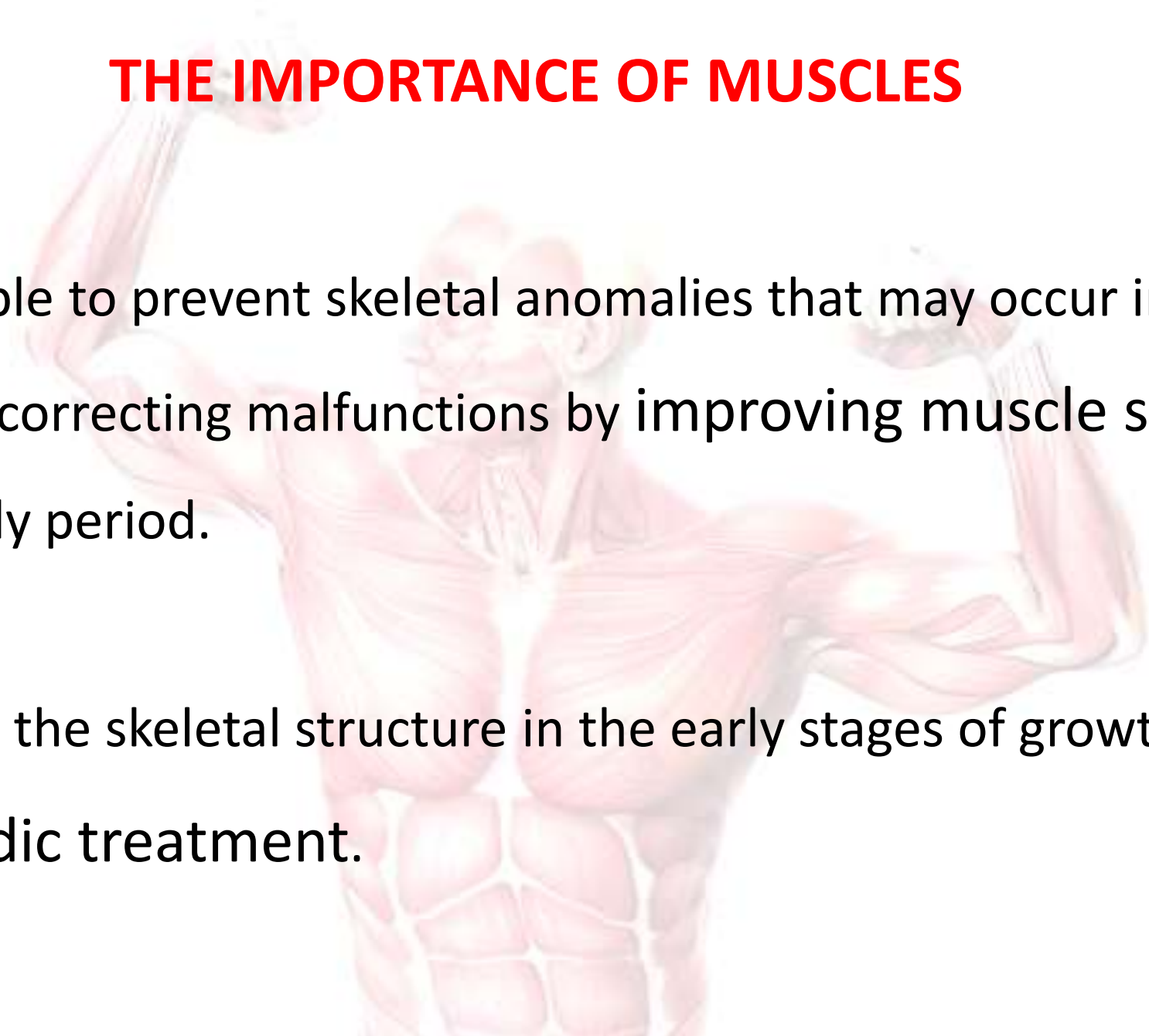
If the balance is disturbed in favor of the lips and cheeks, crowding occurs between the teeth.



THE IMPORTANCE OF MUSCLES

It is possible to prevent skeletal anomalies that may occur in the future by correcting malfunctions by improving muscle strength in the early period.

Healing in the skeletal structure in the early stages of growth is called orthopedic treatment.



FUNCTIONAL APPLIANCES USED IN CLASS II MALOCCLUSION TREATMENT

✓ VESTIBUL SHIELD

✓ ACTIVATOR



FUNCTIONAL APPLIANCES USED IN CLASS III MALOCCLUSION TREATMENT



Lip bumper



Class III Monoblock

ORTHOPEDIC APPLIANCES USED IN CLASS III MALOCCLUSION TREATMENT



CHIN CUP

FUNCTIONAL APPLIANCES USED IN OPENBITE TREATMENT



TONGUE CRIB

FUNCTIONAL APPLIANCES USED IN OPENBITE TREATMENT



Openbite activator

SOURCES OF ORTHODONTIC FORCE

A. Natural (*muscles*)

B. Mechanical (*every kind of orthodontic and orthopedic appliances*)

a. Intraoral

b. Extraoral

Mechanical Sources of Force

INTRAORAL

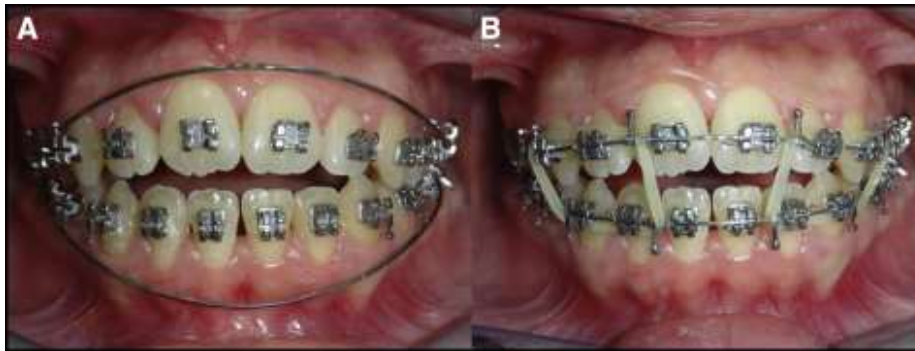


EXTRAORAL



Mechanical Sources of Force

INTRAORAL



Arch wires
Elastics
Protusion springs
Expansion screws

- Only the movement of the teeth is the orthodontic effect
- Orthodontic effect is provided by intraoral mechanical elements

CONTENT of the LECTURE

1. Sources of Orthodontic Force

a. Sources of natural force

b. Sources of mechanical force

2. Properties of Orthodontic Force

3. Characteristics of Optimal Force



Properties of Orthodontic Force

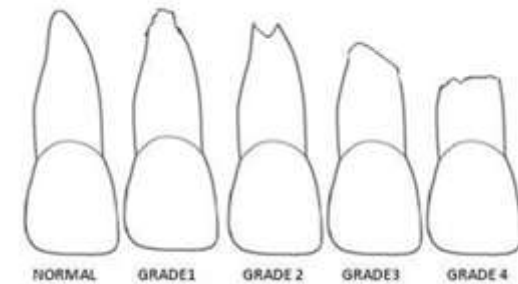
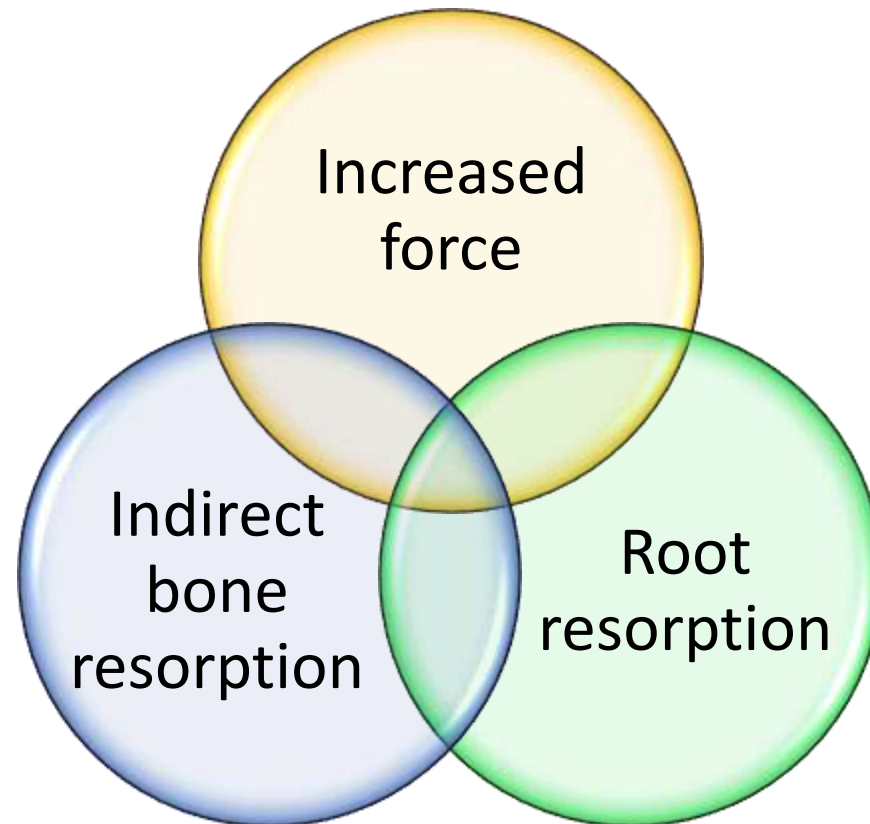
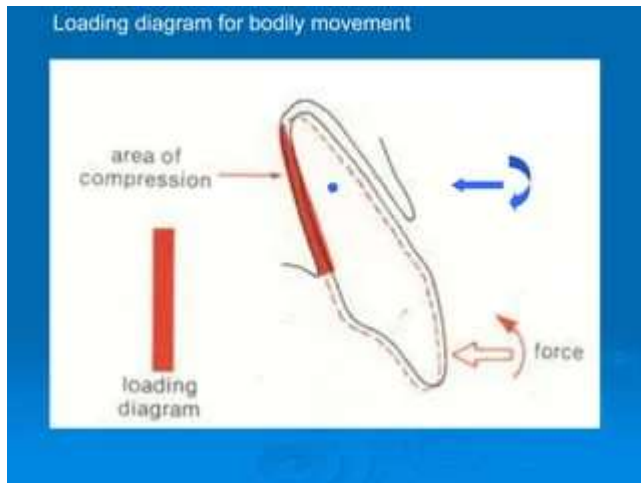
There are 4 properties of orthodontic force;

Şiddeti	Degree
Dağılımı	Distribution
Yönü	Direction
Süresi	Duration

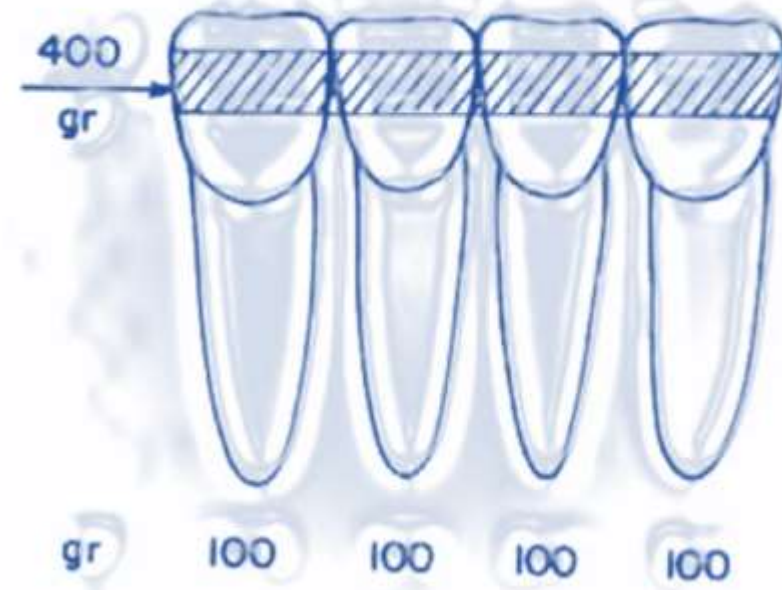
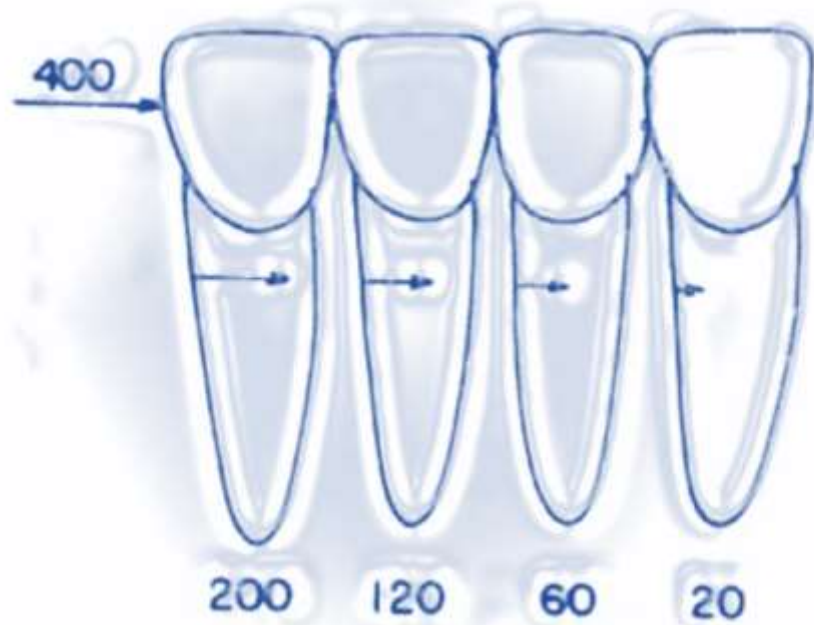
DEGREE of ORTHODONTIC FORCE

In order for a tooth to move, it is necessary to apply more force to the tooth than the resistance of its periodontium.

However;



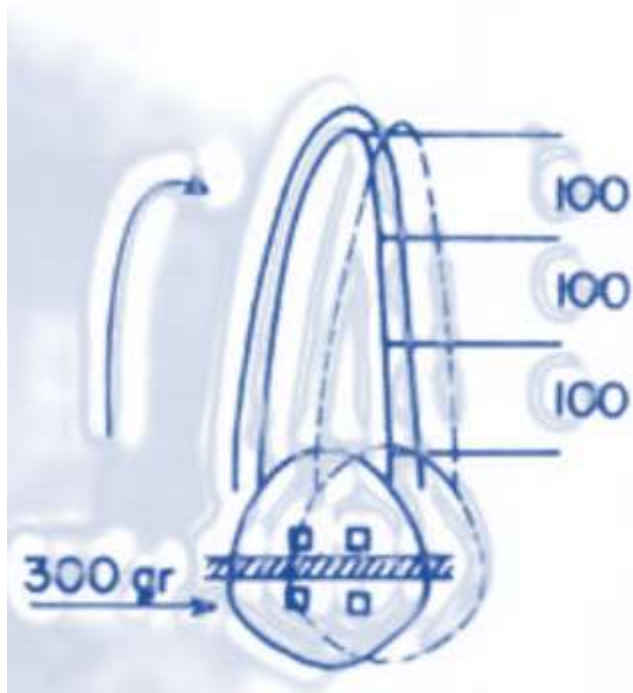
DISTRIBUTION of ORTHODONTIC FORCE



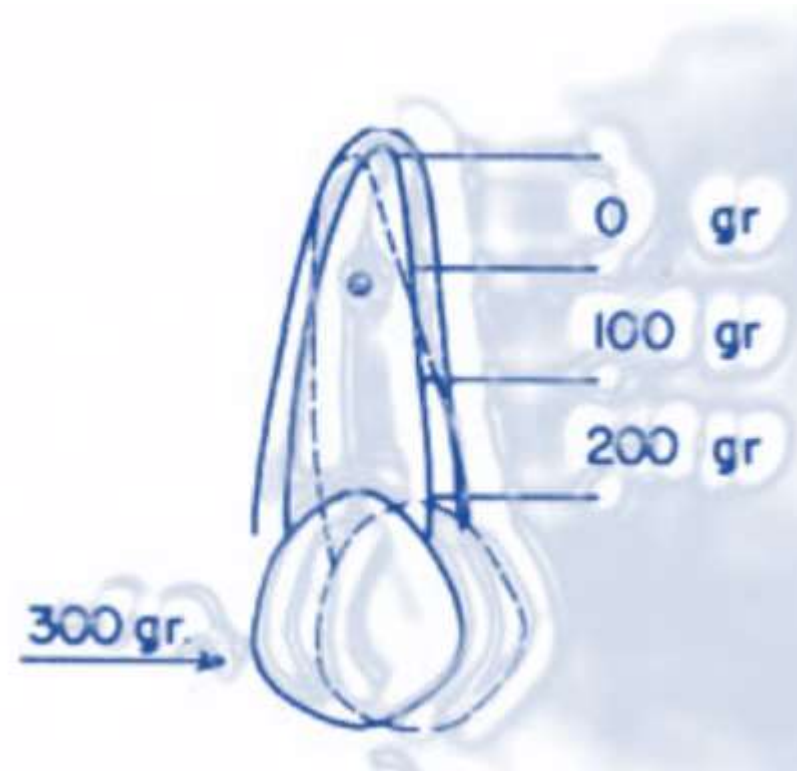
The force affecting one tooth spreads to neighboring teeth via transseptal fibers.

DISTRIBUTION of ORTHODONTIC FORCE

Parallel Movement

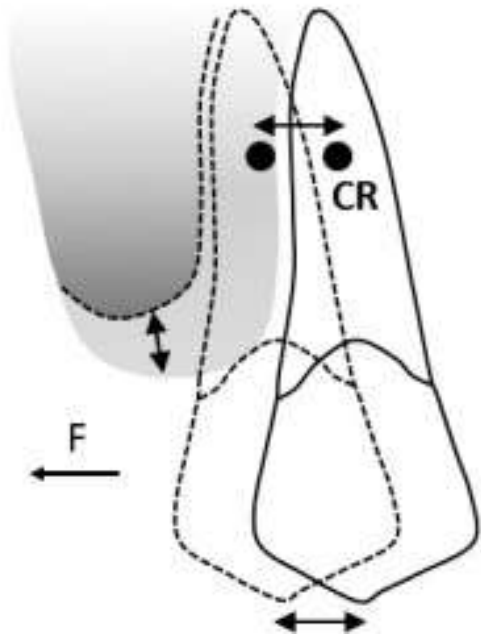


Tipping Movement

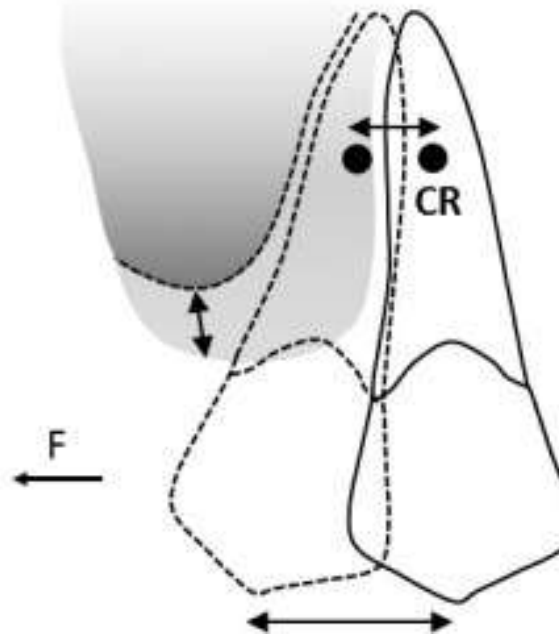


DISTRIBUTION of ORTHODONTIC FORCE

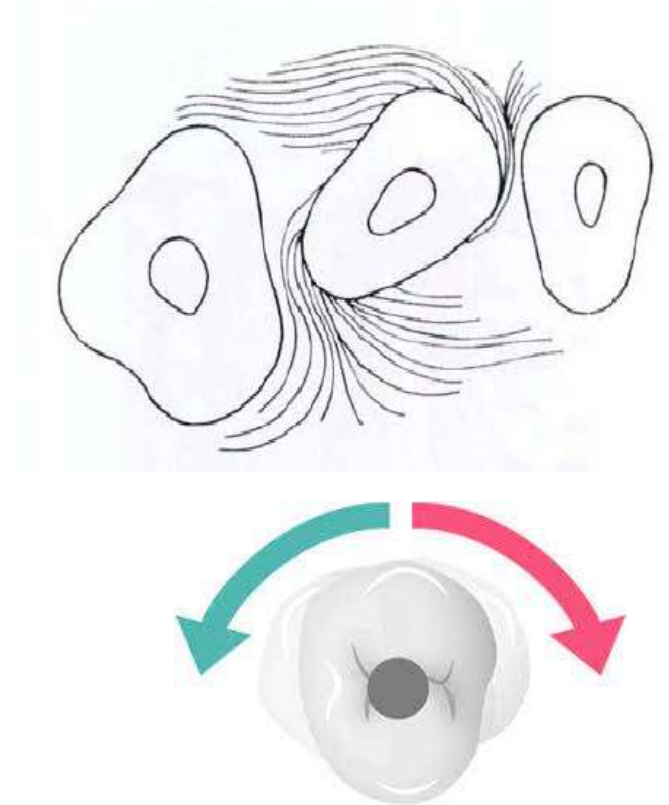
A Bodily movement



B Tipping movement



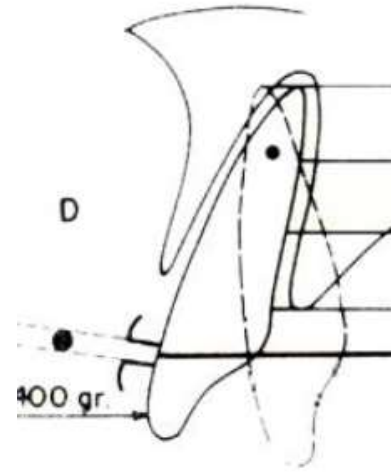
C Rotation movement



DIRECTION of ORTHODONTIC FORCE

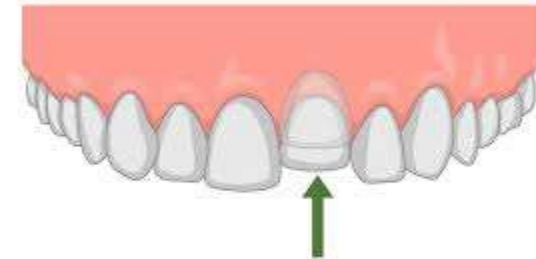
SAGITTAL DIRECTION

- Distalization and mesialization of molars
- Protrusion and retraction in incisors



VERTICAL DIRECTION

- Intrusion
- Extrusion



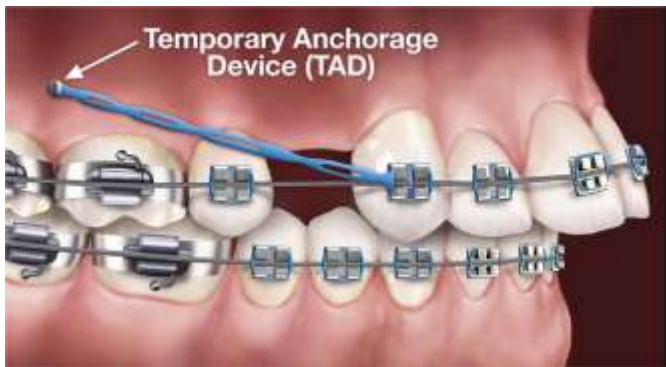
TRANSVERSAL DIRECTION

- Buccal
- Lingual



DURATION of ORTHODONTIC FORCE

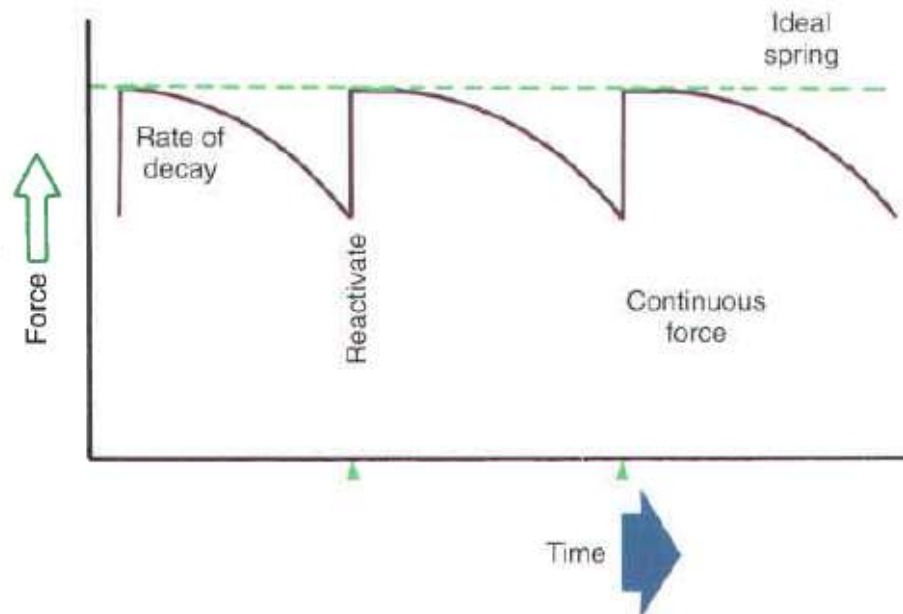
1. Continuous (Devamlı)
2. Interrupted (Kesikli)
3. Intermittent (Aralıklı)



1. Continuous Force

The force intensity is initially high and decreases over time. But, it never resets or disappears

Example: coil springs and forces applied from temporary anchorage devices

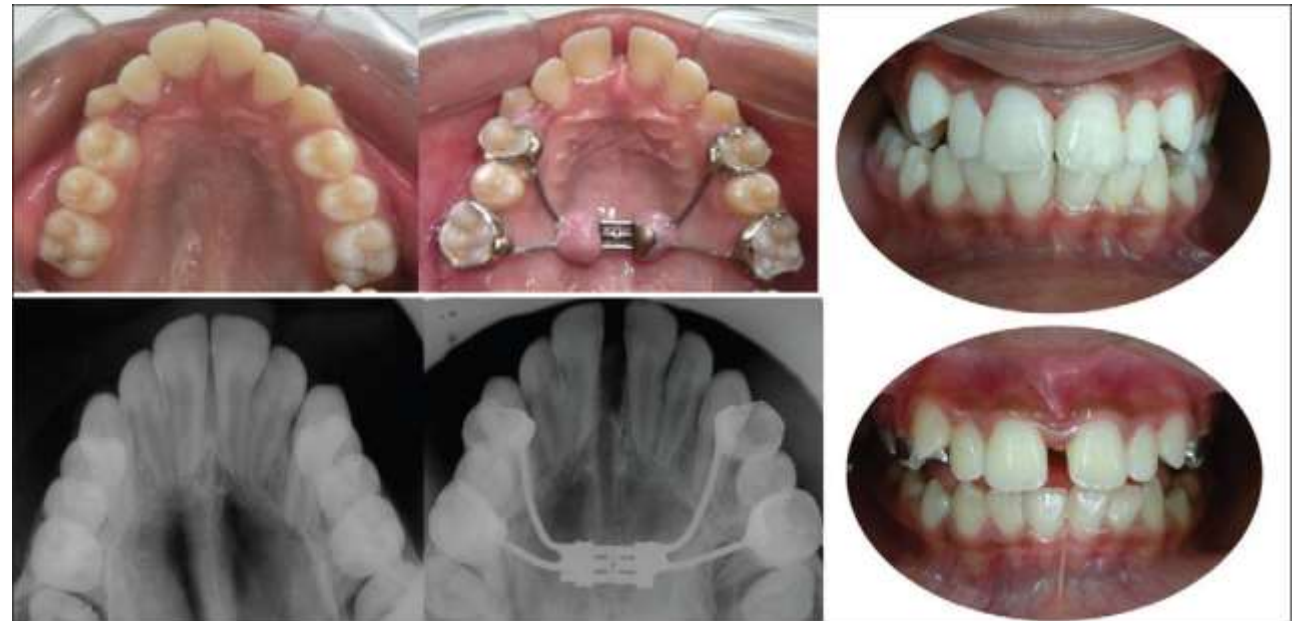
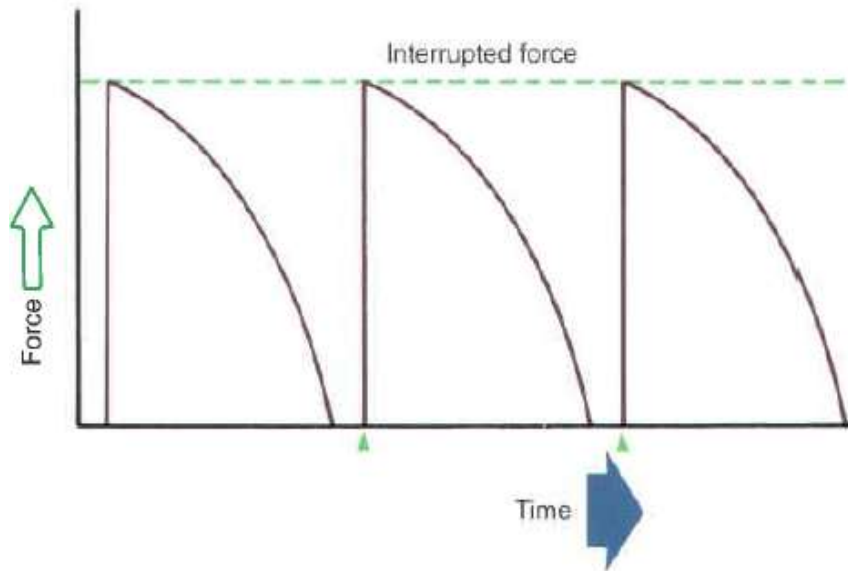


2. Interrupted Force

It resets shortly after force is applied. They cause indirect resorption in surrounding tissues.

Their activation is carried out at intervals that allow the repair of tissues.

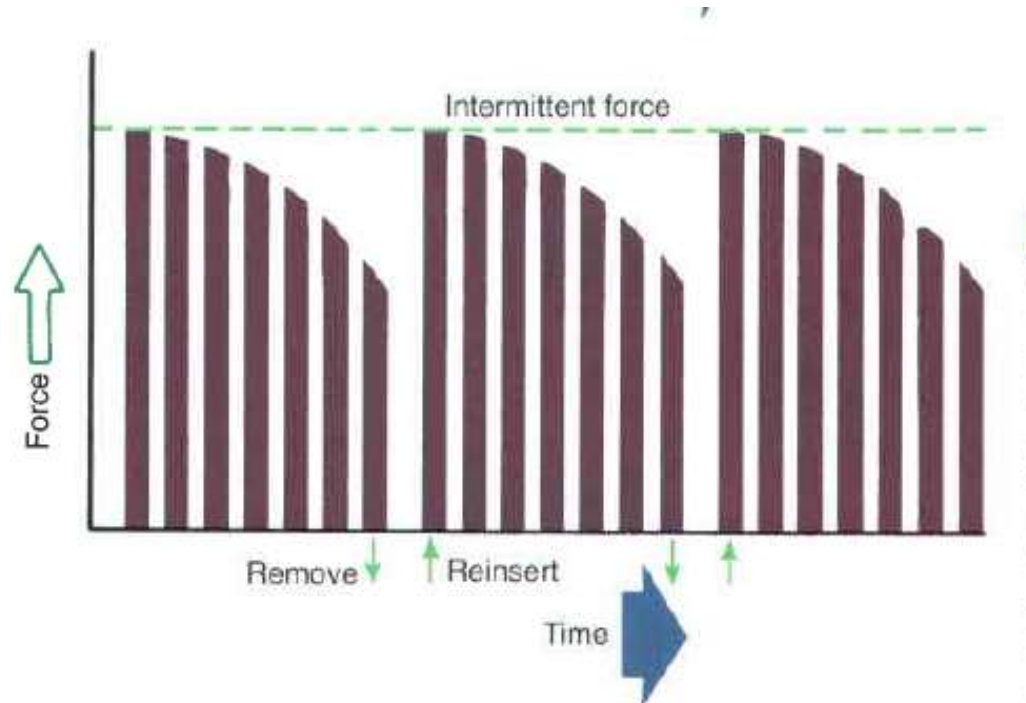
Example: Rapid Maxillary Expansion



3. Intermittent Force

The intensity of the orthodontic force is high at the beginning and decreases to zero in a short time.

Example: Removable orthodontic appliances (slow expansion appliances)



CONTENT of the LECTURE

1. Sources of Orthodontic Force

a. Sources of natural force

b. Sources of mechanical force

2. Properties of Orthodontic Force

3. Characteristics of Optimal Force



Optimal Force for Teeth

- ✓ **It should be applicable in the desired direction and distance**
- ✓ **Should not cause severe tissue pathology**
- ✓ **Clinical discomfort should be minimal**
- ✓ **Must create the fastest individual movement possible**

Optimal Force for Teeth

Optimal force for upper (maxillary) teeth

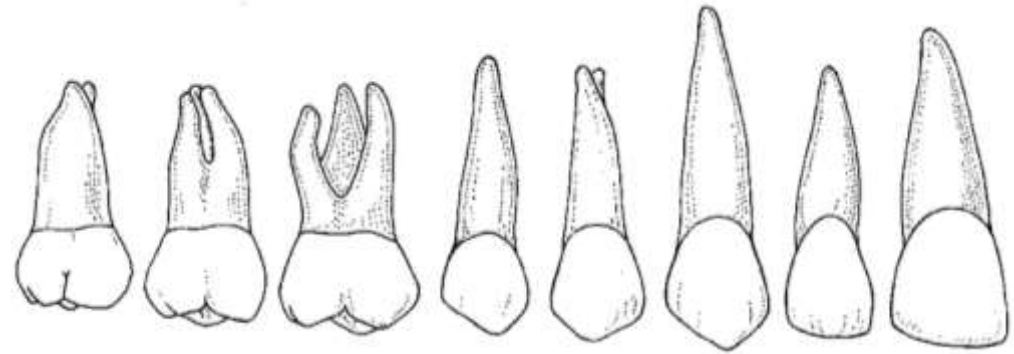
Maxillary incisors 75-85 gr

Maxillary lateral incisors 65-70 gr

Maxillary canine 115-130 gr

Maxillary premolars 100-120 gr

Maxillary molars 300-320 gr



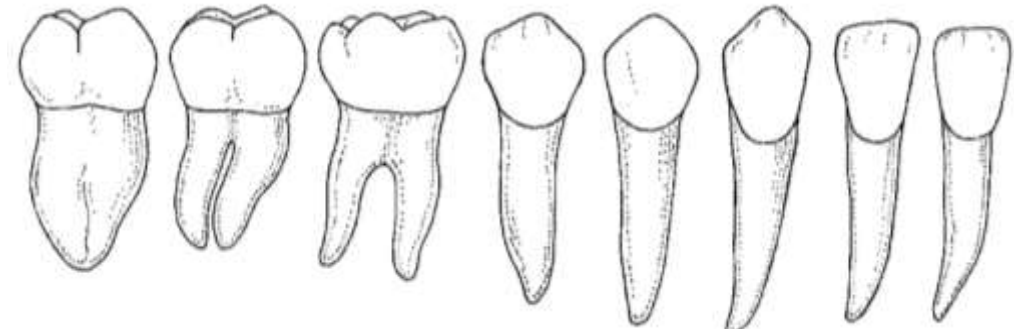
Optimal force for lower (mandibular) teeth

Mandibular incisors 55-65 gr

Mandibular canine 95-100 gr

Mandibular premolars 80-90 gr

Mandibular molars 250-270 gr



Types of Tooth Movement

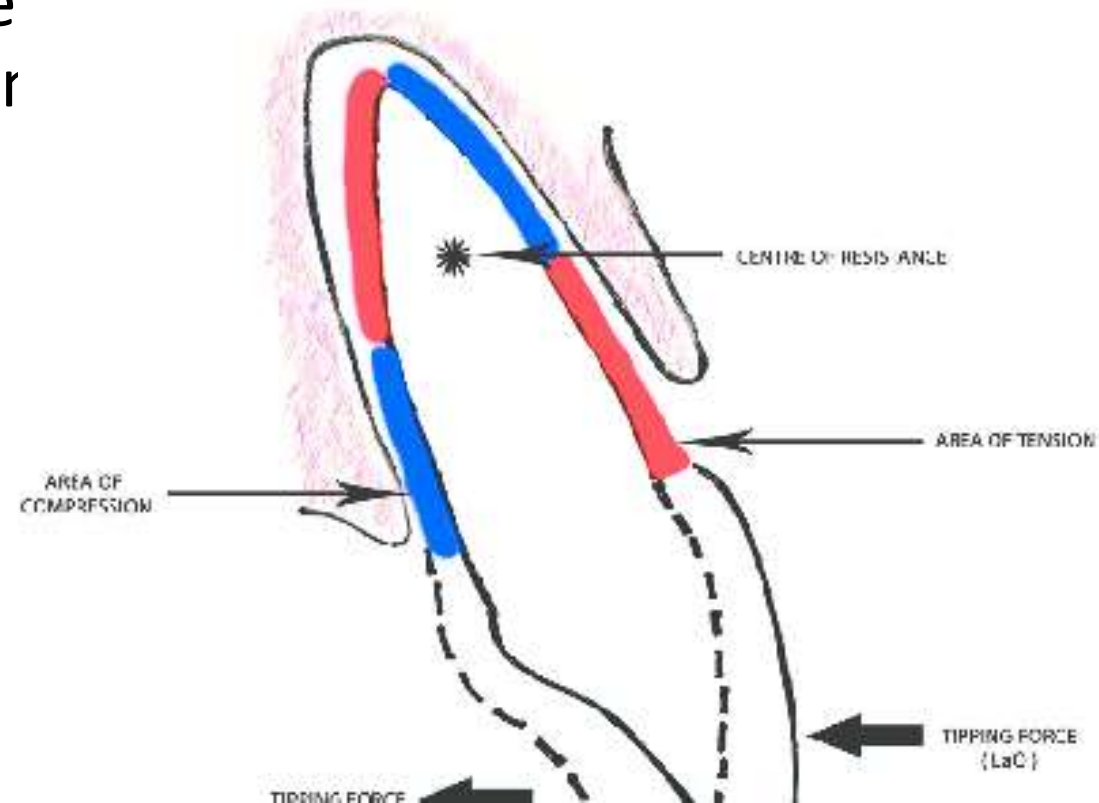
1. Tipping
2. Translation (parallel tooth movement)
3. Torque
4. Rotation
5. Extrusion
6. Intrusion

Tipping

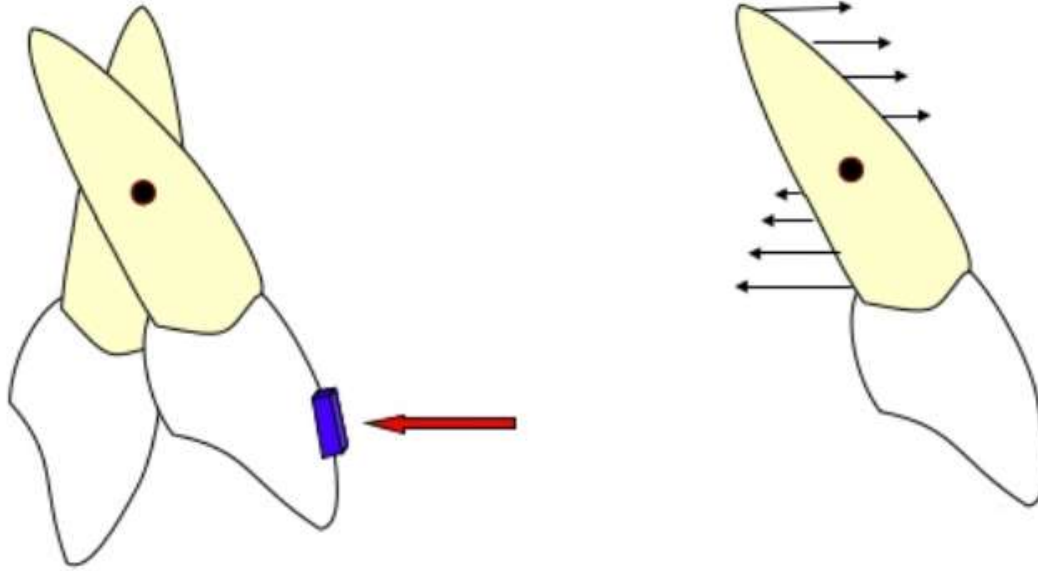
- It is the rotation movement of the tooth around its center of rotation when a force is applied from a single point on the crown
- Mutual tension-pressure zones emerge.
- It is the easiest tooth movement to achieve.

There are 2 types of tipping;

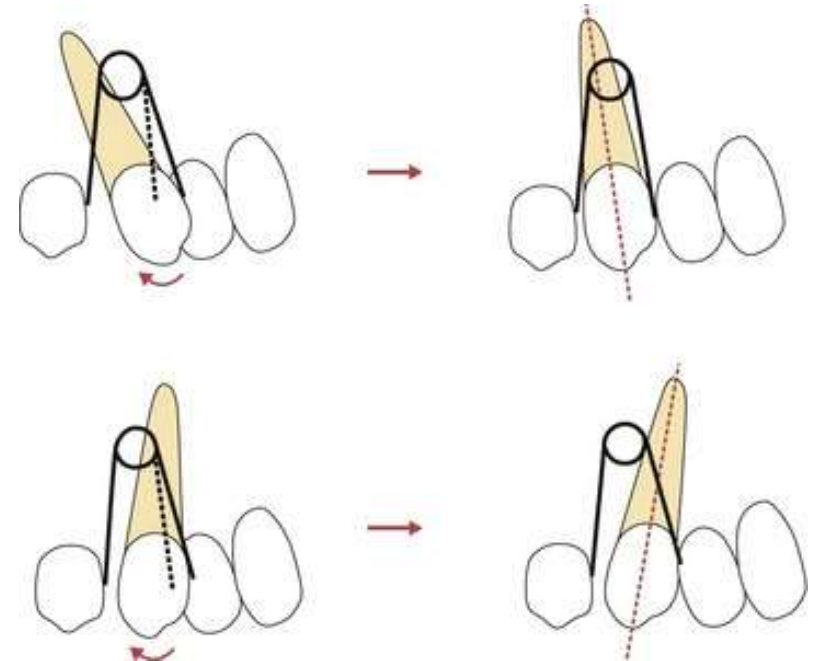
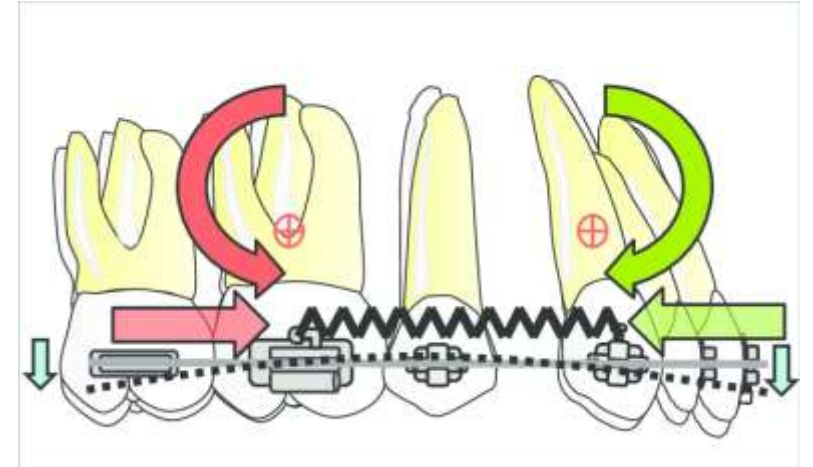
1. Controlled tipping
2. Uncontrolled tipping



Uncontrolled Tipping

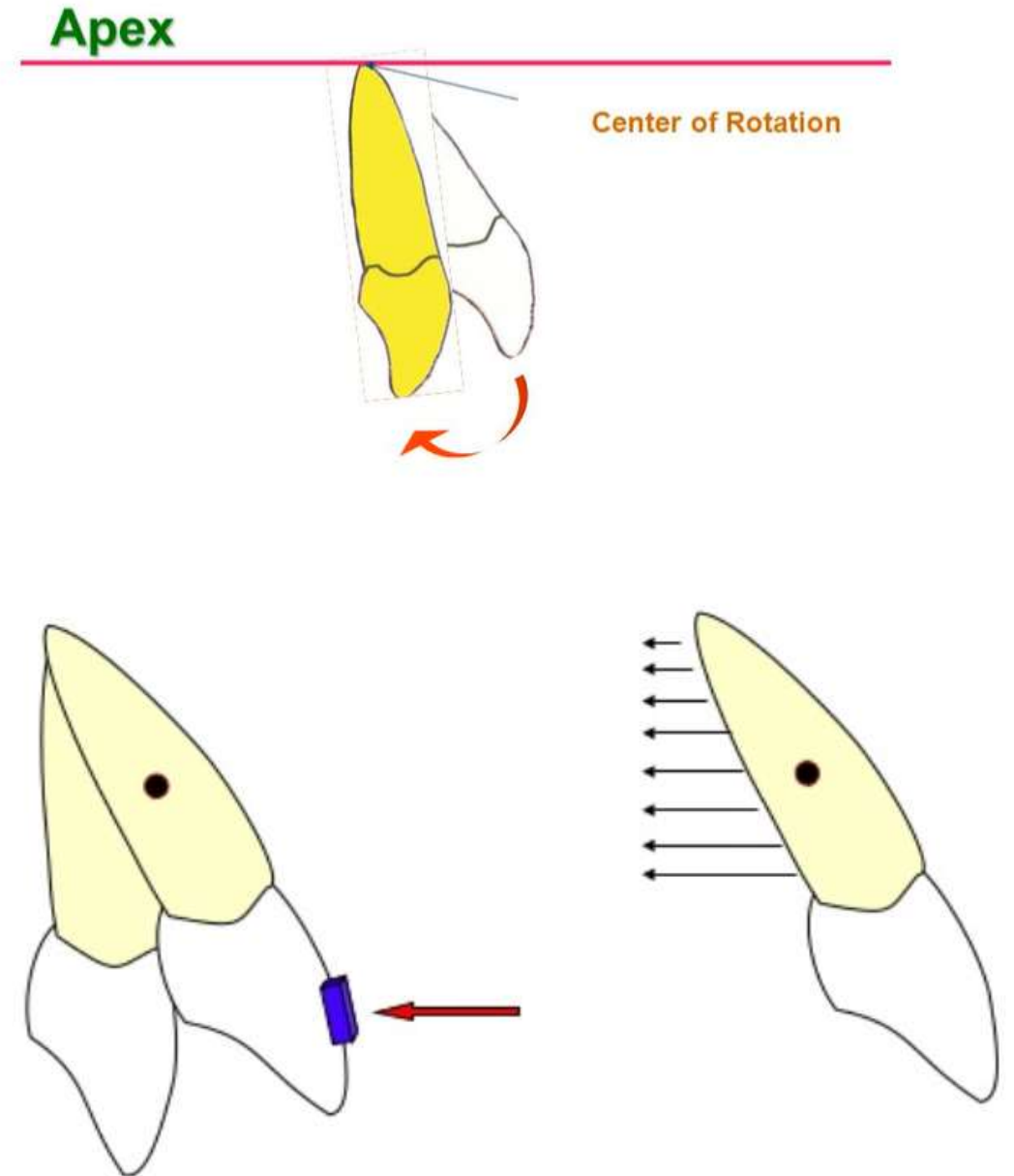


- It is the movement made on the round arch wire.
- The center of rotation is in the middle of the part where the root remains within the alveolar bone.
- Crown and root move reciprocally.

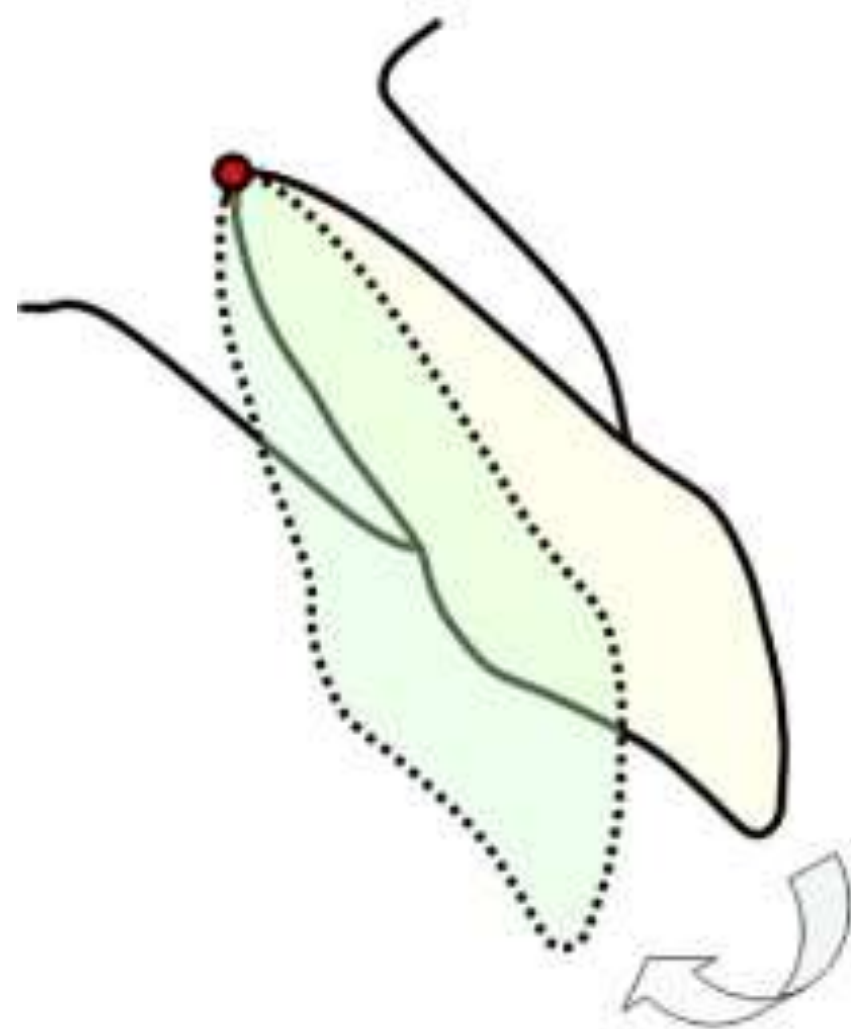


Controlled Tipping

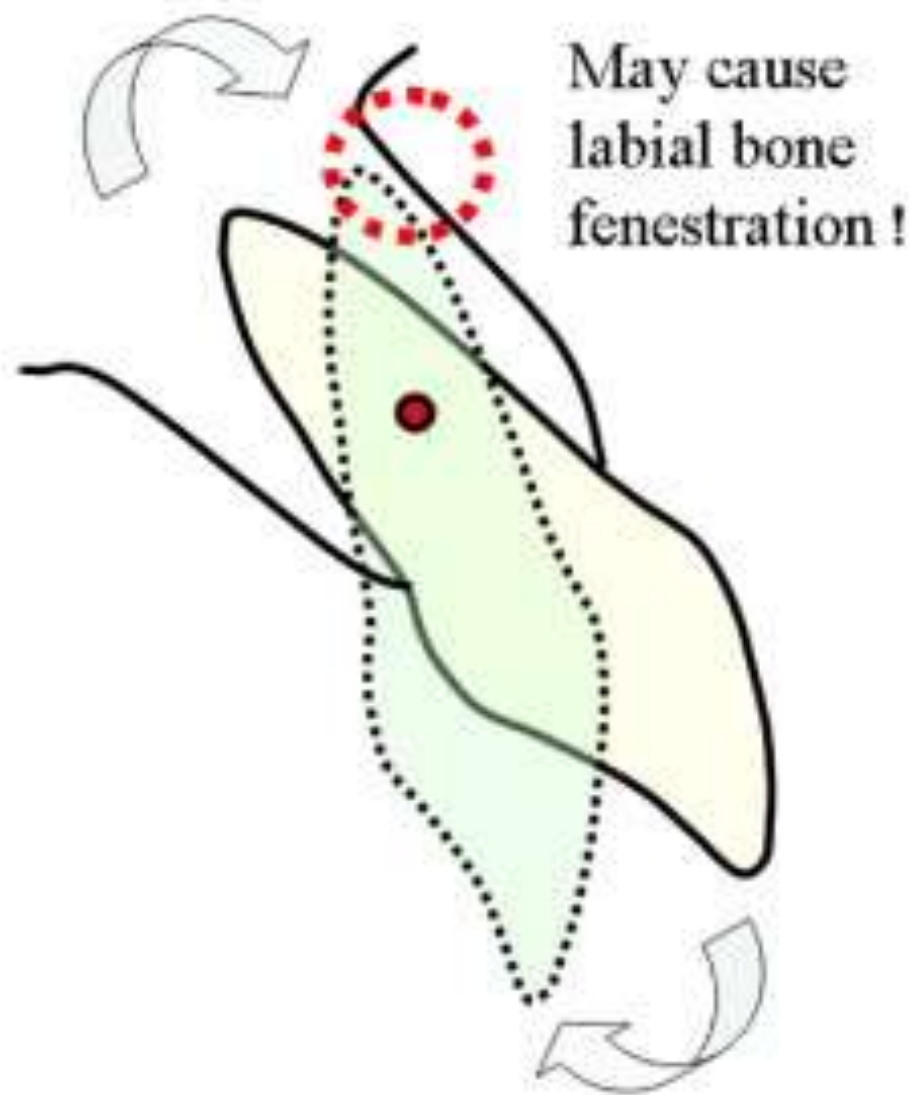
- It is applied on angular arch wire.
- The center of rotation is located at the root apex.
- While the crown moves in the direction of the force, the root remains in place.



Center of rotation ●

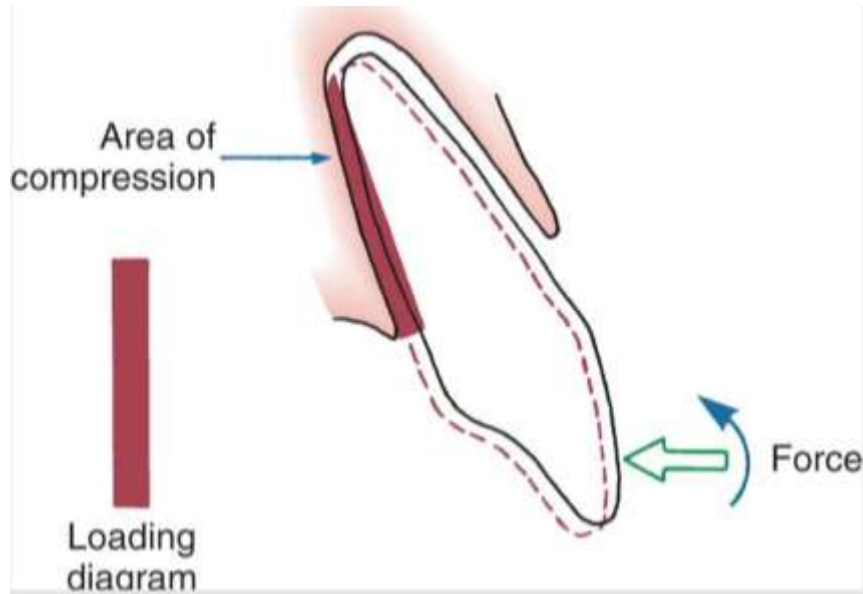


Controlled Tipping

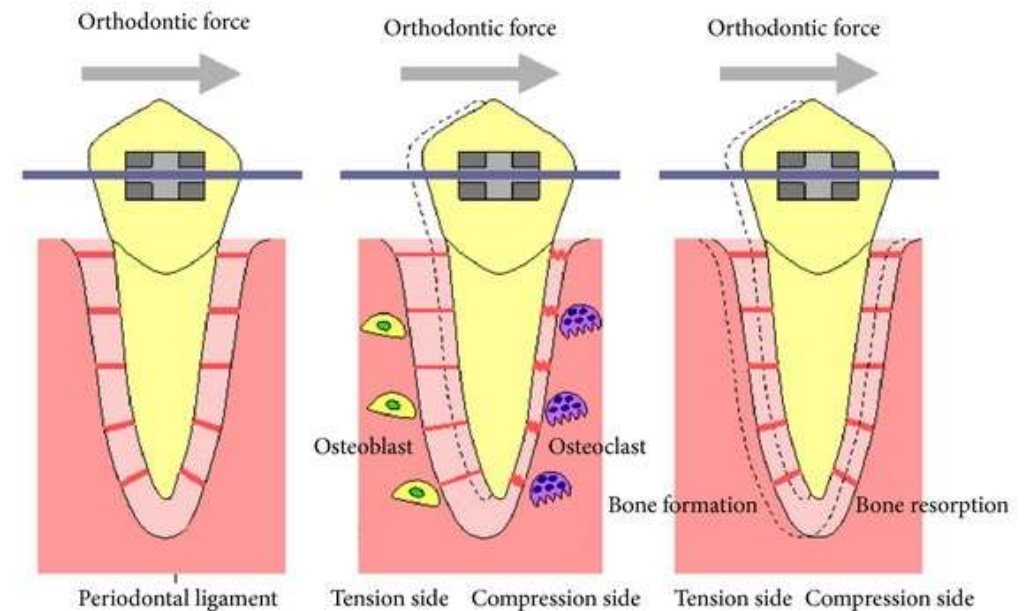


Uncontrolled (Excessive) Tipping

Translation (parallel tooth movement – bodily movement)



- Crown and root move in the same direction.
- It is obtained on thick cornered wires.
- Two simultaneous forces are needed.
- The center of rotation is at infinity.



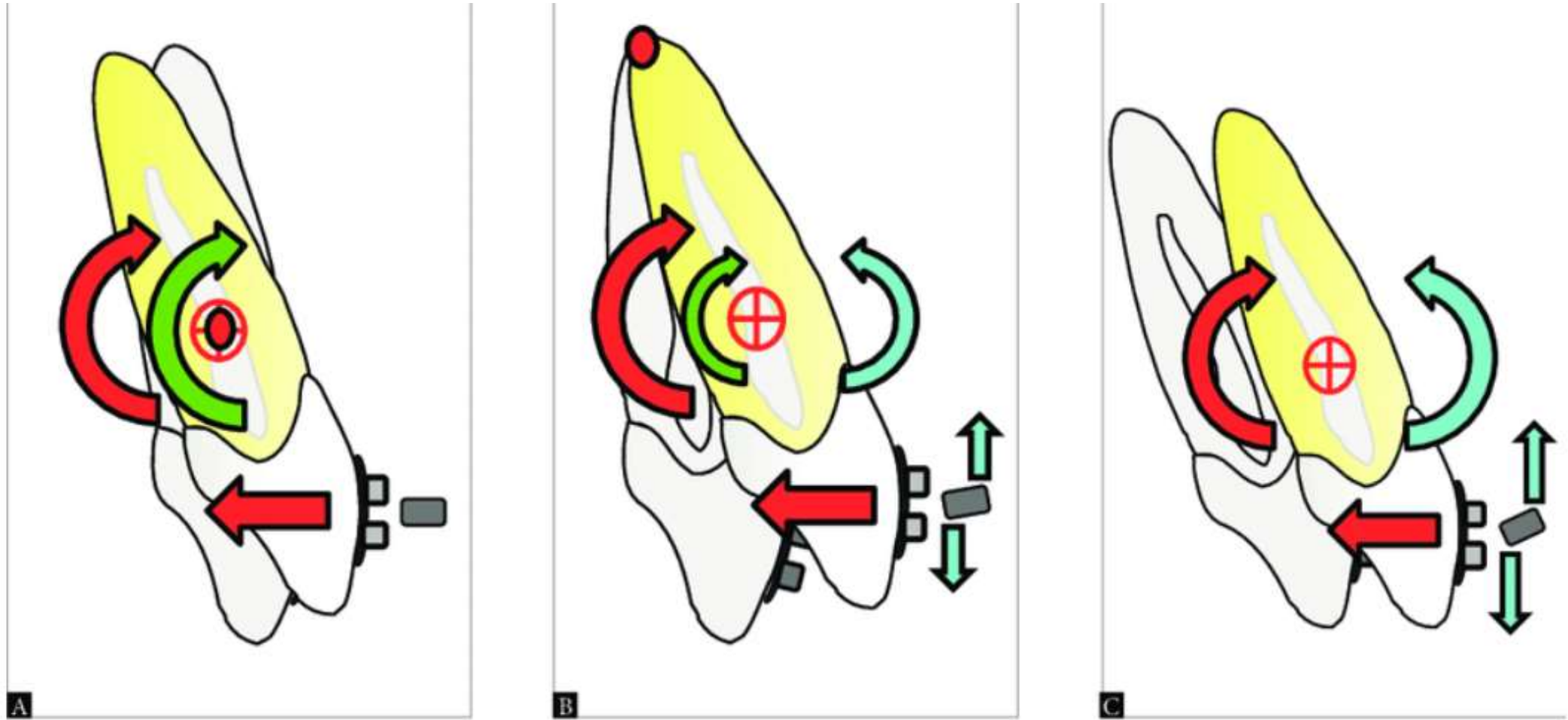
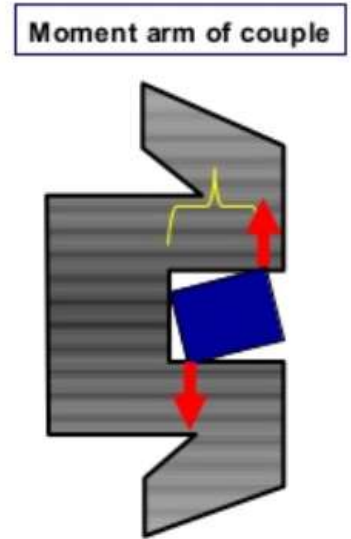


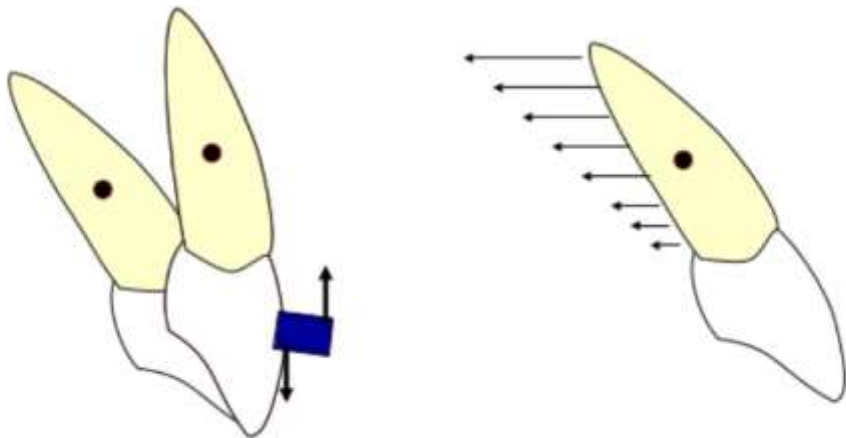
Figure 3 - Types of tooth movement: A) Uncontrolled tipping; B) Controlled tipping; C) Bodily movement;

Torque Movement

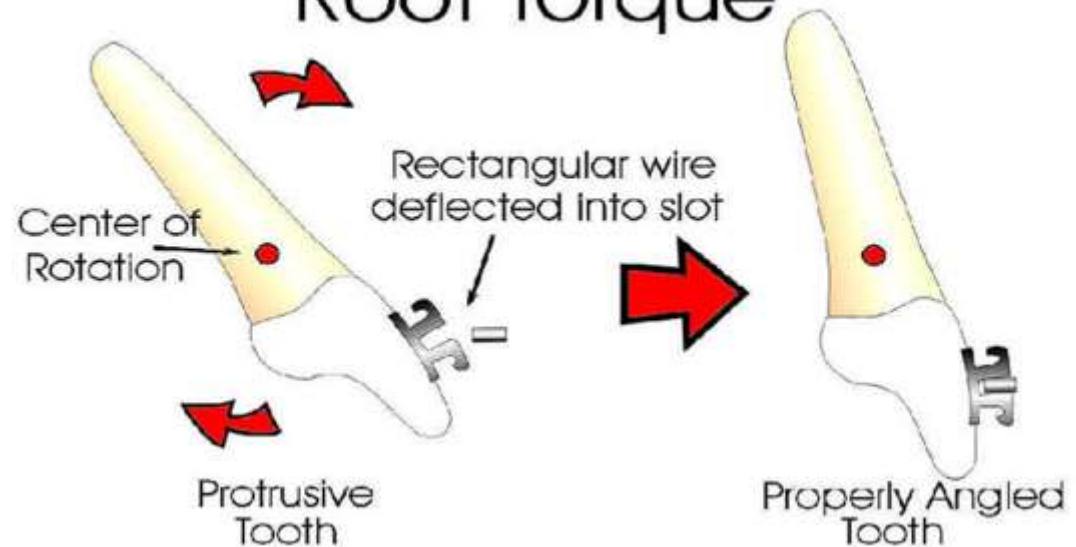
- It is a root movement.
- It is done by placing the angled wire into the slot with a twisting motion.
- A force couple is created.
- The center of rotation is at the incisal edge.



ROOT MOVEMENT



Root Torque



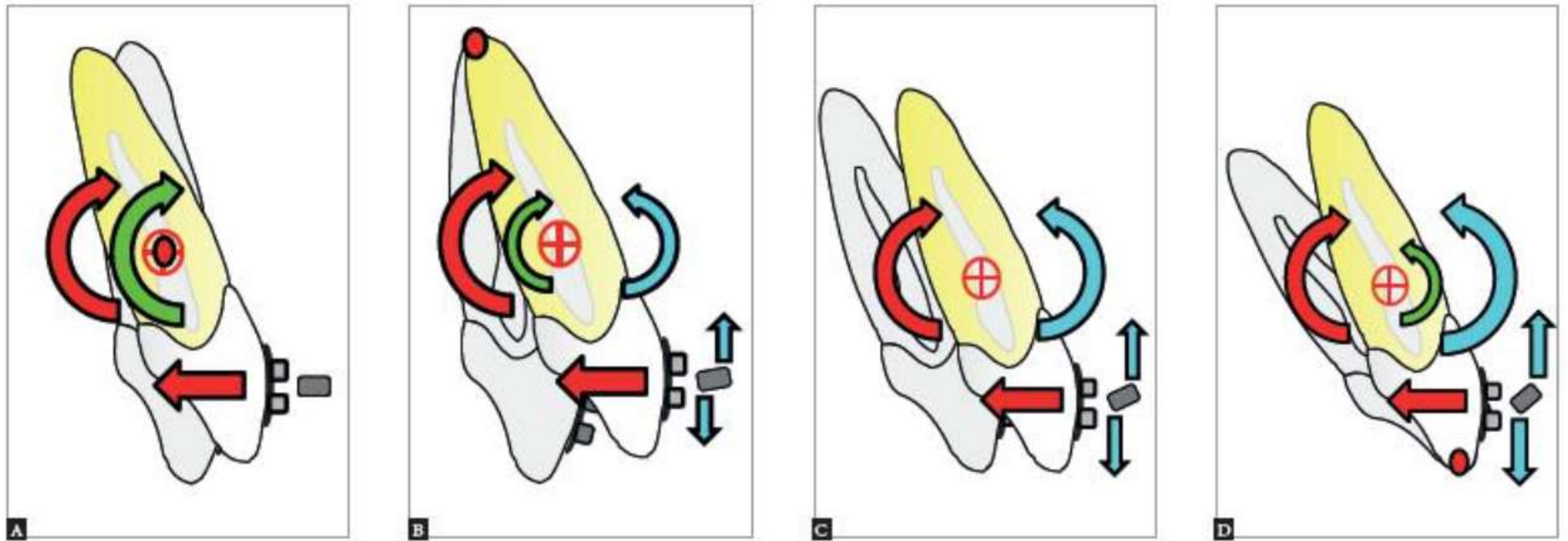


Figure 3 Types of tooth movement: A) Uncontrolled tipping; B) Controlled tipping; C) Bodily movement; D) Root movement. The red arrows represent the force applied to teeth and the moment of force. The blue arrows represent the force of a wire into the bracket and the moment of a couple. The green arrow is the resultant moment (moment of force minus moment of a couple).

Rotation

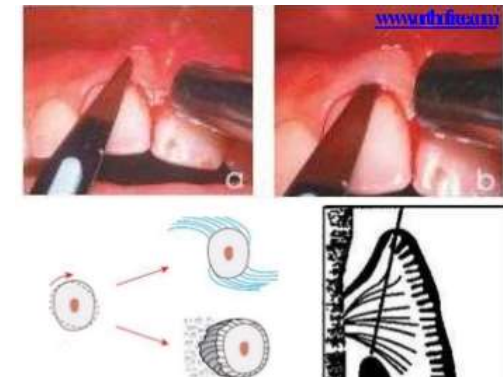
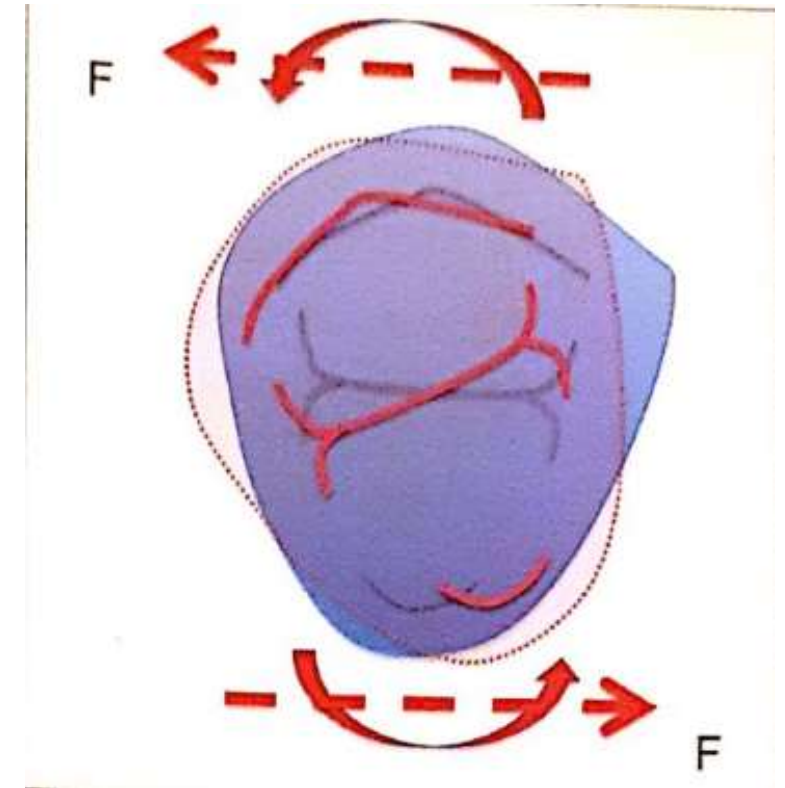
It is the rotational movement of the tooth in its socket.

It is done by applying two forces (force couple) in opposite directions to the tooth crown.

The tooth rotates centered on the center of resistance.

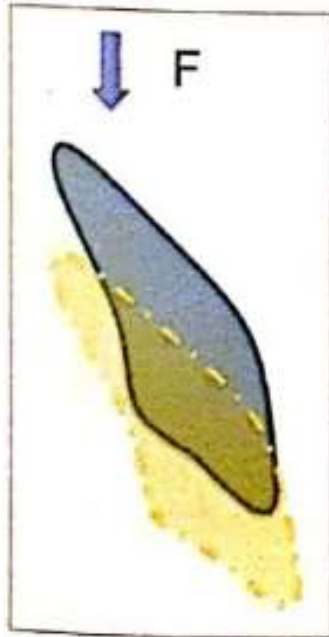
Since the transseptal fibers can maintain their tension for 6-7 months, the tendency to return to the original position is high.

Supracrestal circumferential fiberotomy should be considered for stability.



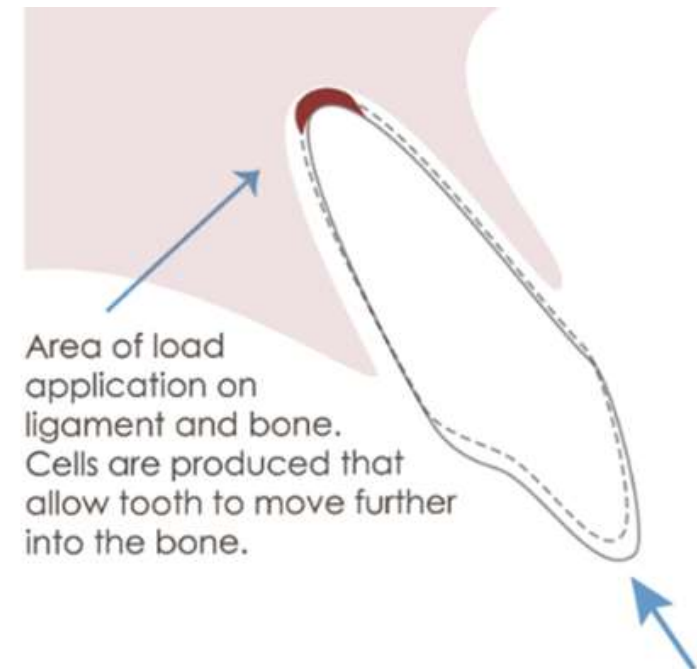
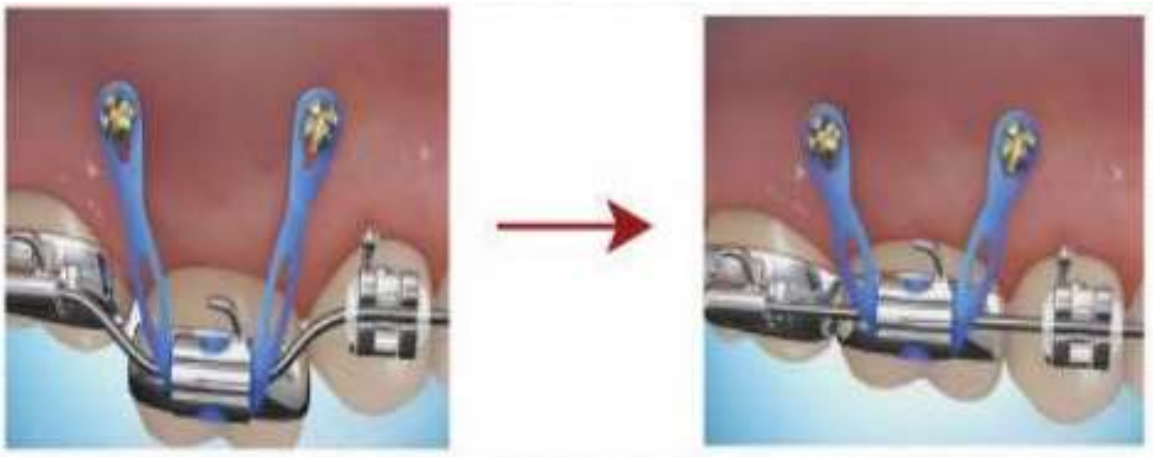
Extrusion

- It is the elongation movement of the tooth in its socket along its long axis.
- It is the most painful tooth movement.
- The greatest tension in the PDL occurs in the supracrestal fibers.
- There is no rotation center.



Intrusion

- It is the digging in movement of the tooth in its socket along its long axis.
- Light forces must be applied.
- It is the movement in which the most root resorption is observed.
- There is no rotation center.
- It is the movement with the least relapse observed.



Optimum Forces for Different Tooth Movements - Profitt

TABLE 9-3 *Optimum Forces for Orthodontic Tooth Movement*

Type of movement	Force* (gm)
Tipping	35-60
Bodily movement (translation)	70-120
Root uprighting	50-100
Rotation	35-60
Extrusion	35-60
Intrusion	10-20

*Values depend in part on the size of the tooth; smaller values appropriate for incisors, higher values for multirooted posterior teeth.

EVENTS



60. Aşağıdaki ortodontik tedavi tiplerinden hangisi kök rezorpsiyon riskini artırır?

- A) Anterior diastemanın kapatılması
- B) Self-ligating braket kullanımı
- ☒ C) Keser intrüzyonu
- D) İntraoral elastik kullanımı
- E) Molar mezializasyonu

56. Aşağıdaki diş hareketlerinden hangisi dişin paralel hareketlerini ifade eder?

- ☒ A) Translasyon
- B) Tork
- C) Kontrollü tiping
- D) Rotasyon
- E) Kontrolsüz tiping

55) Alt keser dişlerin intrüzyonu için gerekli optimum kuvvet aşağıdakilerden hangisidir?

- A) 35-60 g
- B) 70-120 g
- ☒ C) 10-20 g
- D) 50-100 g
- E) 30-35 g

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53. Aşağıdakilerden hangisi ortodontik kuvvet kaynaklarından biri değildir?

- A) Ortodontik teller
- ☒ B) Molar bantlar
- C) Vidalar
- D) Yaylar
- E) Elastikler

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55. Aşağıdaki ortodontik diş hareketi tiplerinden hangisinde gerekli optimal kuvvet en azdır?

- ☒ A) İntrüzyon
- B) Ekstrüzyon
- C) Tipping
- D) Translasyon
- E) Rotasyon



MAY
THE FORCE
BE WITH YOU



Happy 100th Anniversary of Turkish Republic