

The wrist

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Anatomy and mechanics of the wrist

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The Wrist

➔ Teaching:

Anatomy ?

Mechanics ?

Both are basic?

Both are evidence?

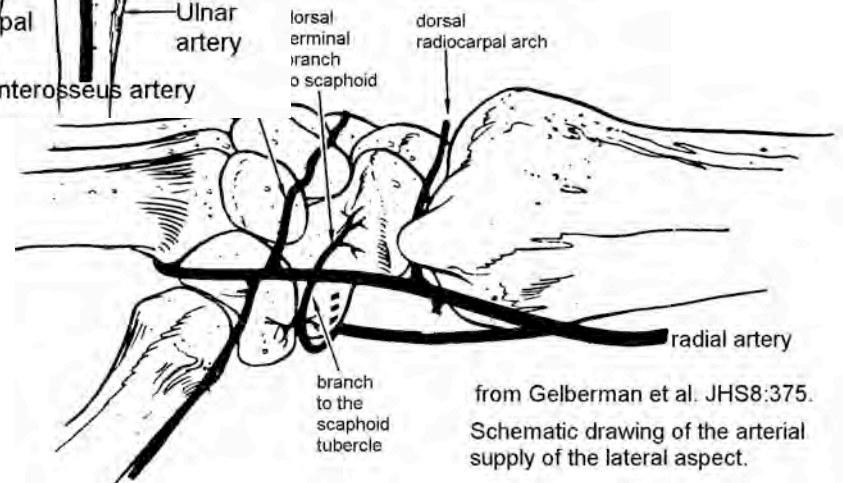
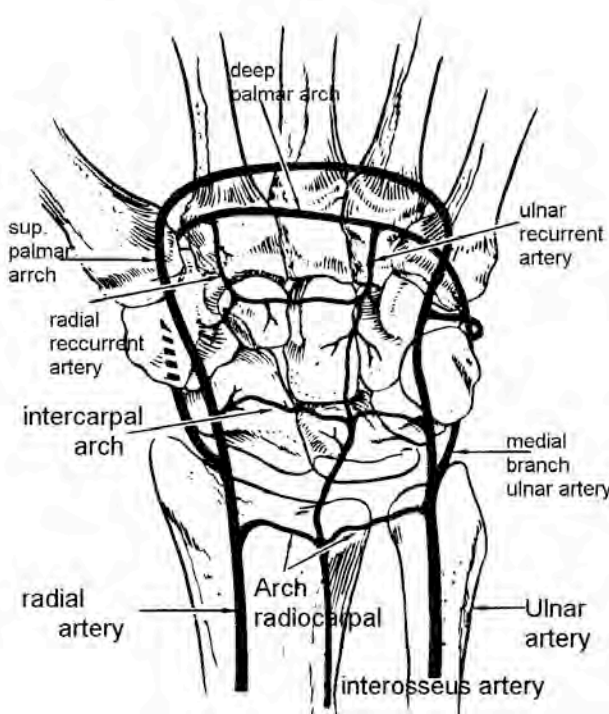
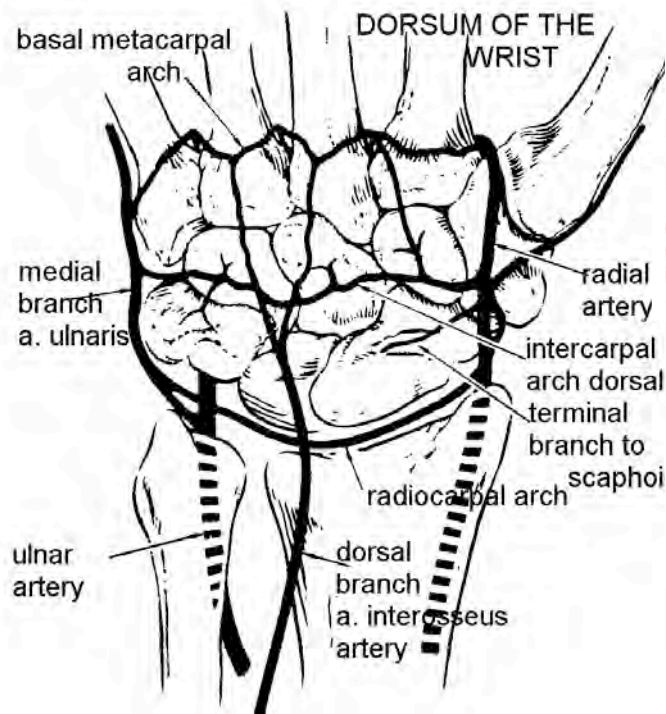
Both are related to one another!

The Wrist

Anatomy

Anatomy

vessels The Wrist



Seems accepted & important
vascularisation of scaphoid
lunate

from Gelberman et al. JHS8:375.
Schematic drawing of the arterial supply of the lateral aspect.

Anatomy The Wrist

**Vascular pattern of the lunate accoring to Gelberman:
3 major vascular pattern as presented:**



30%

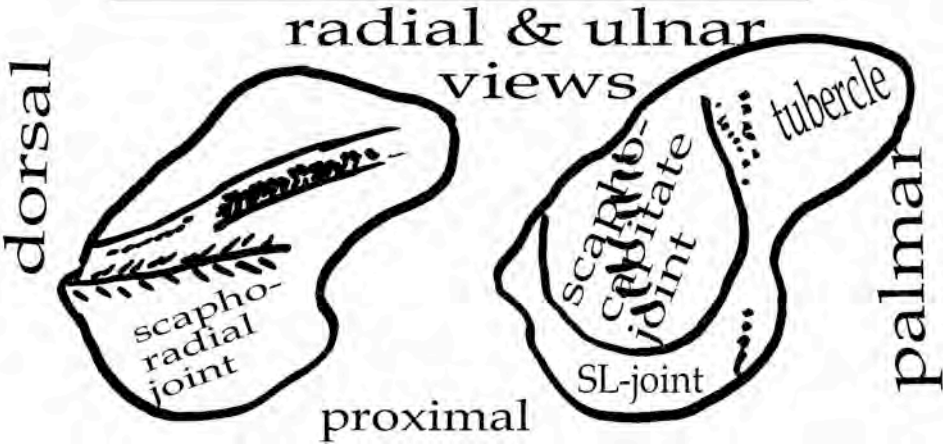
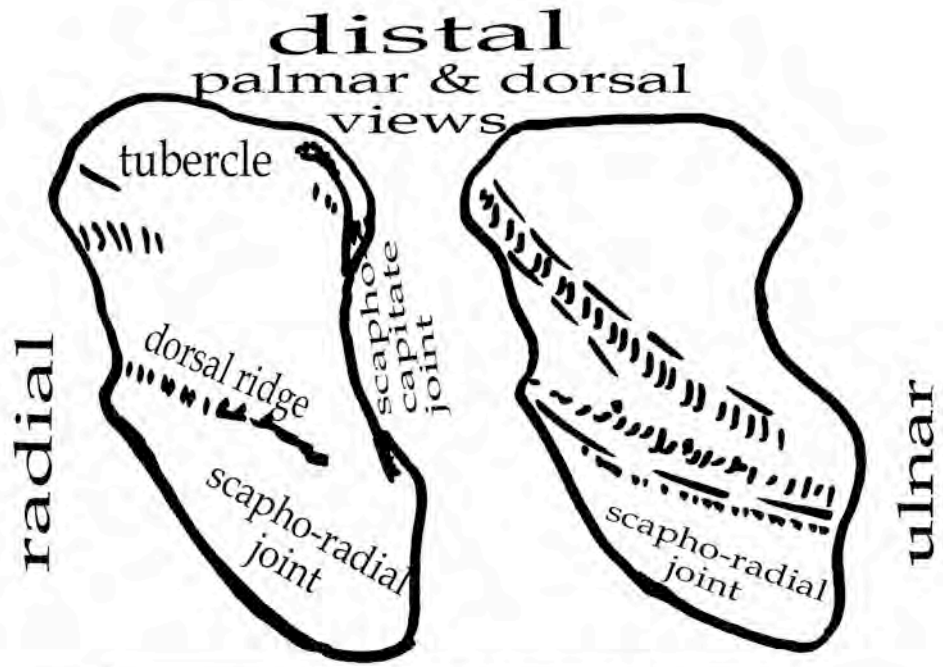
10%

60%

But 20% have an exclusive palmar supply!

Anatomy

Bones The Wrist

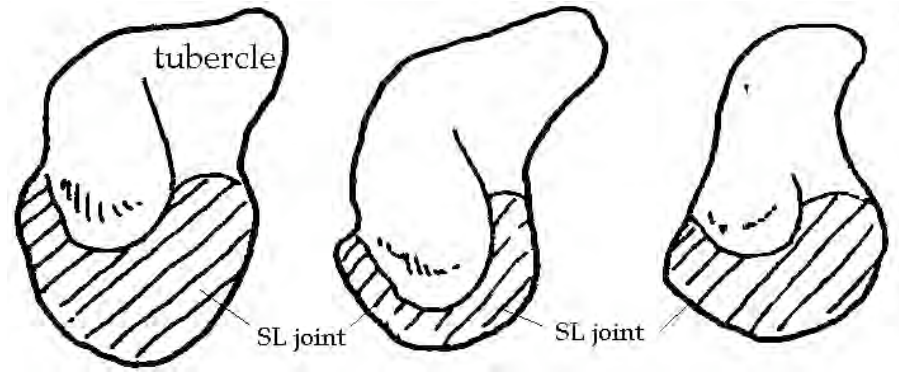


Compson: geometry of the scaphoid

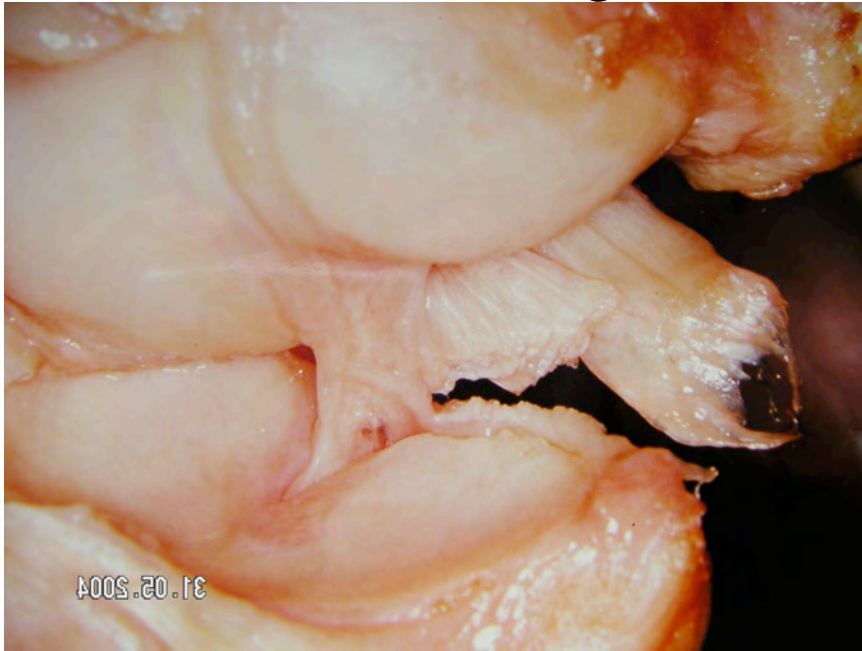
The problems

➤ Anatomical variations

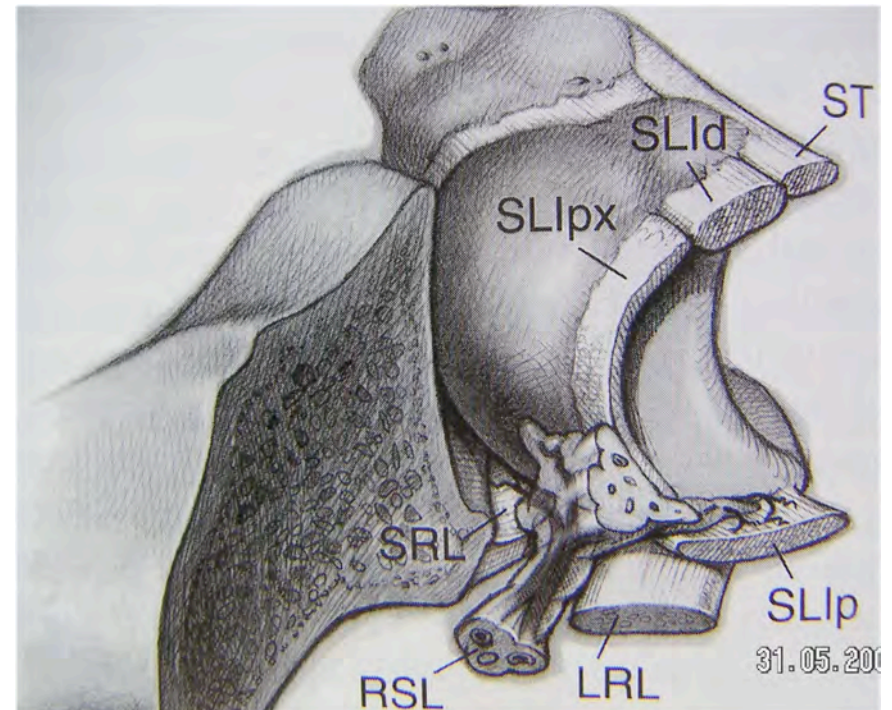
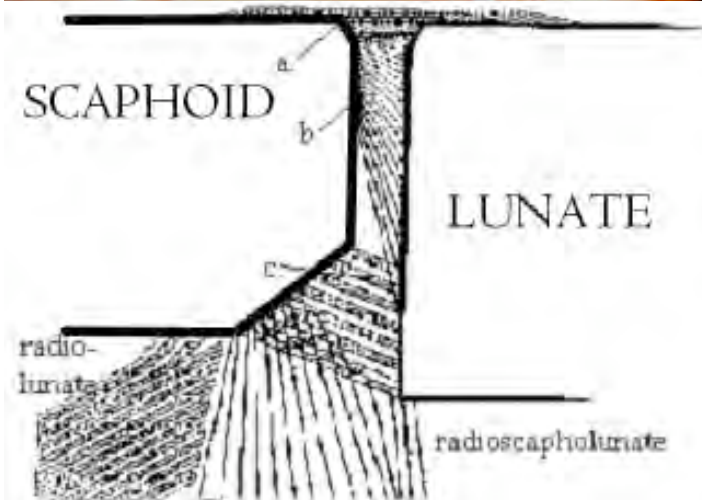
Consequences !



Anatomy The Wrist

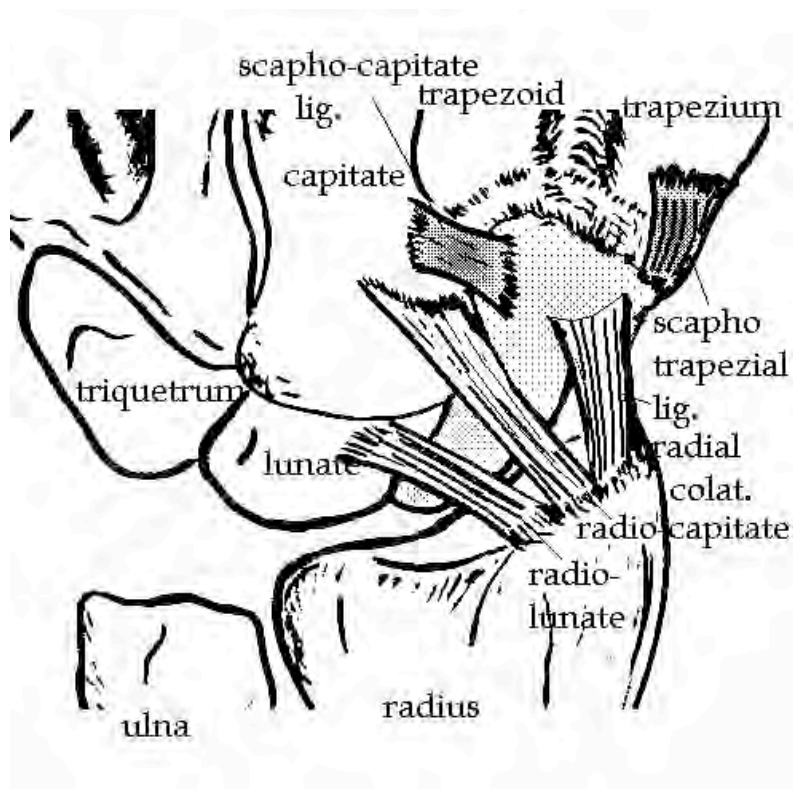


**Berger
Viegas**

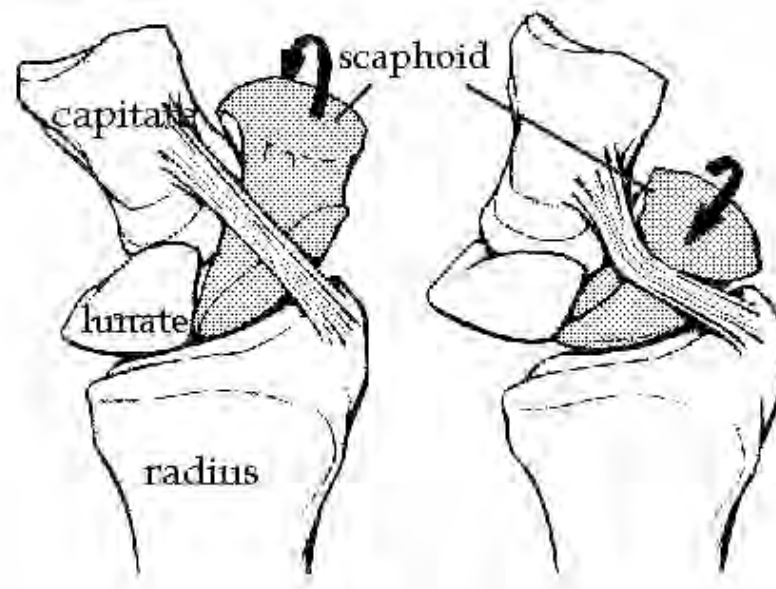


Anatomy ~~The~~ Wrist

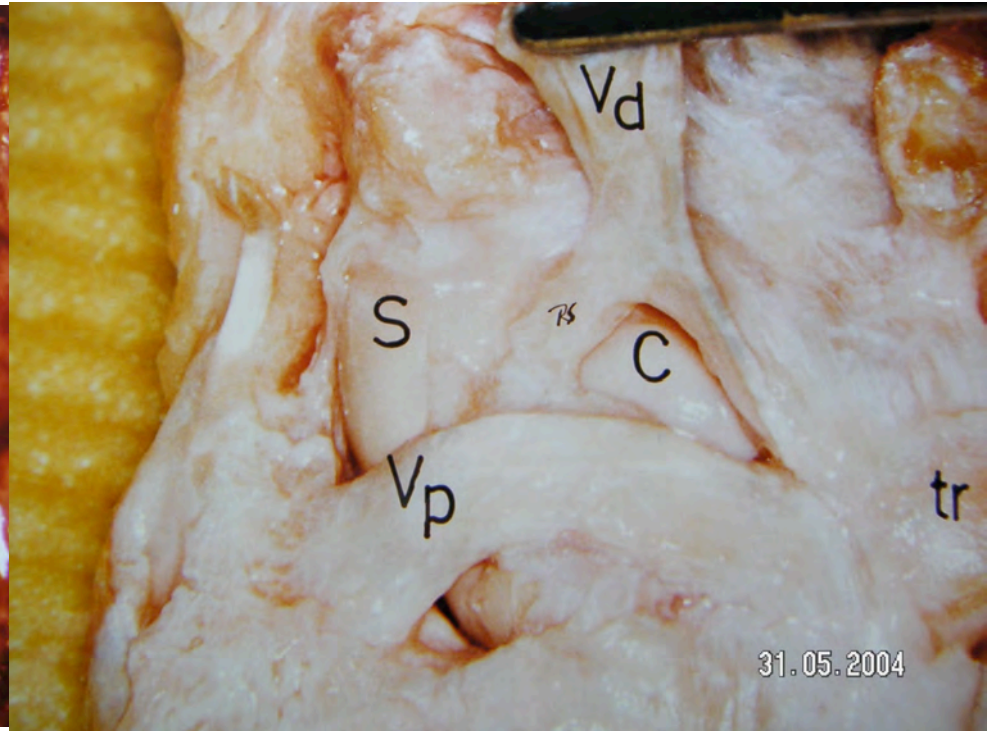
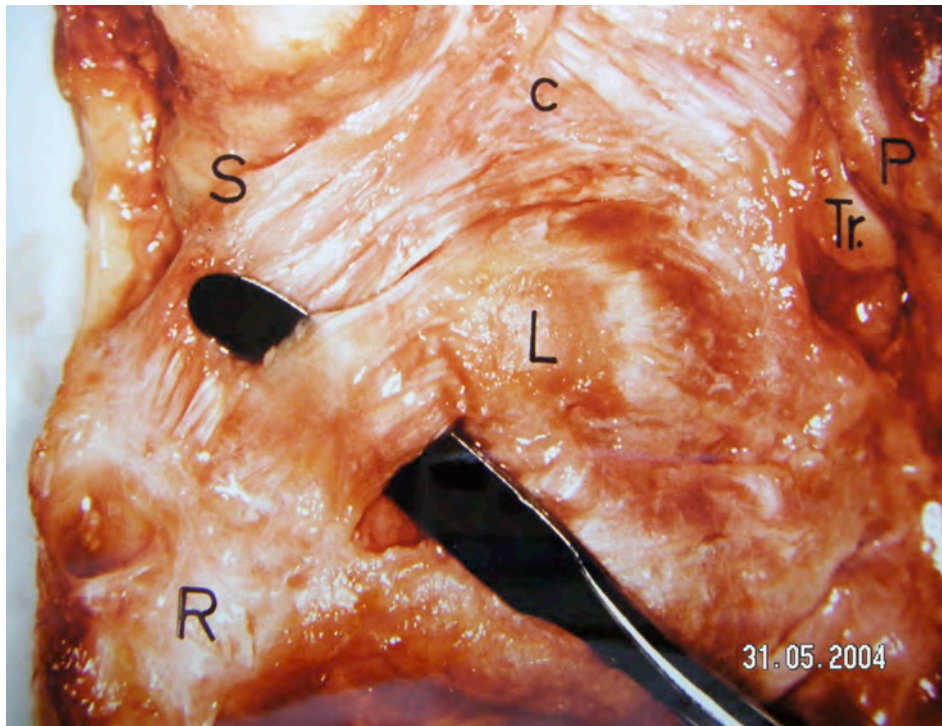
Ligaments Kuhlmann; Masquelet



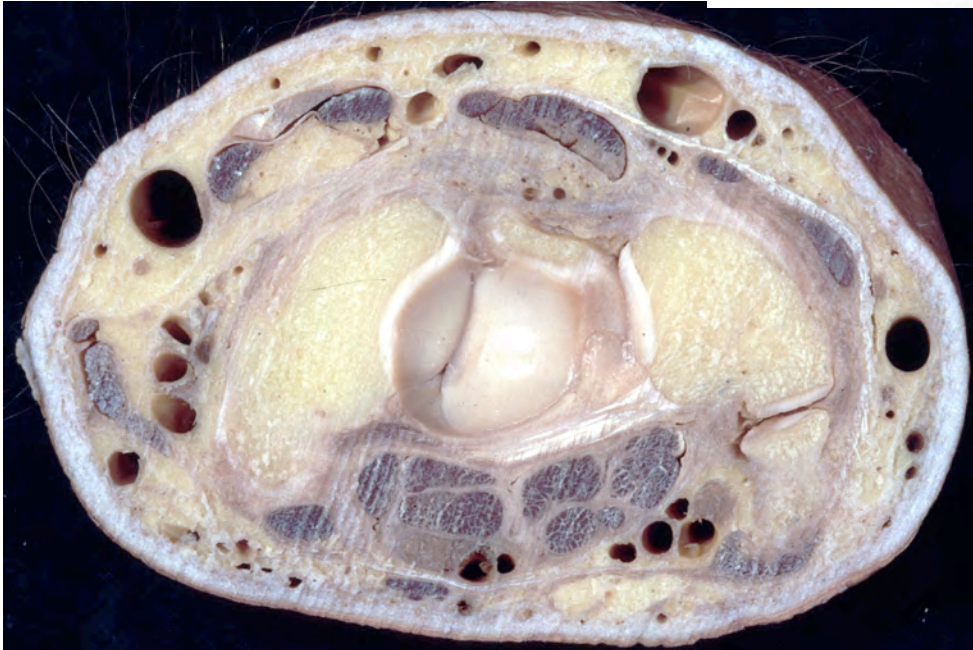
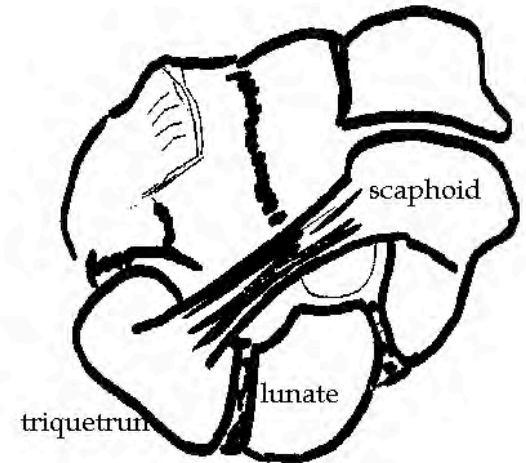
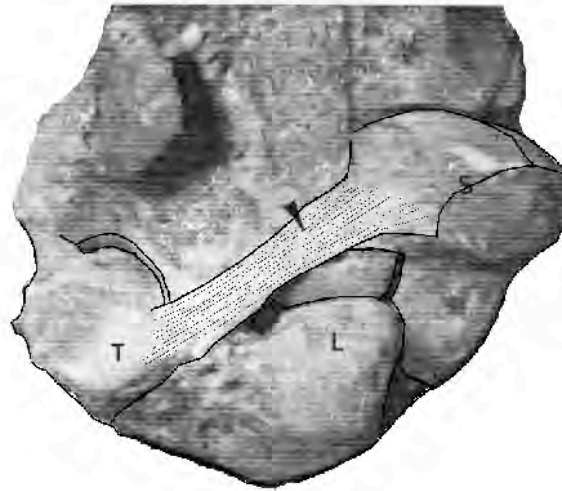
Verdan The RC ligament



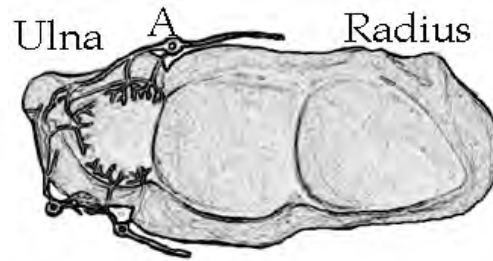
Anatomy The Wrist



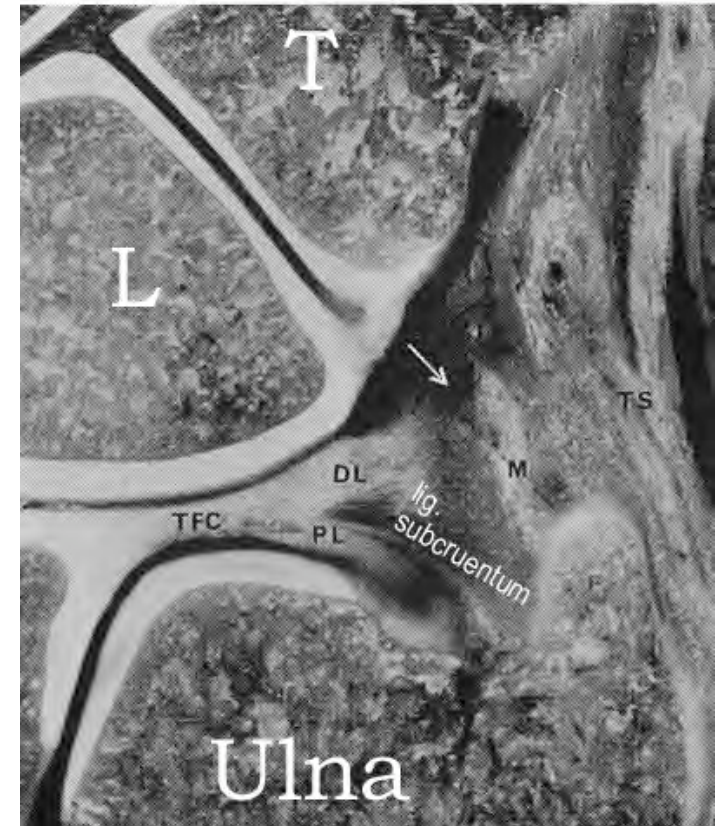
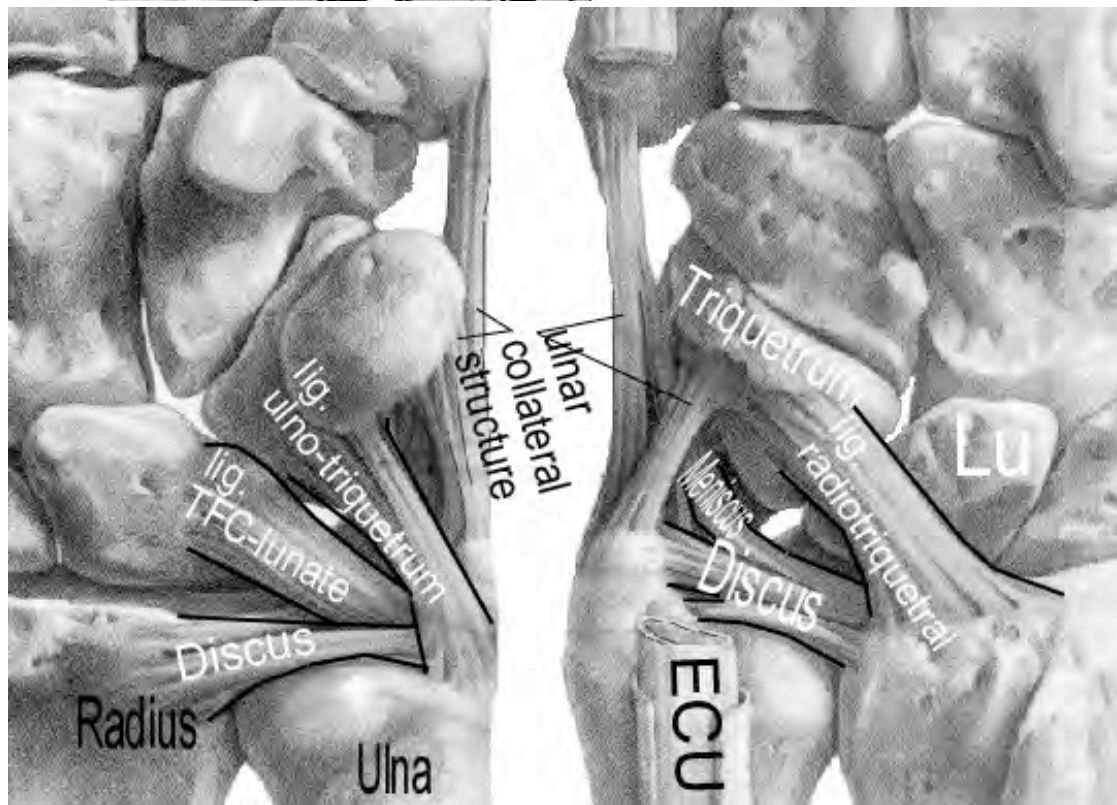
Anatomy The Wrist



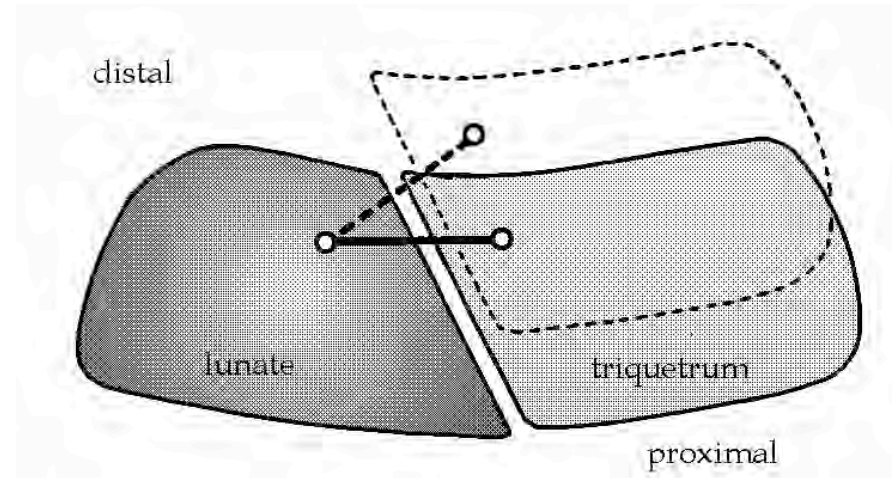
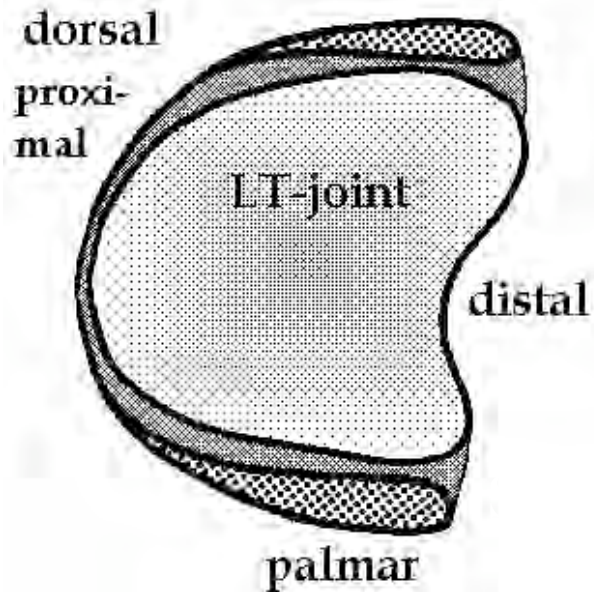
Anatomy The Wrist



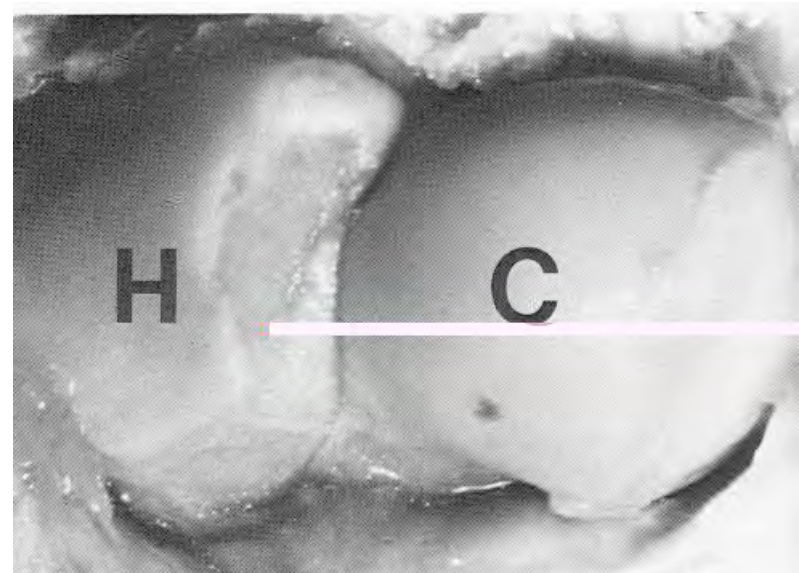
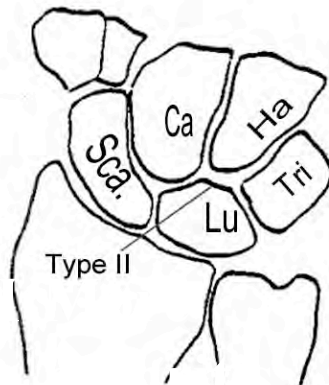
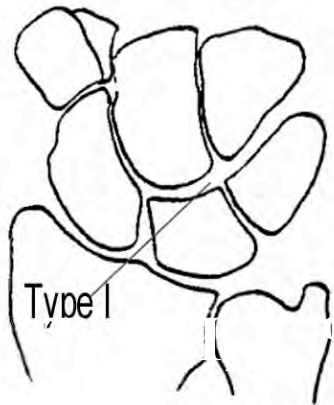
Schmid



Anatomy The Wrist

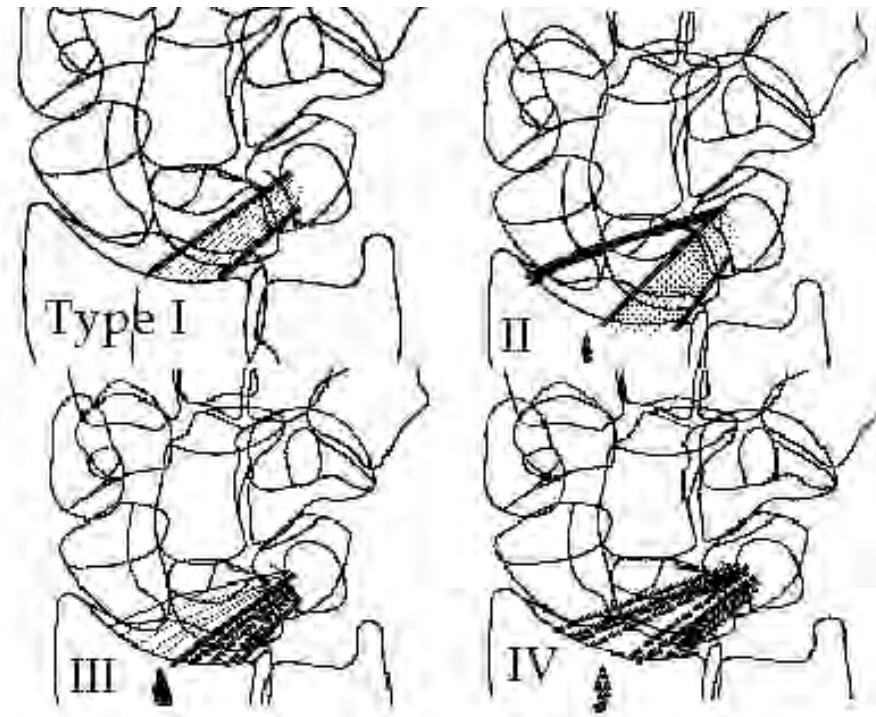
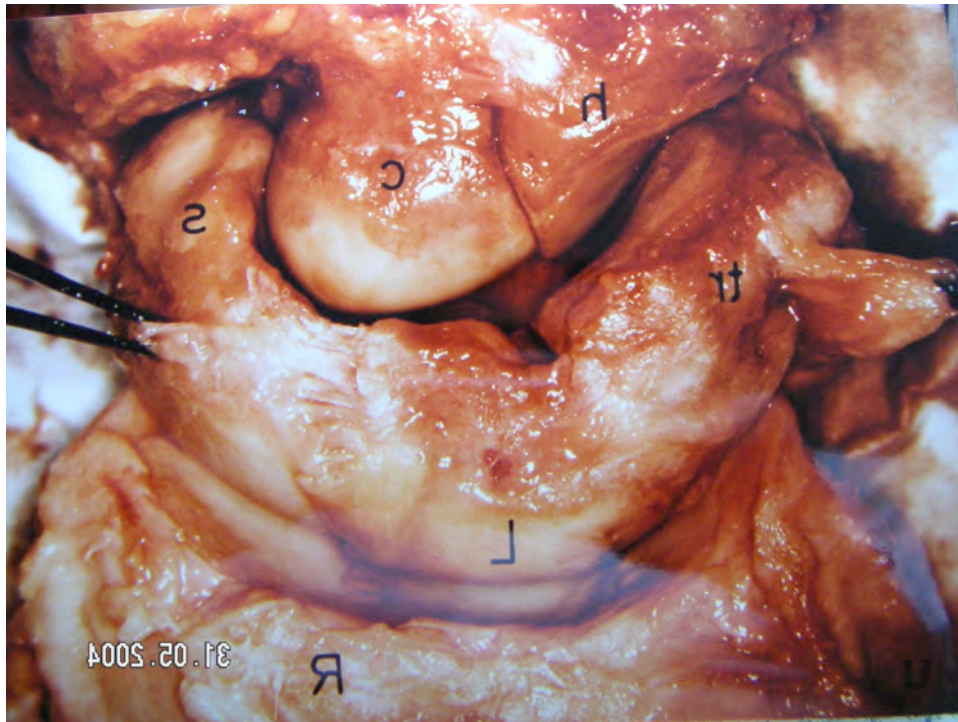


nger



Anatomy The Wrist

Viegas



Type I = 54 %

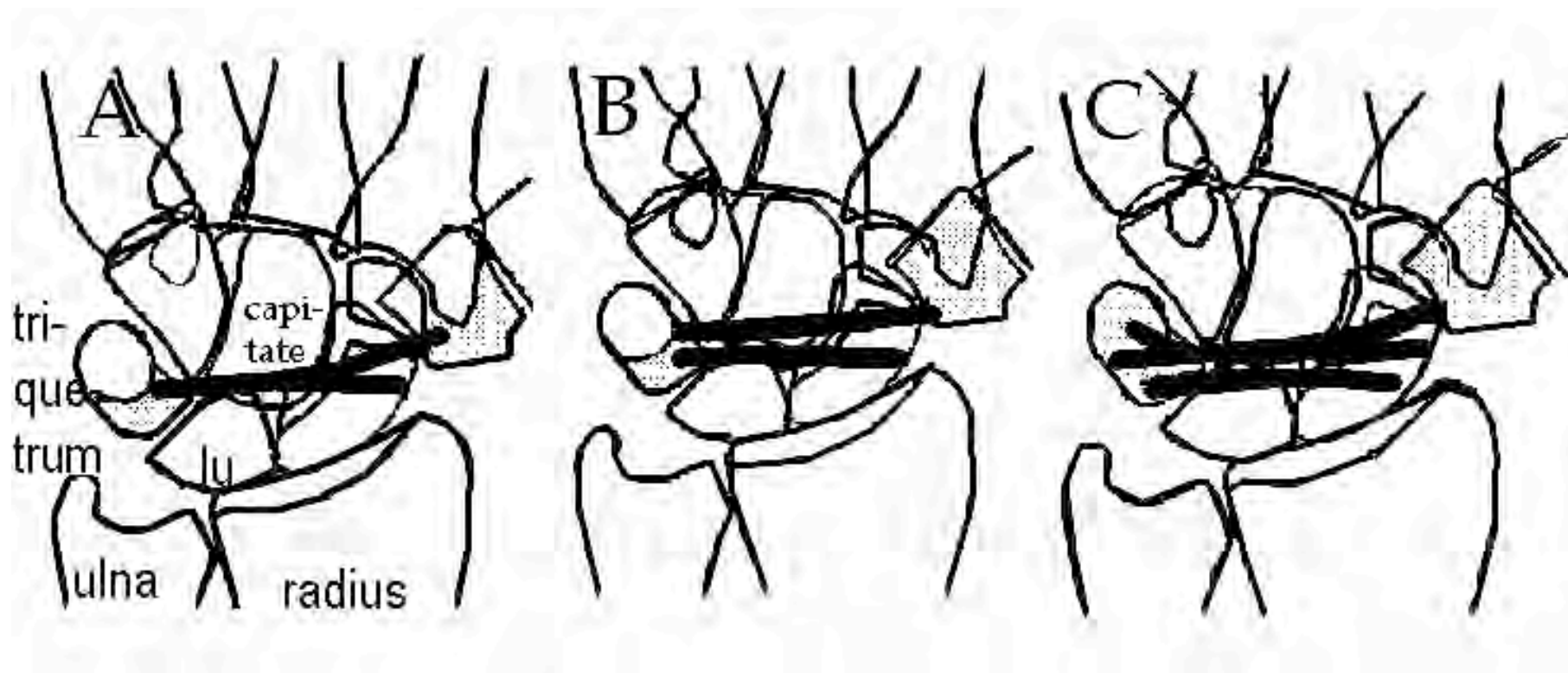
III = 12%

II = 24%

IV = 9%

Anatomy & Mechanics: The Wrist

DIIC

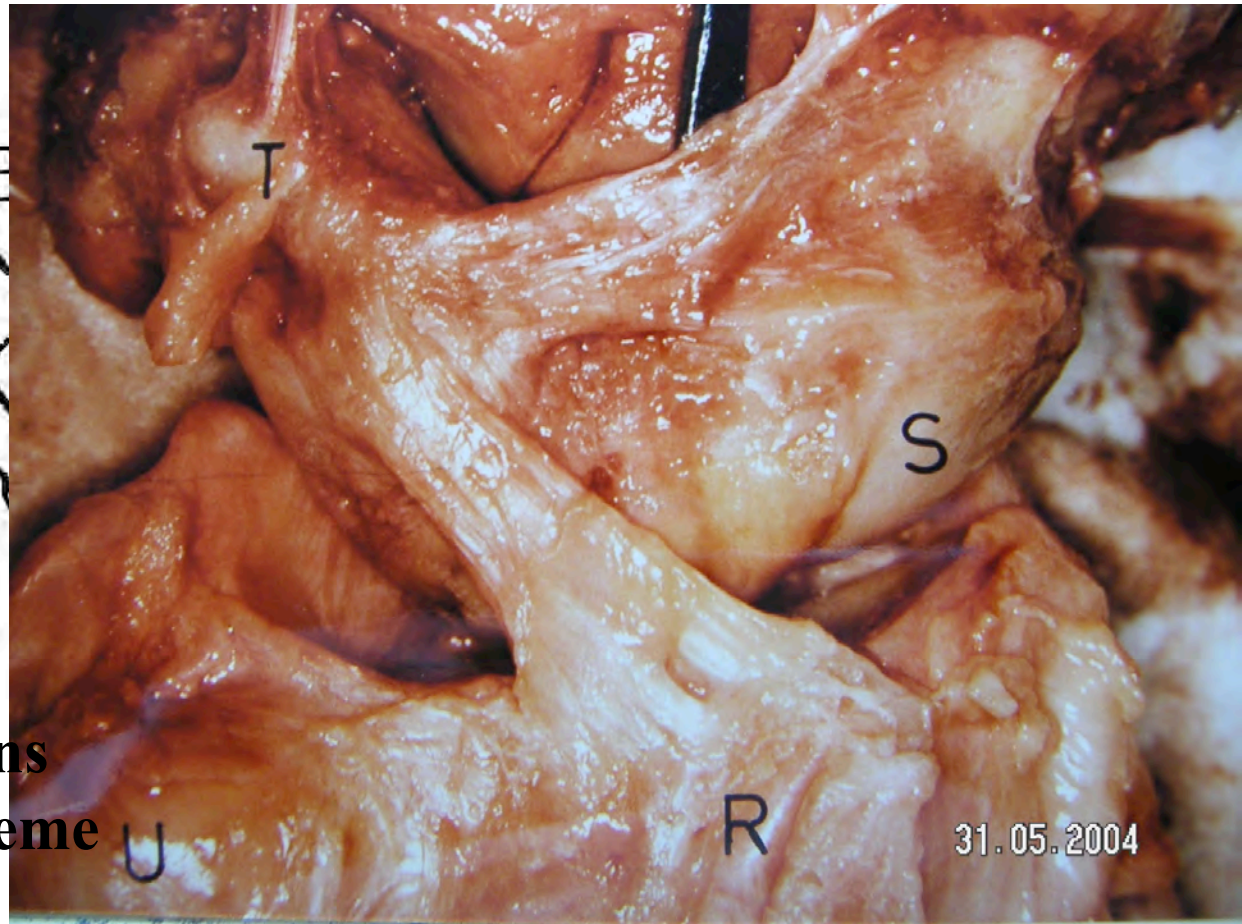
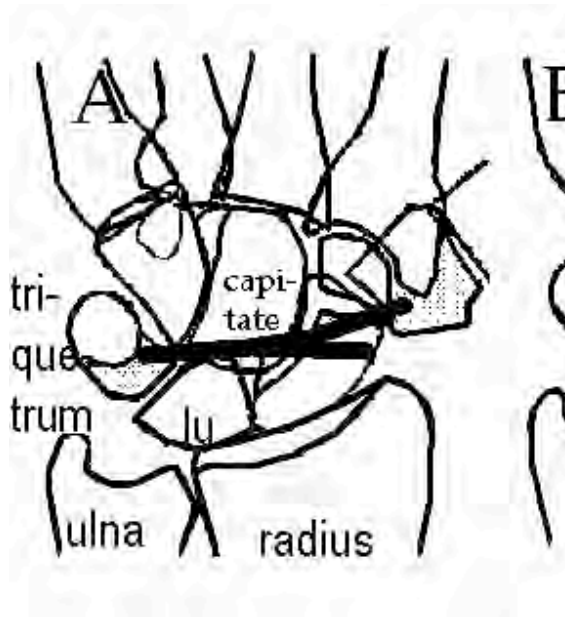


30%

44%

26%

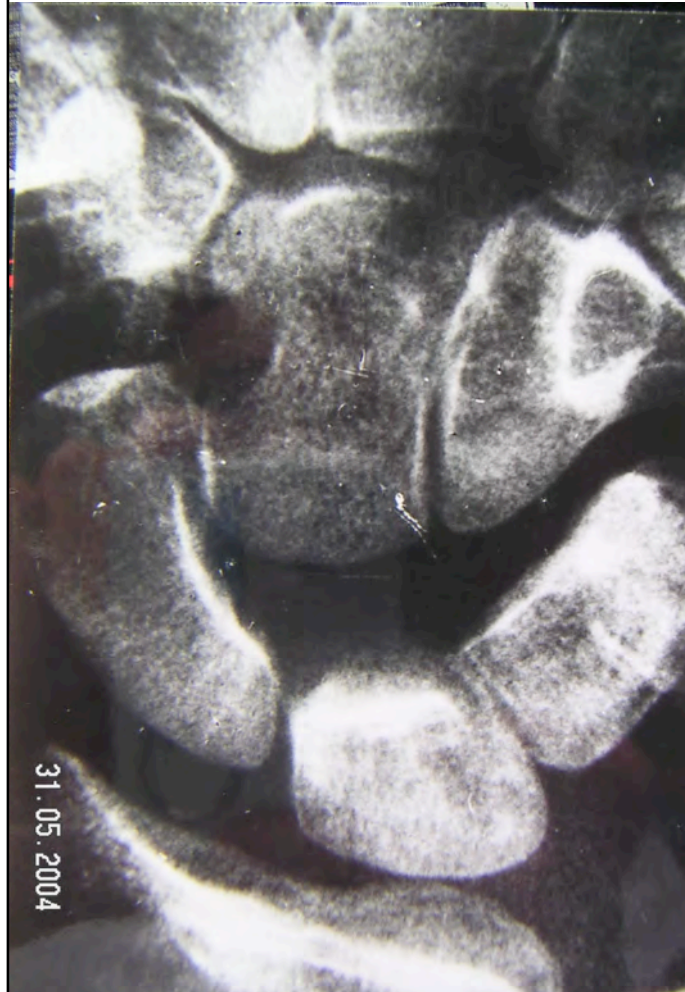
Anatomy & Mechanics: **The Wrist** DIC, combined to dorsal SL



Various presentations
Taleisnik: other scheme

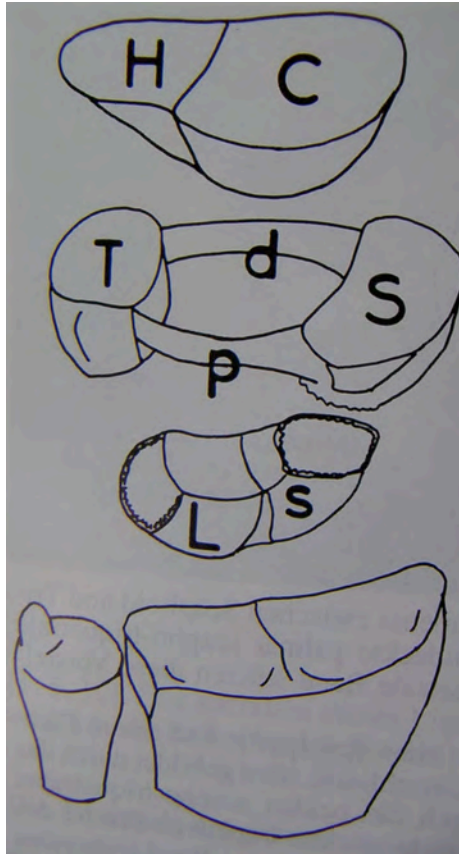
Anatomy & Mechanics The Wrist

**Orientation of
ligaments render
ligamentotaxis
inefficient**



mechanics

The Wrist



**Head of the
capitate, fixed
between
dorsal &
palmar ST
ligament.**

**Potential shear
forces =
scaphoid
fracture**



Mechanics

The Wrist

Mechanics

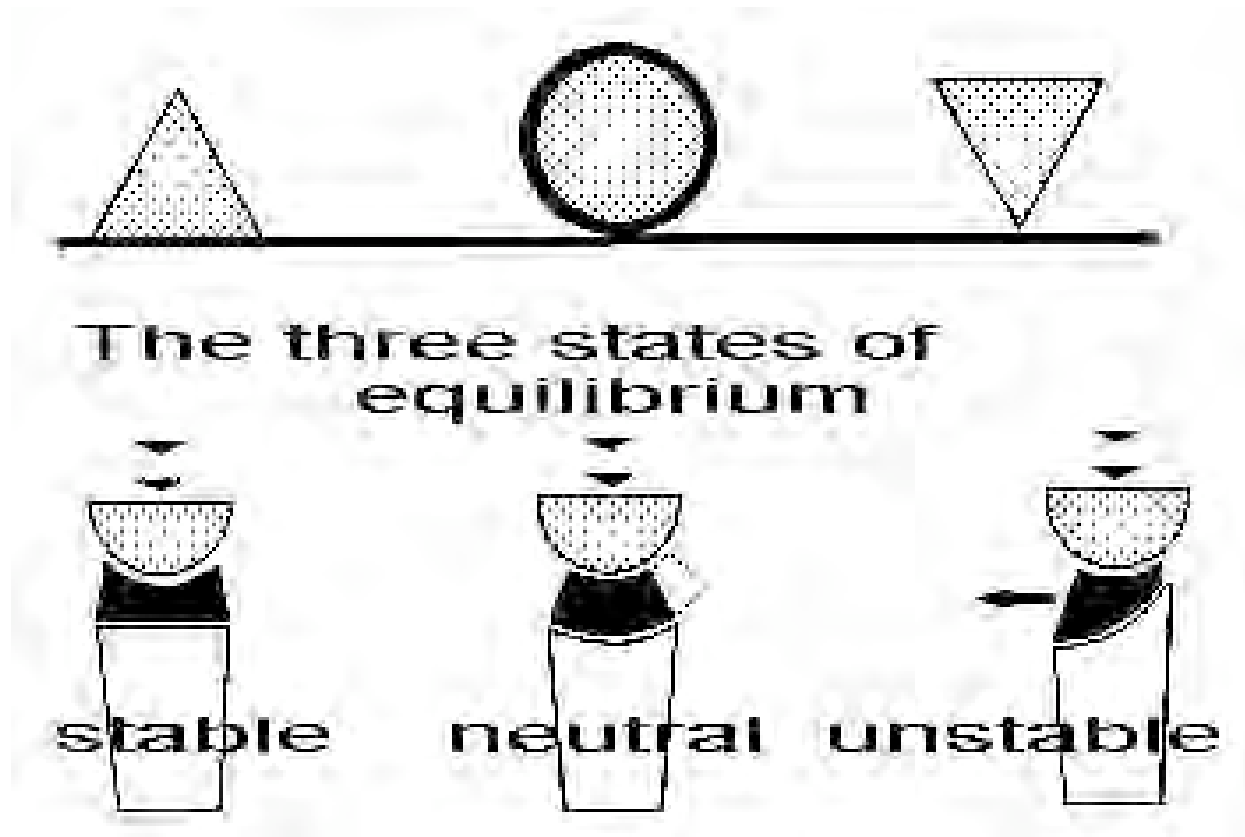
Understanding of mechanical
laws i.e.

load transfer
stability.

Mechanics

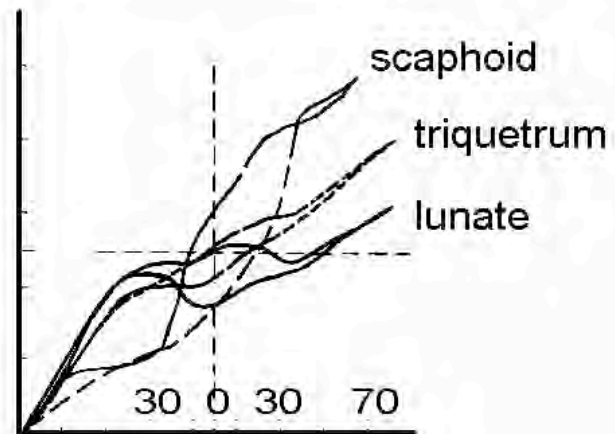
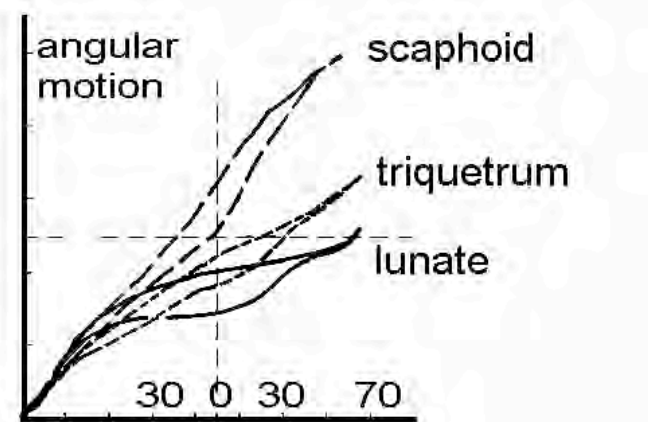
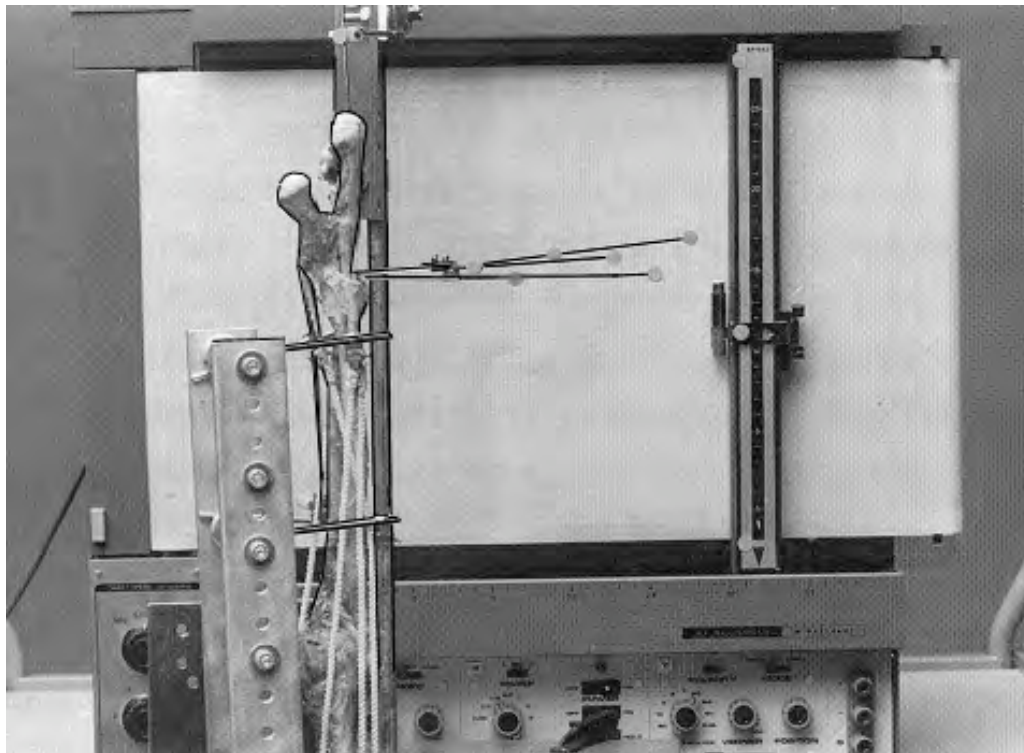
The Wrist

Definition of stability
Mechanical approach



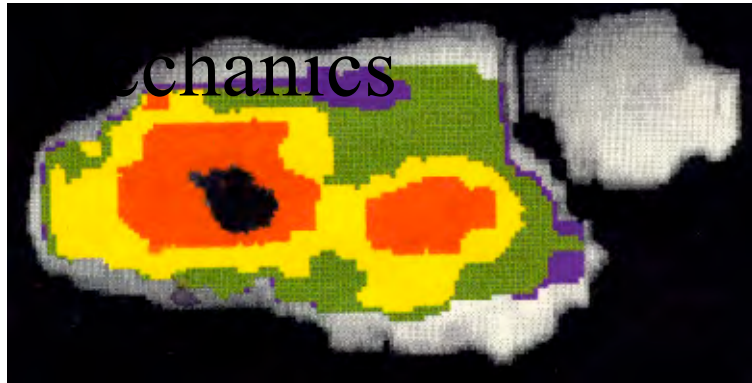
Mechanics

The Wrist



The Wrist

⇒ *A stable wrist has the ability to return to a definite position after removal of any destabilizing force at any point within the whole physiological range of motion.*



The Wrist

- ⇒ *Stability enables optimal joint contact, minimizes stress in any physiological position of the joint.*
- ⇒ *It ensures a smooth and reproducible motion pattern.*
- ⇒ *It warrants optimal load transfer.*

Mechanics

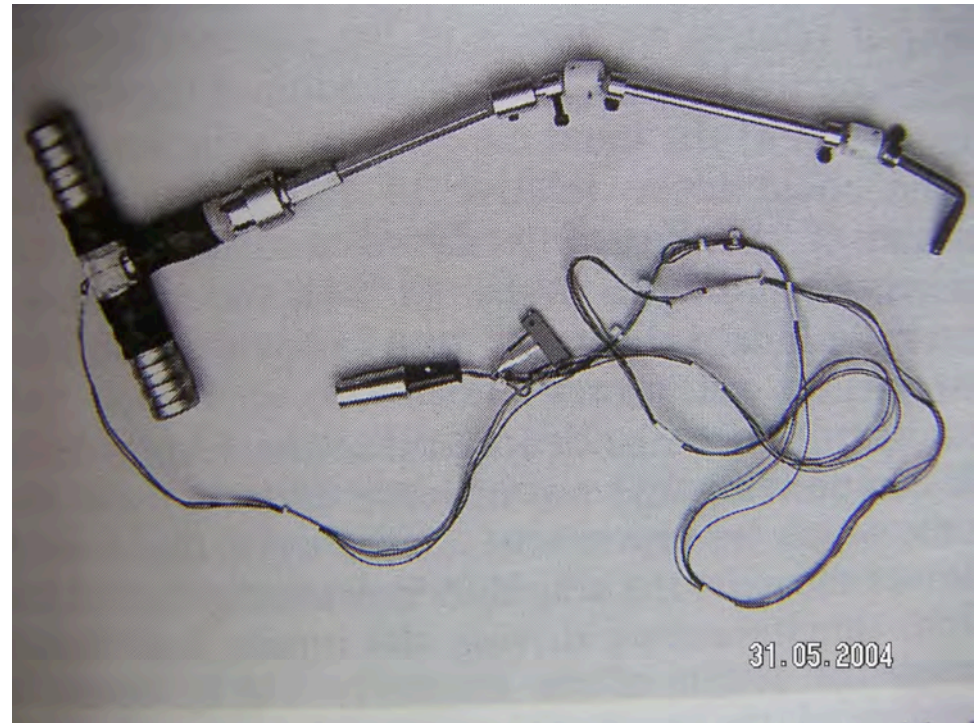
The wrist

- Ligaments of the proximal carpal row and function.

Mechanics, proximal row The Wrist

- Characteristics of pure torque is important:
pure torque can be introduced with the same effect at any point of the object.

**Torque wrench
with Hooke's universal
joints**



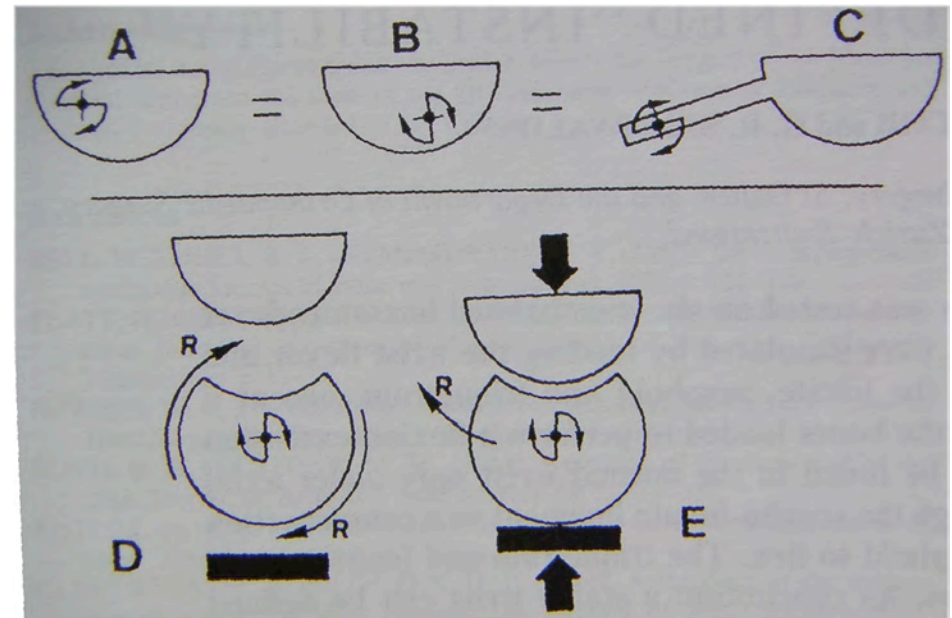
Mechanics, proximal row

The Wrist

➤ Characteristics of pure torque is important:

pure torque can be introduced with the same effect at any point of the object.

➤ The Reaction R of the pure torque depends on the constraints applied to the object.



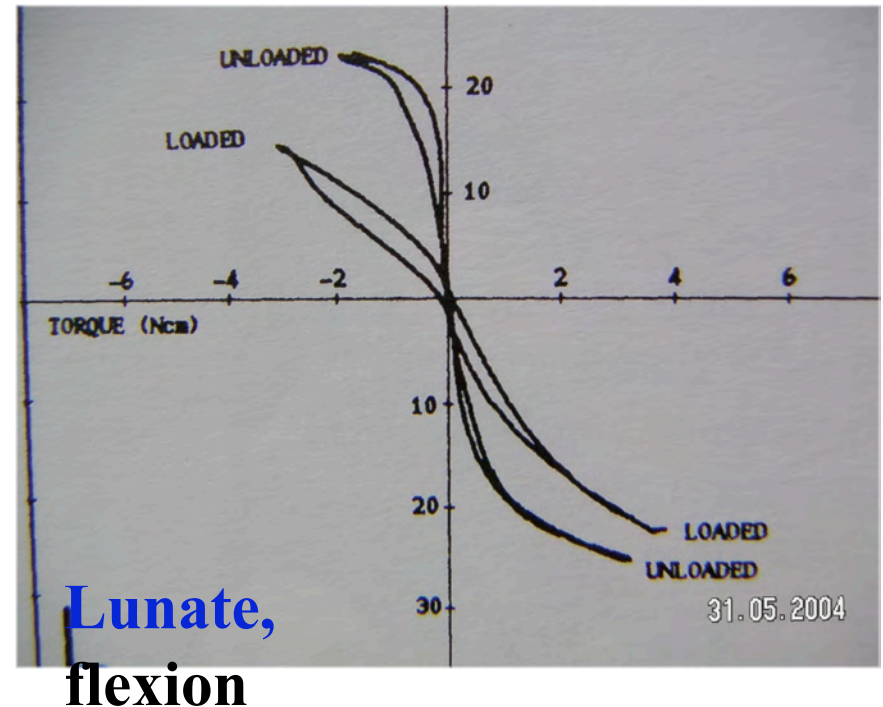
Mechanics, SL function

The Wrist

- Primary angular motion of the lunate in relation to the applied torque (Ncm).

After *loading*, the shape of the curve became oblique showing that much more torque is required to displace the bones.

On release of torque, the starting position is immediately regained.

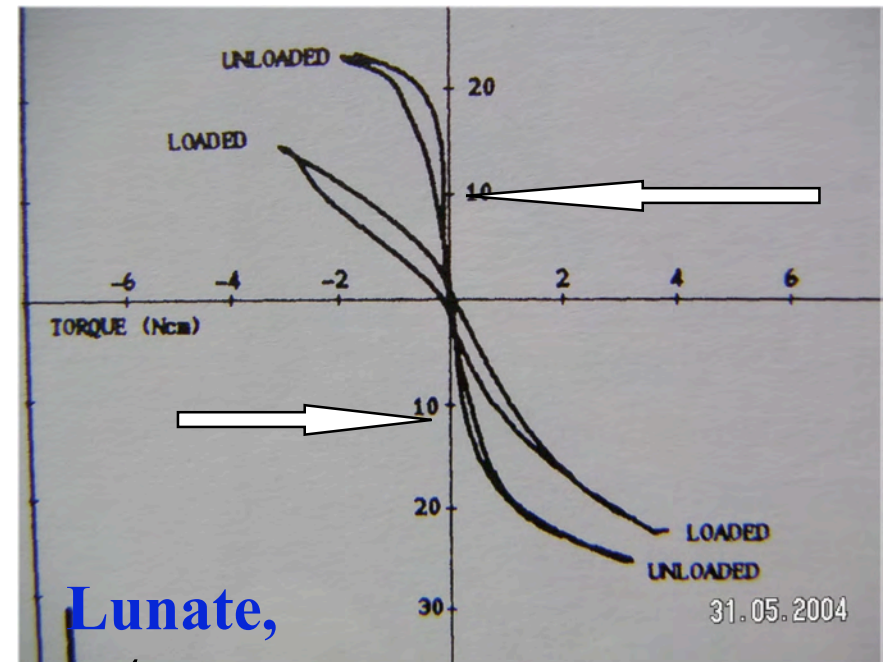


Mechanics, proximal row

The Wrist

- Unloaded curve:

Its middle part shows a range of positions within which the bones can be moved on application of a minimum amount of torque, *remaining stationary in the newly acquired position: this represents*



Lunate,

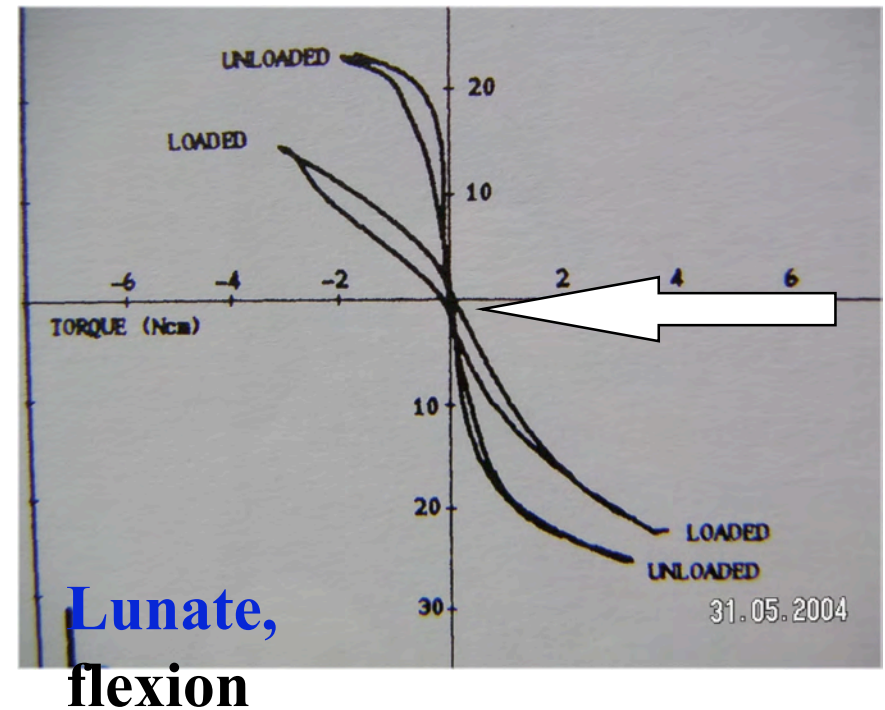
NEUTRAL EQUILIBRIUM

Mechanics, proximal row The Wrist

- Loaded curve:

The curves became oblique at the zero-torque crossing. They show that much more torque is required & that the starting position is immediately regained on release of the torque:

STABLE EQUILIBRIUM

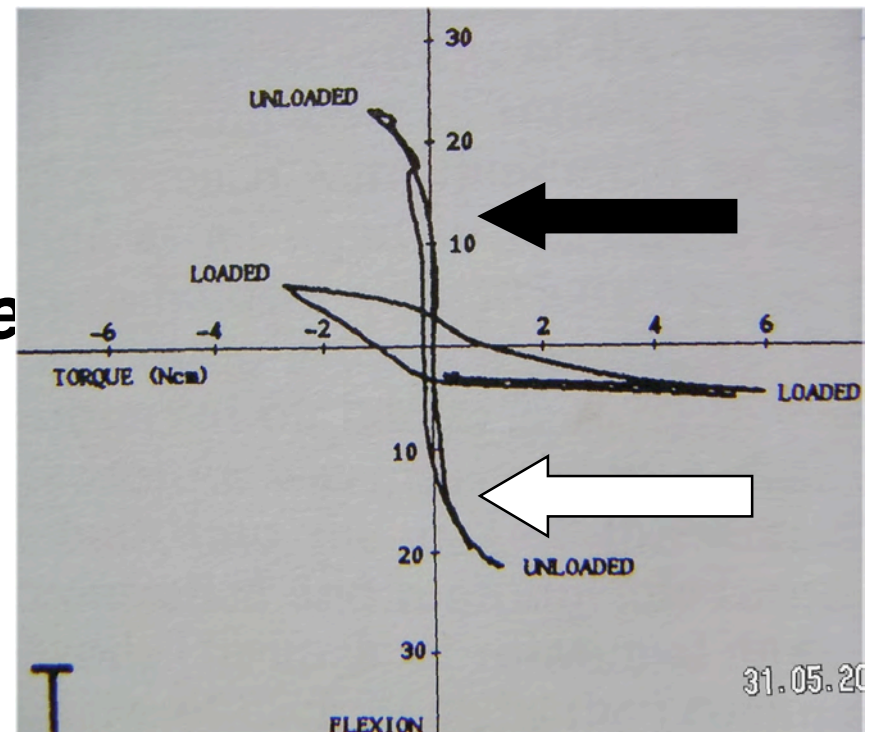


Mechanics, proximal row

The Wrist

- Primary angular motion of the triquetrum in relation to the applied torque (Ncm).

How much the bone suffers displacement by application of a given small amount of torque *depends on whether the wrist is loaded or not.* The return to the starting position = stable equilibrium

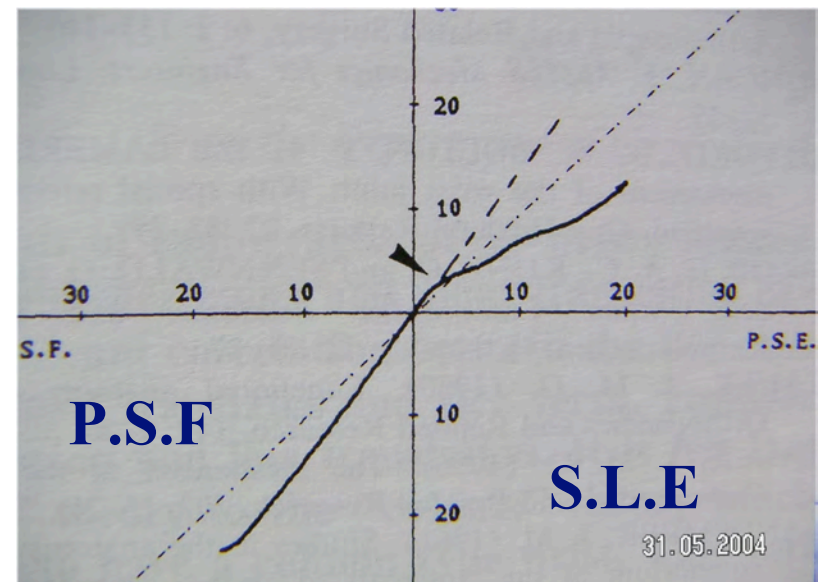


Mechanics, proximal row

The Wrist

- P.S.F: Primary Scaphoid Flexion.
- S.L.E: Secondary Lunate Extension

Primary induced motion of the scaphoid causes a secondary motion of the lunate. During extension, the lunate suddenly follows at a slower rate!



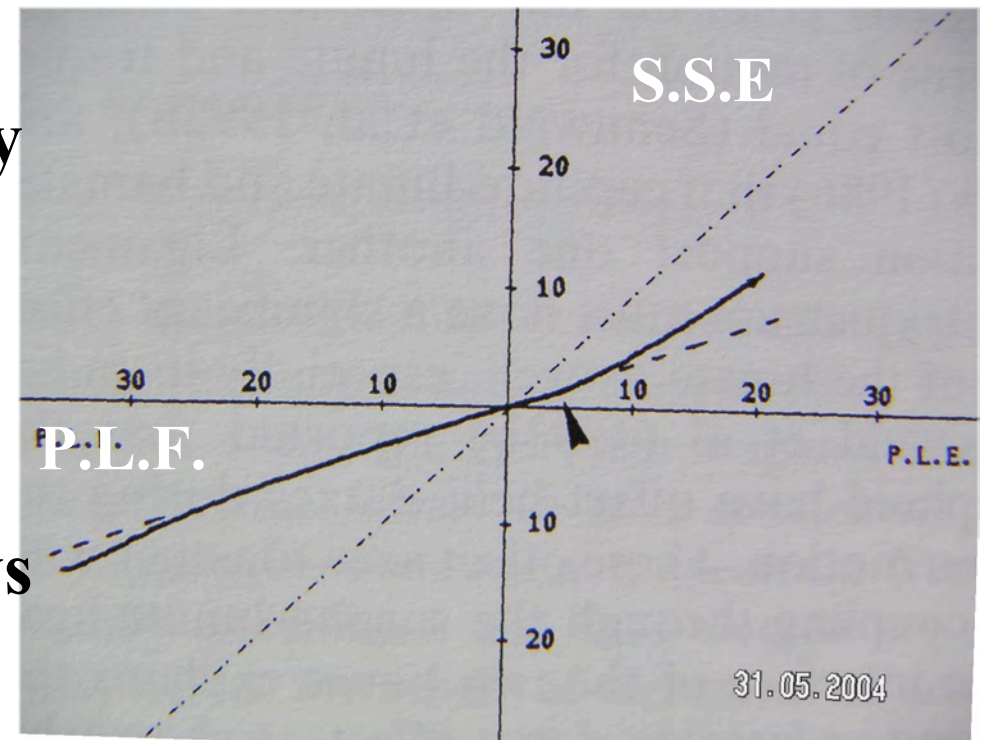
Mechanics, proximal row

The Wrist

- P.L.F: Primary Lunate Flexion.
- S.S.E: Secondary Scaphoid Extension

Primary induced motion of the lunate causes a secondary motion of the scaphoid at a lower rate.

During Lunate extension the scaphoid suddenly follows the lunate more closely !



Mechanics, proximal row

The Wrist

The mechanics shows:

- that motion of the lunate and triquetrum are closely coupled bi-directionally with a lag of about 5° .
- a consistent return to the initial position of the bones of the proximal carpal row.
- that the axial load has a stabilizing effect

Mechanics, proximal row

The Wrist

- primary motion of each bone in the proximal row induces a secondary motion of the other two.
- coupling between the scaphoid & lunate depends on the direction of primary motion.
- the SL ligament is under tension =
*tight coupling in flexion,
uncoupling in extension*

Mechanics, proximal row

The Wrist

- the pattern of motion between triquetrum and lunate are similar.
- capitate-lunate and hamate-triquetrum motion support one another.

Mechanics, proximal row

The Wrist

Conclusion

*A stable should be defined as one, which, while being loaded **within a physiological range of stress**, does not lose its stable state of equilibrium at any point within the physiological range of motion.*

The Wrist

Conclusion:

*this allows to be simple: i.e. for
classification of carpal instability*

stage 1 without dissociation

stage 2a, with dissociation reducible

Stage 2 b with dissociation not reducible.

stage 3, with carpal collaps.

stage 4, with pan - arthrosis.

The Wrist

Conclusion: mechanics suggest to be simple, for example, for classification of carpal instability

stage 1 with dissociation

stage 2a, with dissociation reducible

Stage 2 b with dissociation not reducible.

stage 3 with carpal collapse.

stage 4, with pan - arthrosis.

**Thank you
for your attention**