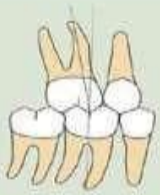
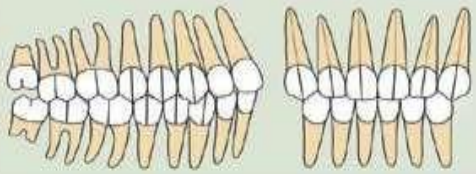
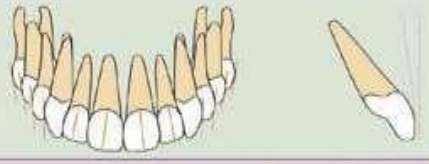
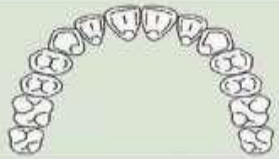
Orthodontic tooth movement

-Andrew's keys for idealocclusion

KEY 1		**Key 1** **Molar relationship** - the distal surface of the distal marginal ridge of the upper first permanent molar occludes with the mesial surface of the mesial marginal ridge of the lower second molar. The mesio-buccal cusp of the upper first permanent molar falls within the groove between the mesial and middle cusps of the lower first permanent molar
KEY 2		**Key 2** **Crown angulation or mesio-distal tip** - the gingival portion of the long axis of each tooth crown is distal to the occlusal portion of that axis. The degree of tip varies with each tooth type
KEY 3		**Key 3** **Crown inclination or labio-lingual/bucco-lingual torque** - for the upper incisors the occlusal portion of the crowns labial surface is labial to the gingival portion. In all other crowns, the occlusal portion of the labial or buccal surface is lingual to the gingival portion
KEY 4		**Key 4** **Rotations** - there should be an absence of any tooth rotations within the dental arches
KEY 5		**Key 5** **Spacing** - there should be an absence of any spacing within the dental arches
KEY 6		**Key 6** **Occlusal plane** - the occlusal plane should be flat

- The nature of orthodontic tooth movement :

= it has a bio – mechanic nature.

= solely based upon stress- strain occurs in the PDL environment

= the orthodontic tooth movement results from forces delivered to the teeth

= the forces are delivered via orthodontic app.
Either fixed or removable

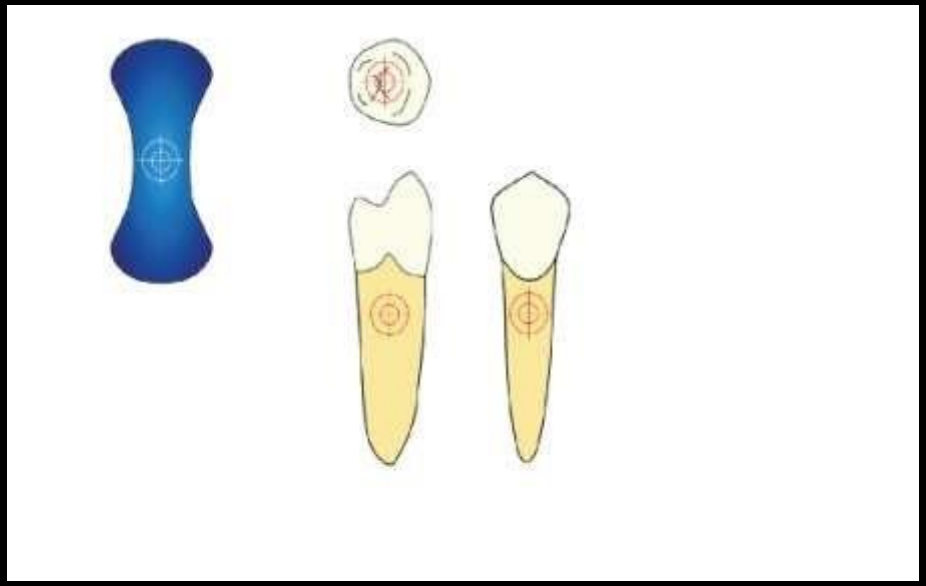
= PDL undergoes biological respond upon the mechanical application of a force i.e to achieve a
precise biological respond the mechanical forces to be delivered should be precise

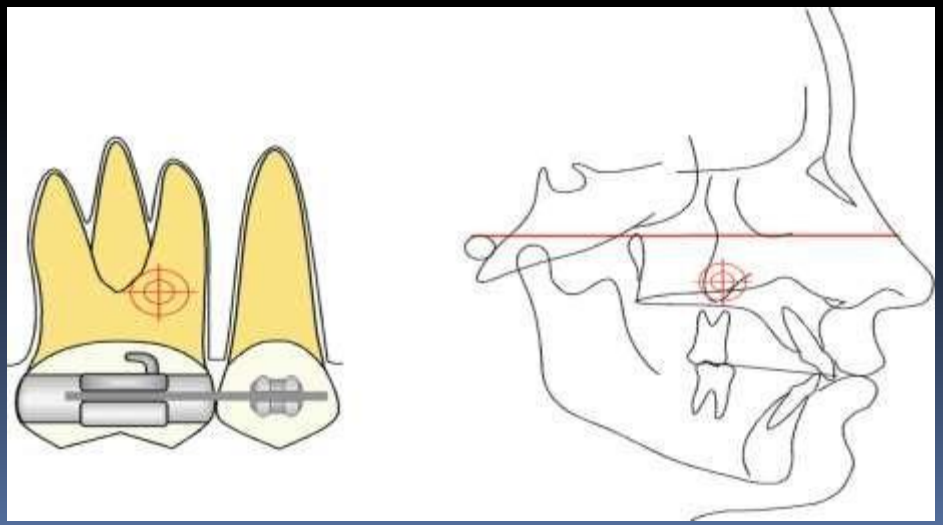
1 = *center of resistance.*

- *All objects have* a center of mass.

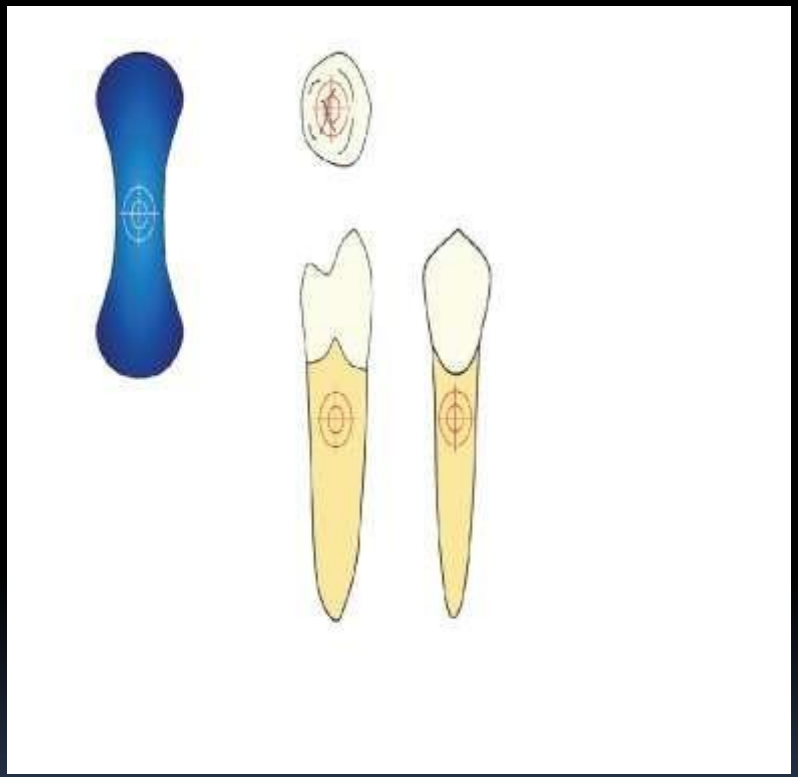
-This is the point through which an applied force must pass for a free object to move linearly without any rotation,

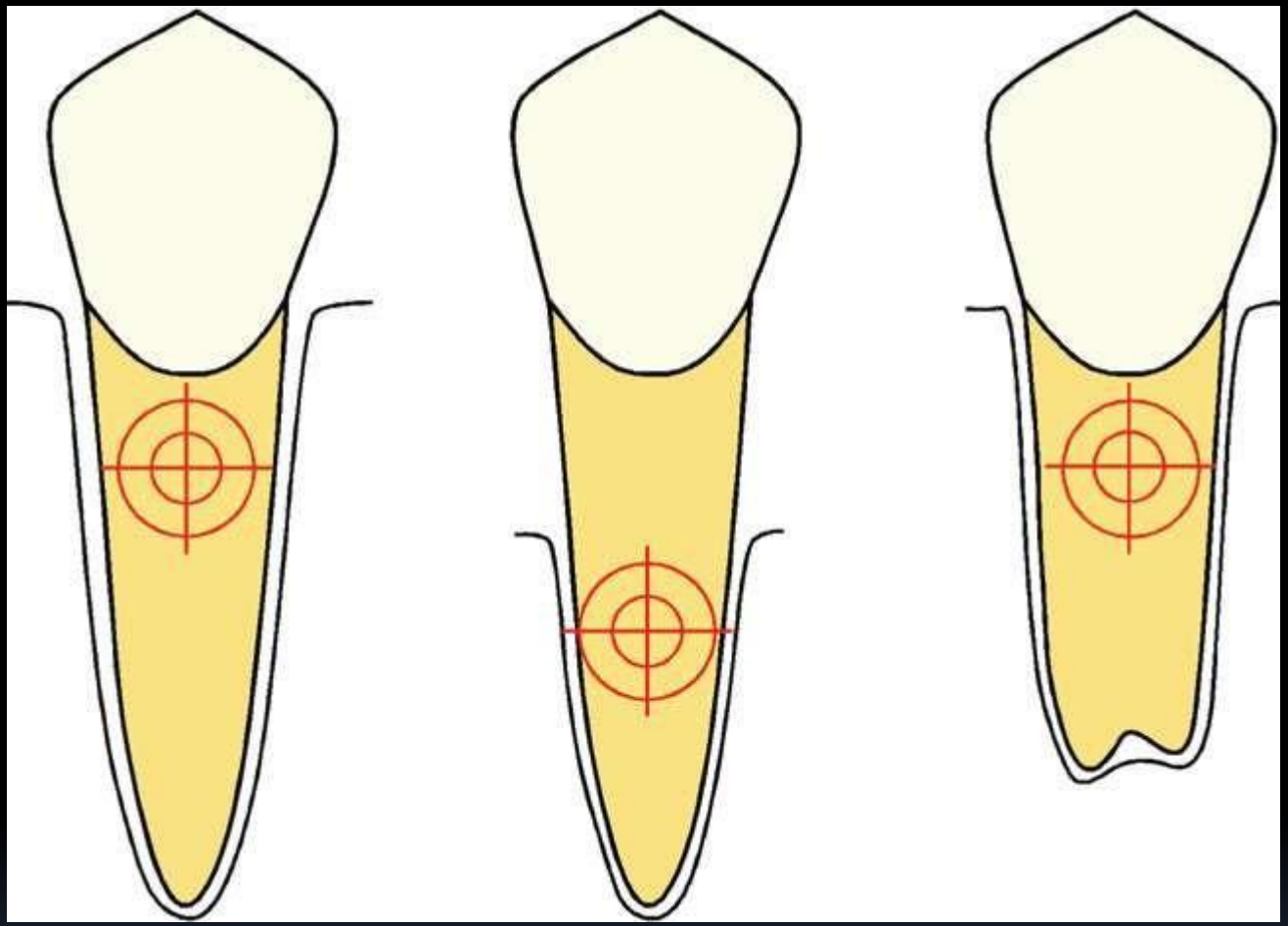
-i.e., the center of mass is an object's "balance point."





analytic studies have determined that the center of resistance for single-rooted teeth with normal alveolar bone levels is about 1/4 to 1/3 the distance from the cementoenamel junction (CEJ) to the root apex.





Location of the center of resistance depends on the alveolar bone height and root length . = Location of the center of resistance with

alveolar bone loss
= with a shortened root

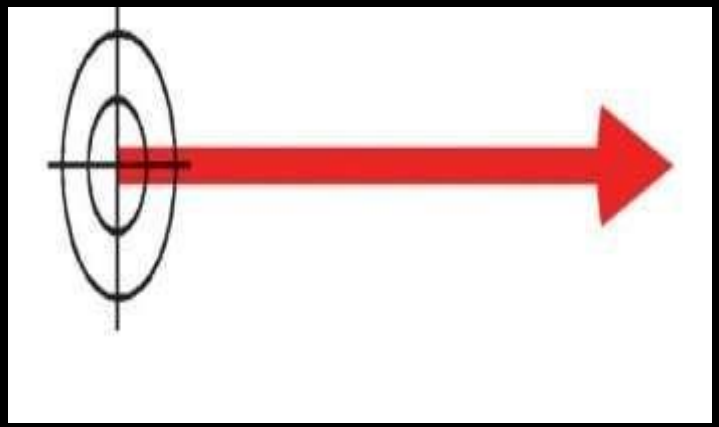
2 - Forces

= they are actions applied to bodies

= they equals (mass X acceleration) F =ma

= in clinical orthodontics its unit is Grams

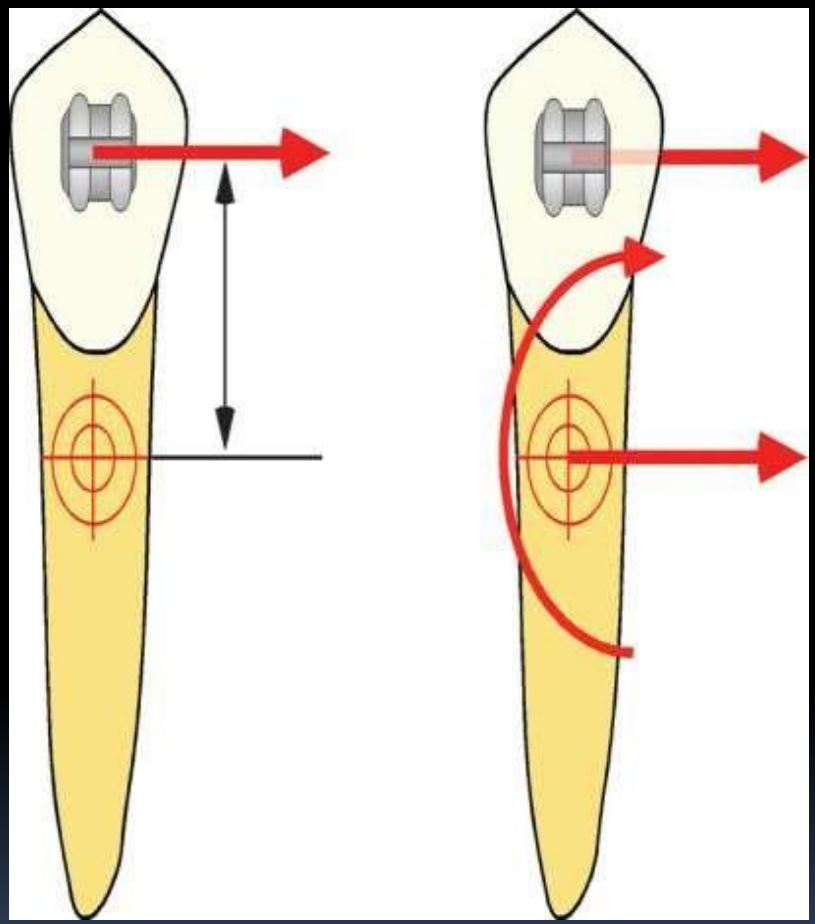
= forces has the characteristics of vectors i.e magnitude & direction

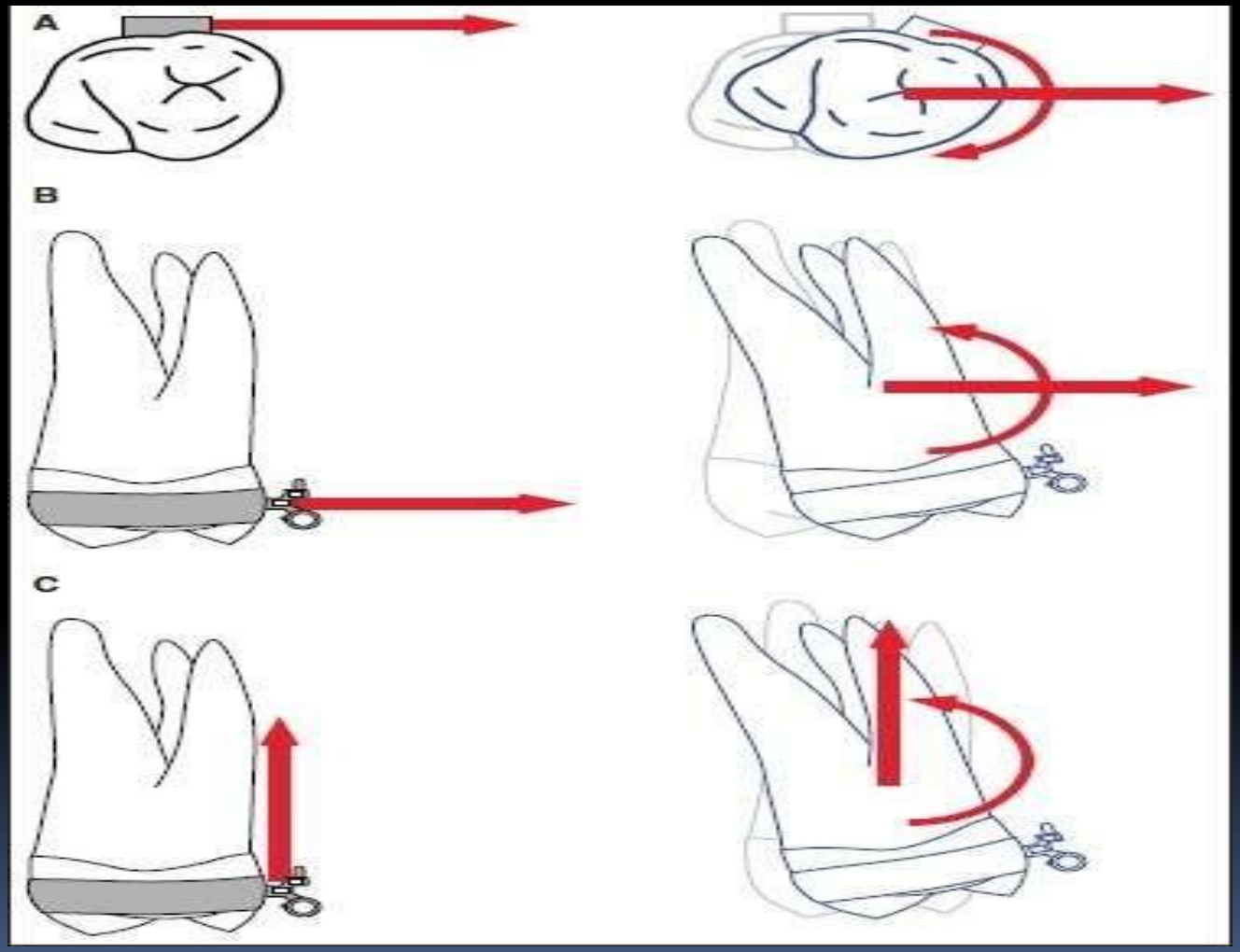


Note : the diagram shows that the force vectors characteristics – magnitude , point of origin & direction

= as the orthodontic forces are delivered through the tooth crown they will not produce a pure linear movement ,, some rotational movement will be present ,, those rotational movements are called *Moment* of the force

= The moment of the force is the tendency for a force to produce rotation.





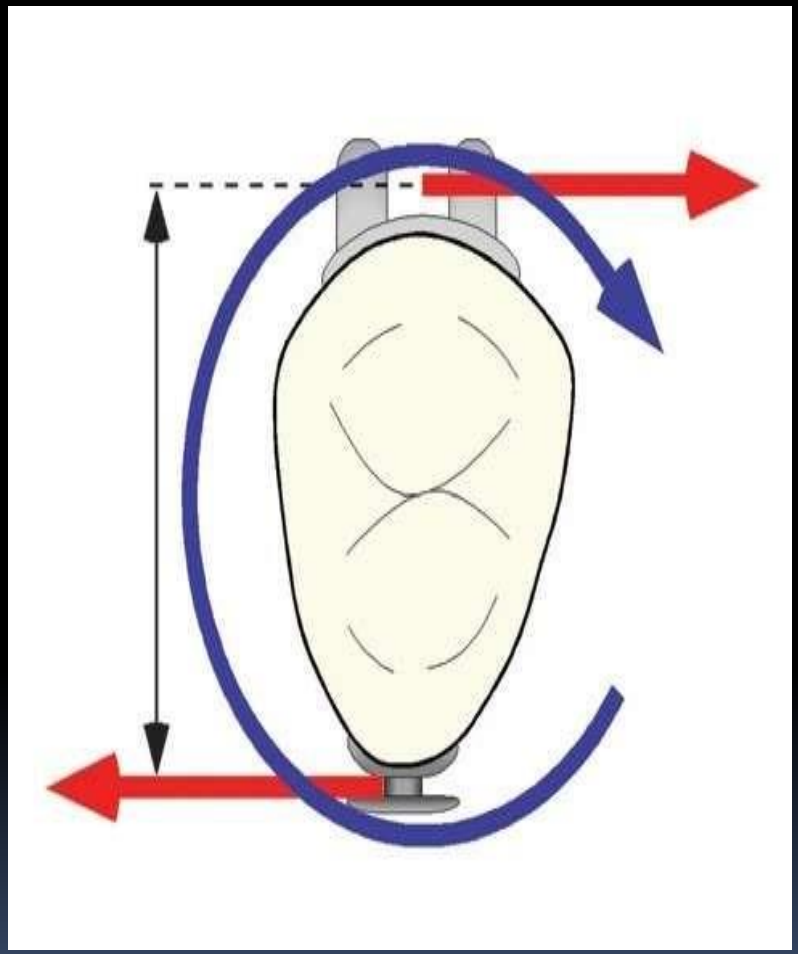
Clinical examples of moments of the forces

3 – Couple

- A couple is

two parallel forces of equal magnitude acting in opposite directions and separated by a distance (i.e. different lines of action)

- The magnitude of a couple is calculated by multiplying the magnitude of force(s) by the distance between them



Couples result in pure rotational movement about the center of resistance

Types of tooth movement :

1 – tipping (controlled & uncontrolled)

2 – translation (bodily)

3 – root movement

4 - rotation

5 - intrusion & extrusion

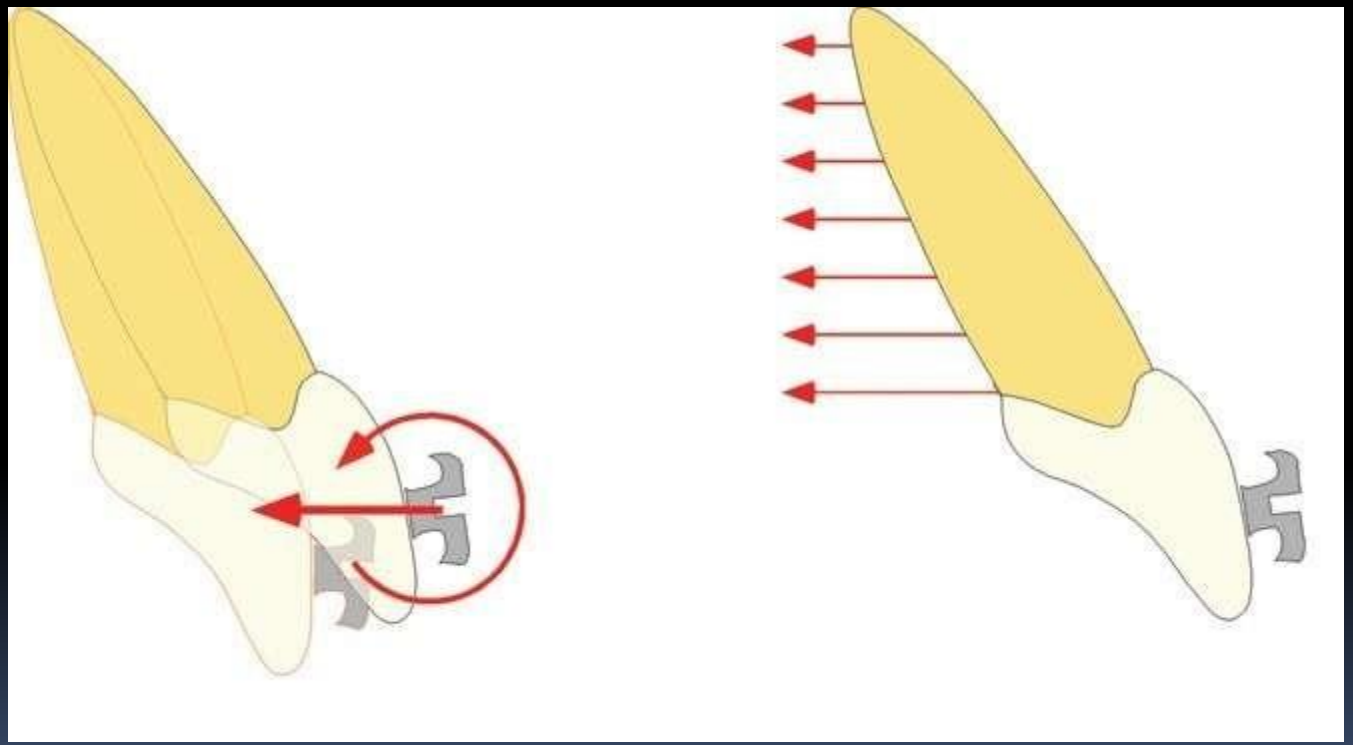
1- Tipping :

* simplest orthodontic movement

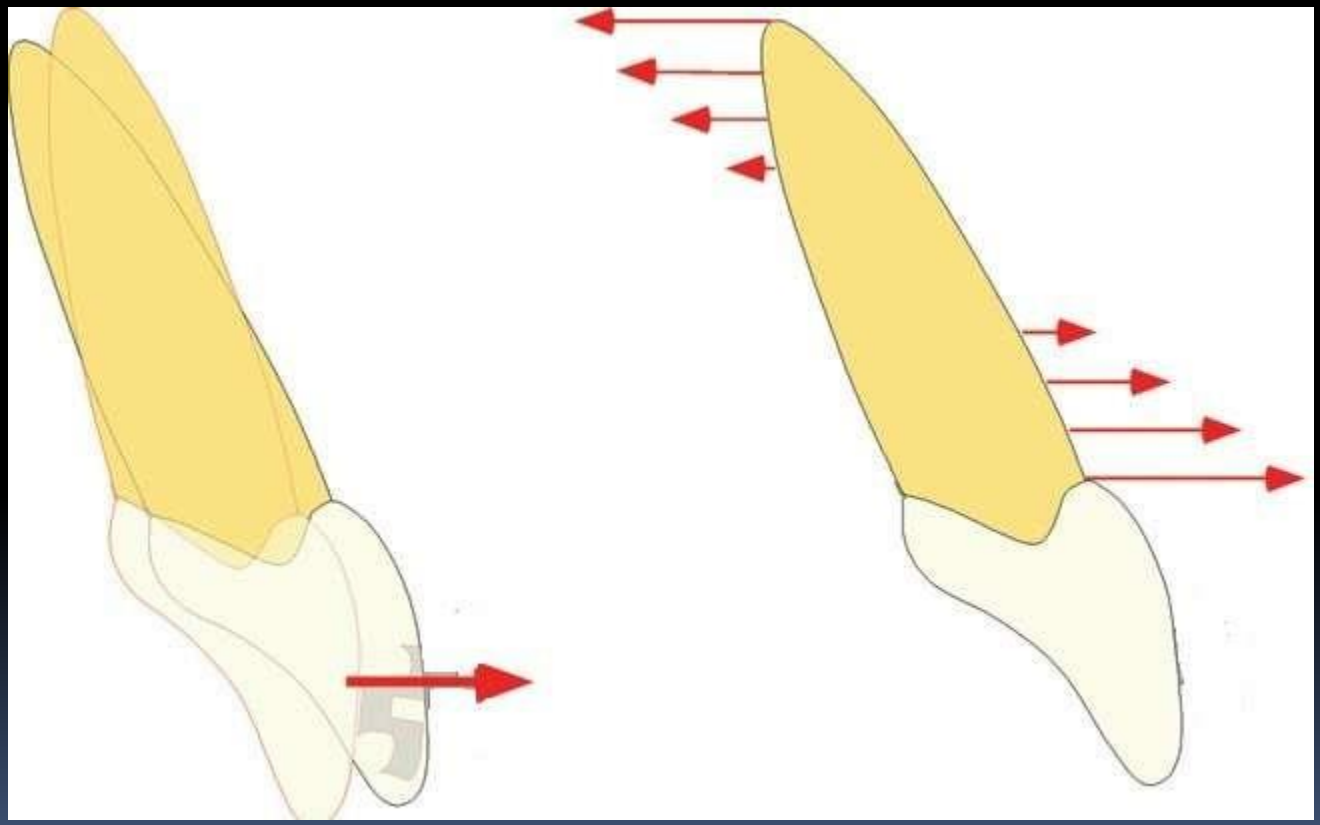
* controlled occurs about the tooth apex
*uncontrolled occurs about CER

* Force needed is about 50 – 75 gm.

Controlled tipping



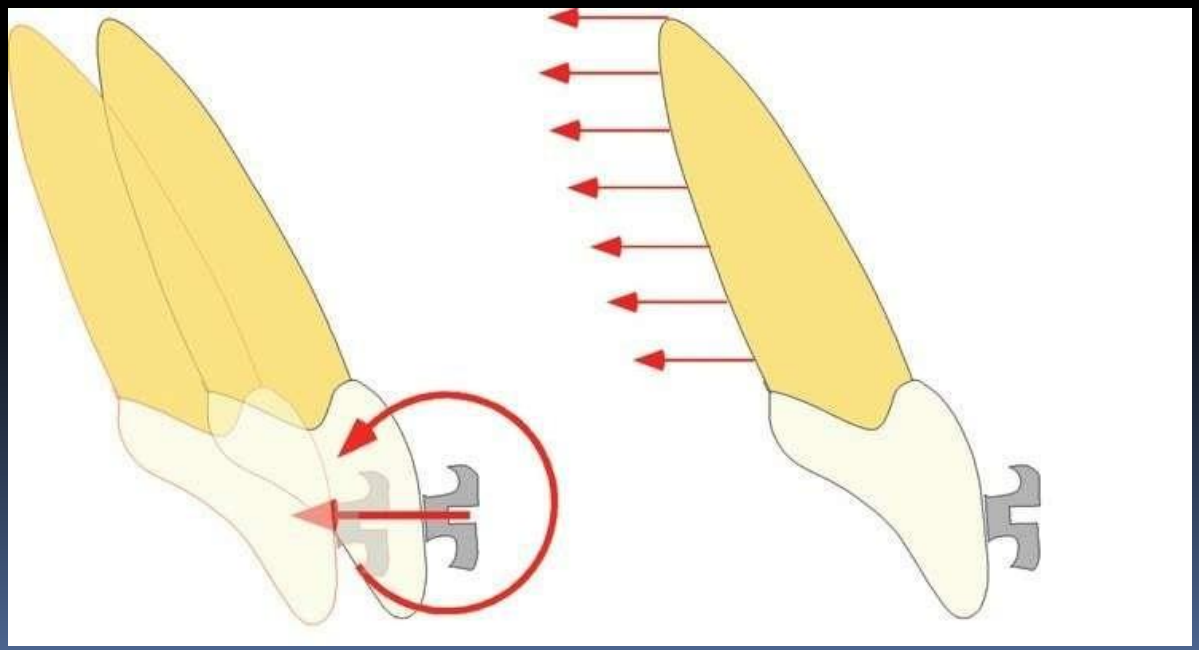
Uncontrolled tipping



2- Translation :

* all PDL is uniformly loaded with the force

* Force needed is about 100 – 150 gm.

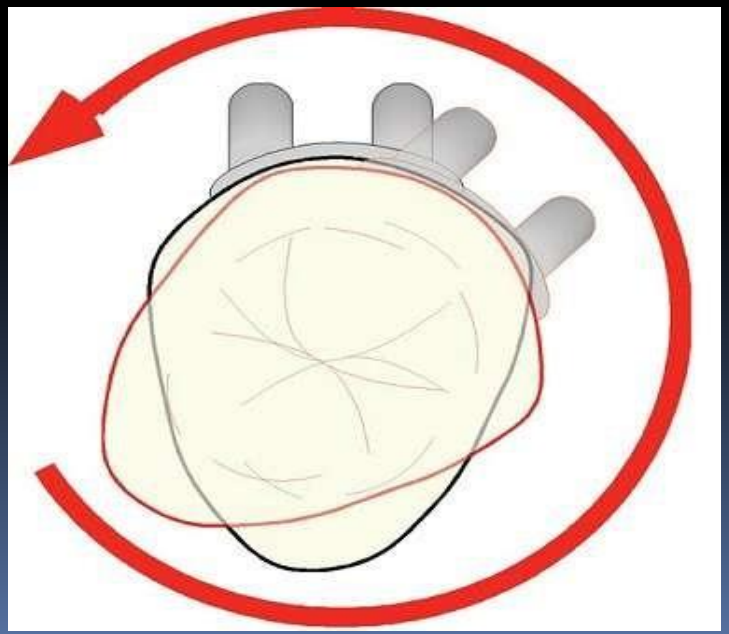


3 – Rotation :

* needs high force

* occurs around the CER

* Force needed is about 50 – 100 gm.



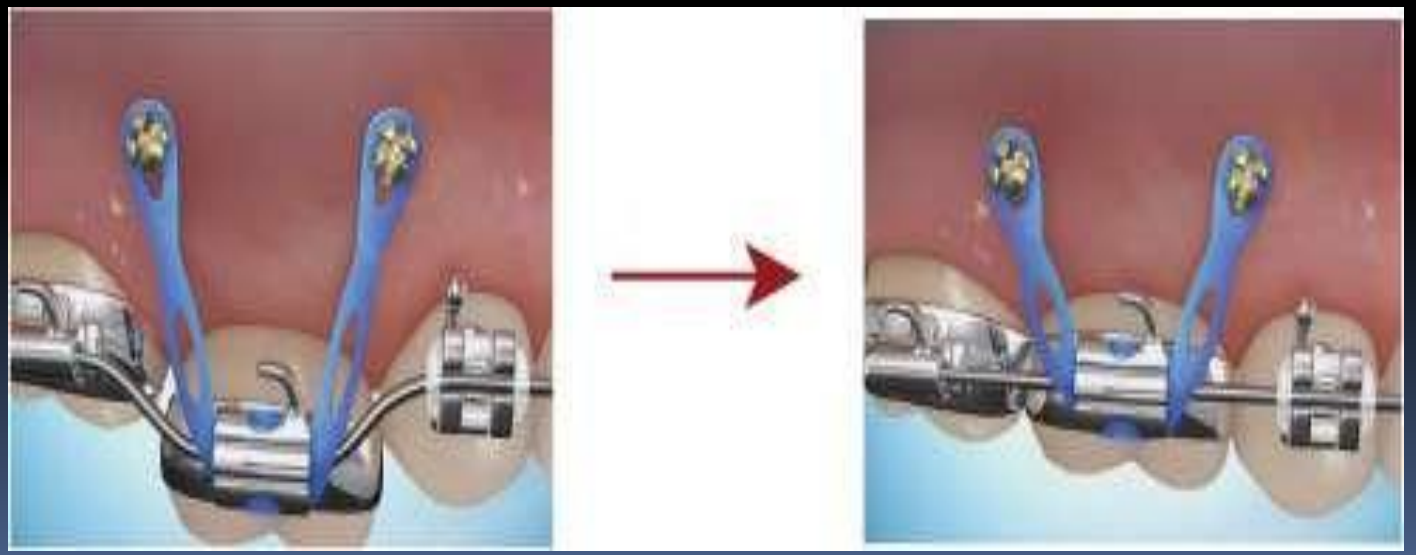
4 – Extrusion :

* needs to produce tension in the PDL ligaments

* Force needed is about 50 gm.

5 – Intrusion :

* forces are nearly at the apex
* needs minimum force application
* Force needed is about 15 – 25 gm.



6- Root movement :

* usually expressed as torque
* the crown is held stationary and the root moves
* CER is the bracket itself
* done by increasing the Moment/Force ratio

Moment / Force ratios needed for different kinds of tooth movement :

1 – tipping

* controlled 5 : 1

* uncontrolled 7 : 1

2 – translation 10 : 1

3 – root movement 12 : 1

Types of orthodontic forces acc. to Duration

- continuous

- interrupted

- intermitted

* Threshold --- 6 hrs per day.

* No tooth movement if forces are applied less than 6 hrs/d.

* From 6 to 24 hrs/d, the longer the force is applied, the more the teeth will move.

- **Continuous force :**

* achievable via fixed orthodontics

*Never declines to zero.

- Interrupted force :

* force starts heavy then decline to optimal

after that may reach zero .

*achievable via removable appliance.

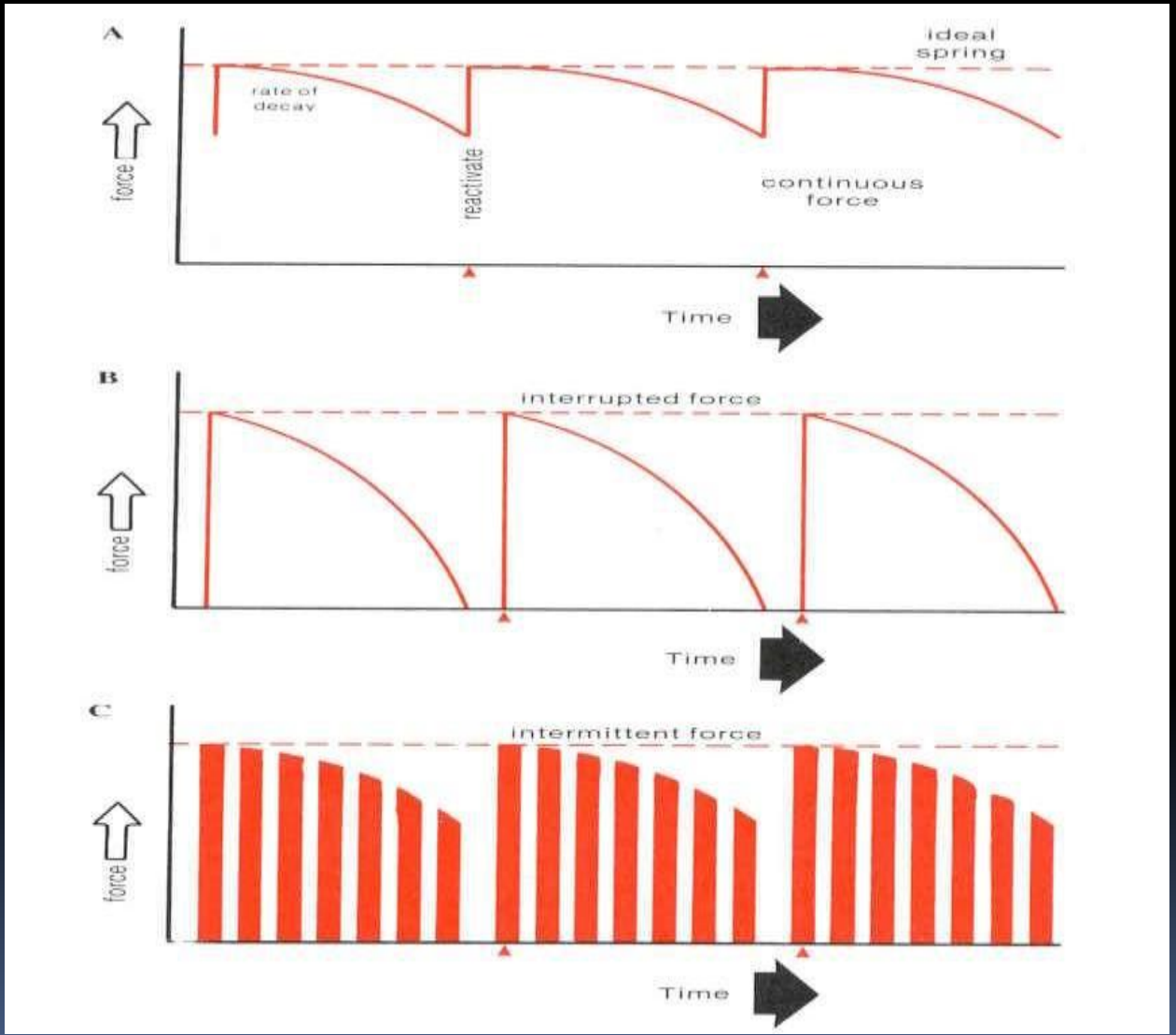
* produces some kind of

undermining resorption .

* reactivated every specific time .

-**Intermittent forces :**

* declines to zero
* very high force 250 – 500 gm.(anch – dist)
* achievable via extraoral appliance
* needs at least 12 hrs/day to be effective
* 14 hrs/day is optimal


A
ideal spring
rate of decay
force
reactivate
continuous force
Time
B
interrupted force
force
Time
C
intermittent force
force
Time

-Force level :

* **Light, continuous forces** are currently considered to be most effective in inducing tooth movement.
* **Heavy forces** cause damages and fail to move the teeth.

N.B. Optimal force : **"High enough to stimulate cellular activity without completely occluding blood vessels in the PDL"**

Heavy Forces

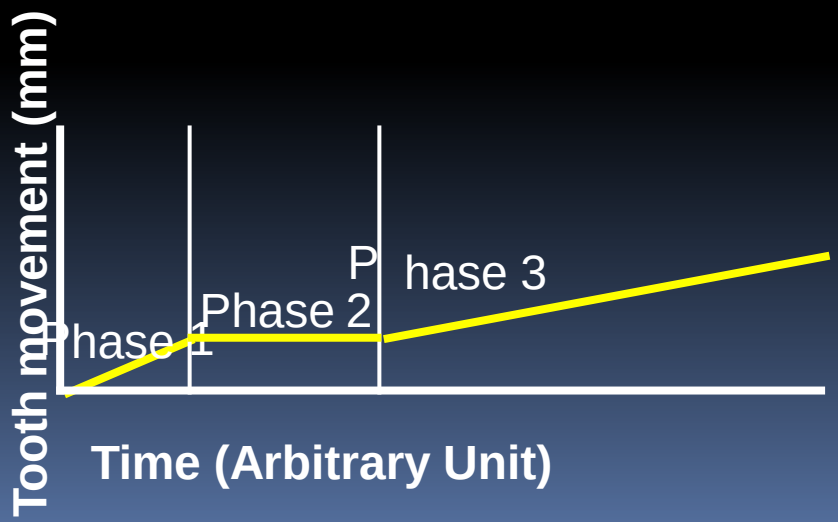
* B.V of PDL is totally occluded ---

then

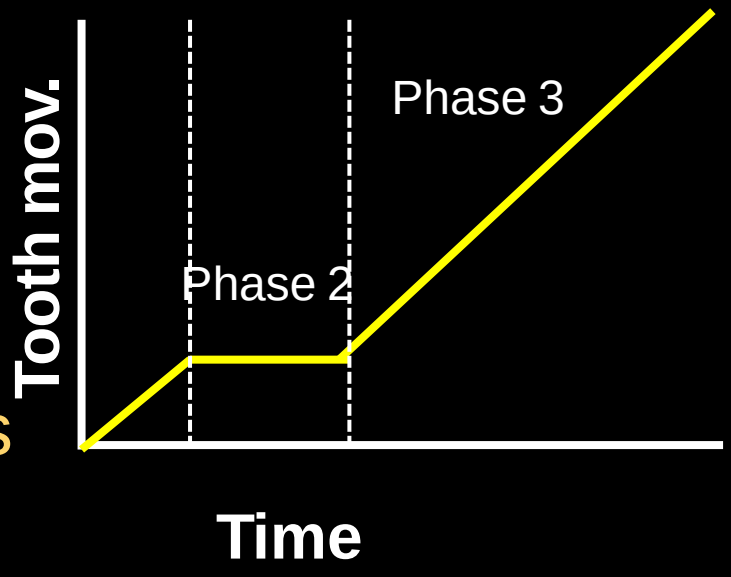
* causes cellular necrosis within the bone ---

then

* hyalinization i.e undermining resorption occur



Light. continuous forces



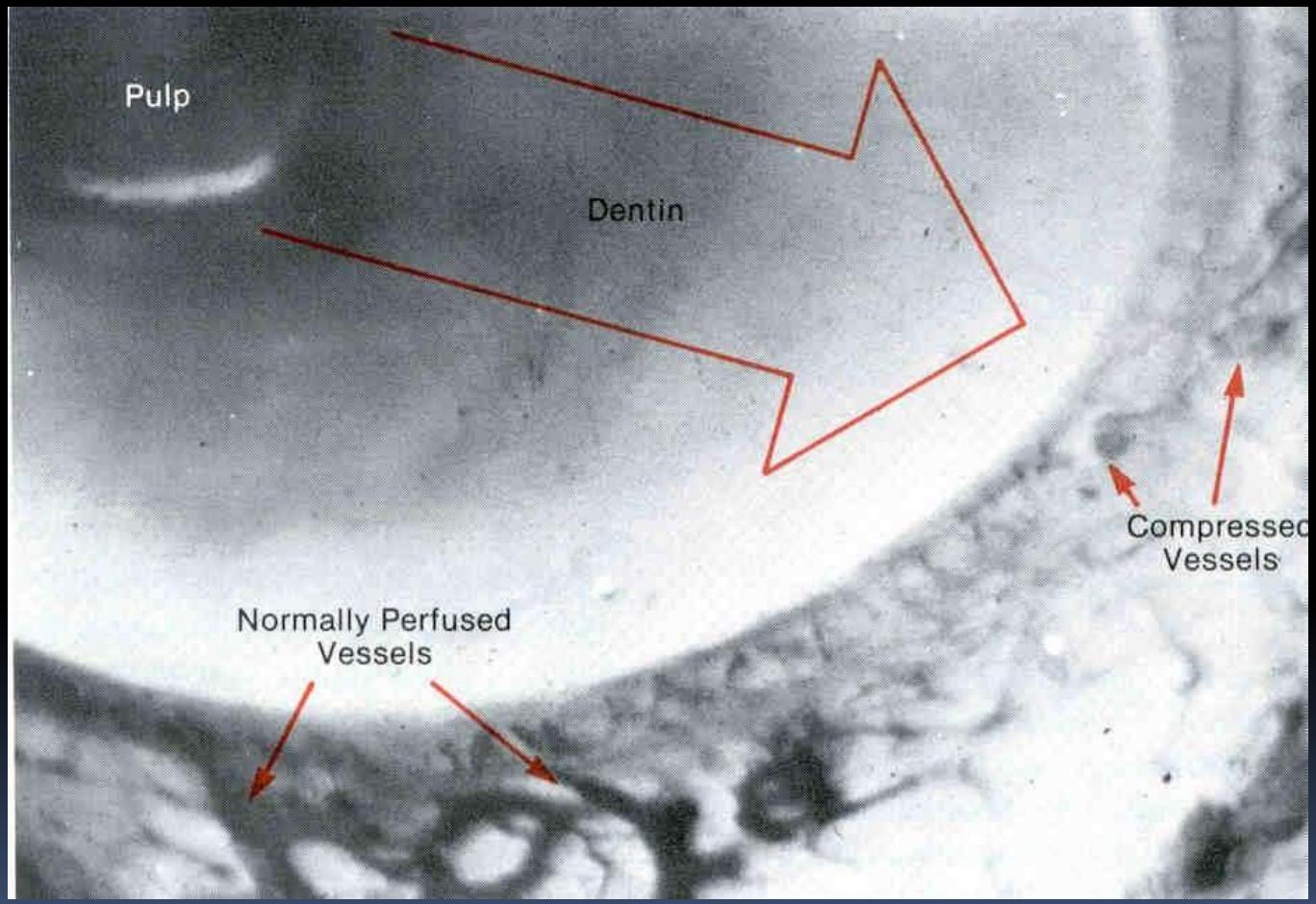
- Osteoclasts formed
- *Removing lamina dura.

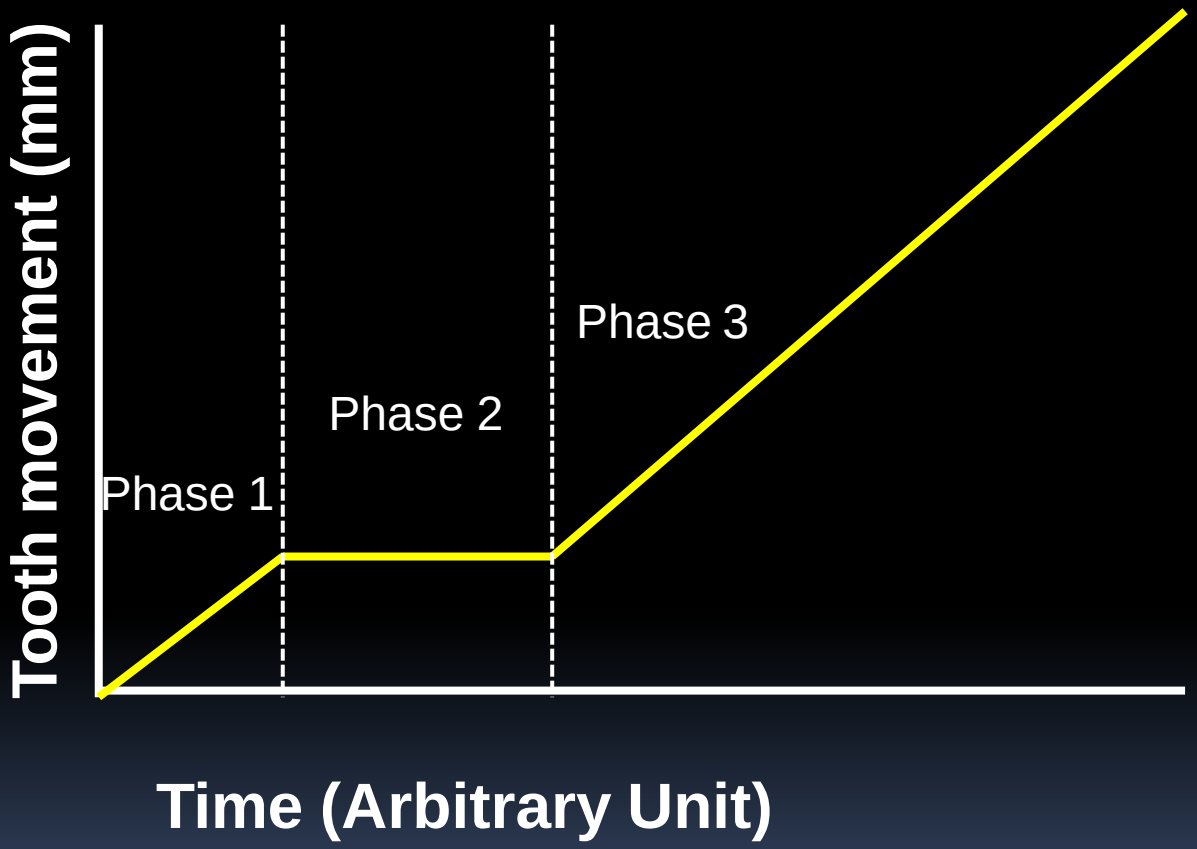
*Tooth movement begins

*This process is called

"FRONTAL RESORPTION".

(remodeling process)


Pulp
Dentin
Compressed
Vessels
Normally Perfused
Vessels


Tooth movement (mm)
Phase 1
Phase 2
Phase 3
Time (Arbitrary Unit)

Finally :

Optimal force

is the lightest force that will move a tooth to a desired position in the shortest possible time without iatrogenic effects

So ,,, we should think optimal ,, it is orthodontics so we (work smarter not harder) ☺

Thank You ☺