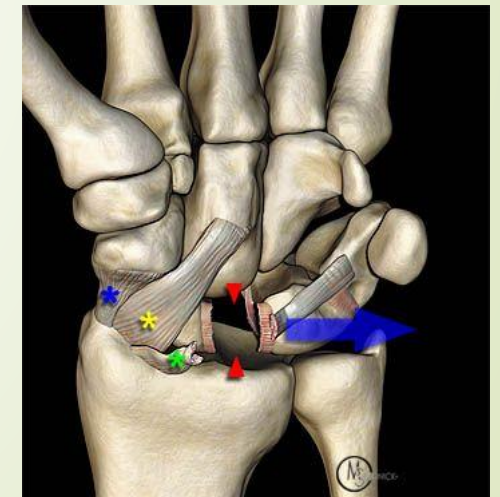
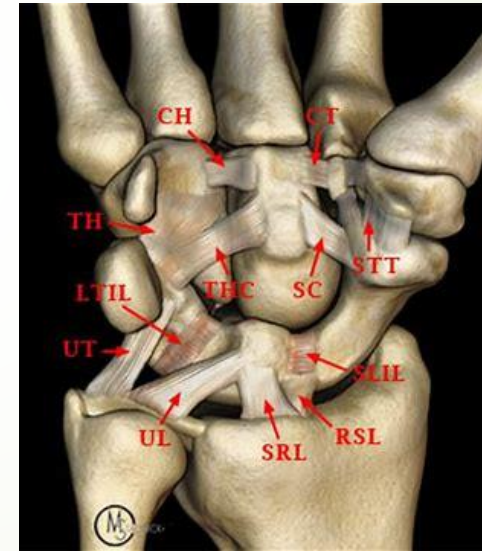
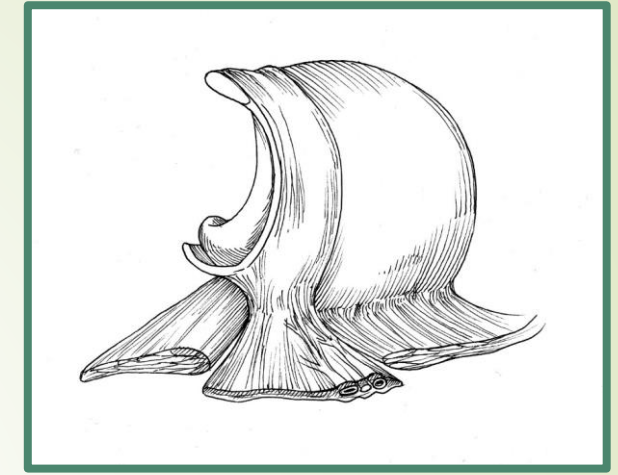


UPDATES FOR TREATING COMPLETE SLIL INJURIES



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Dubai

- The average thickness of the dorsal portion is 3 mm in comparison to the volar region than is 1 mm.
- The dorsal component fail at 260 N of stress compared to 118 N of the volar part.
- The dorsal component plays the major role in translation and rotatory stability whereas the palmar component act as an additional rotational constrain.
- Secondary stabilizers are: Palmar Radio-scapho-capitate, Scapho-capitate and Anterior STT ligaments.



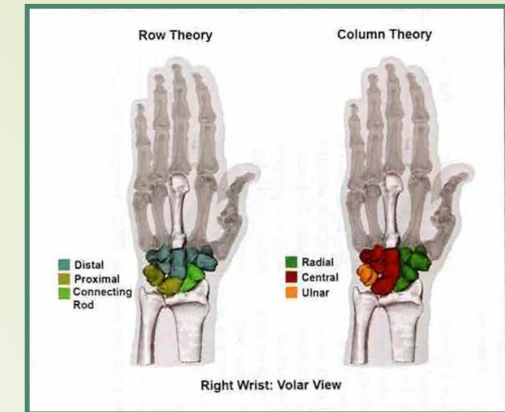
Kinematic function of the wrist

2 rows (Bryce & Destot 1926)

- ▶ Lunate and Triquetrum form the proximal row. Refer as the Intercalate segment due to the lack of musculotendinous attachments.
- ▶ Distal row (Trapezium, Trapezoid, Capitate and Hamate) are bound to the MCs and move together as a rigid unit.
- ▶ Scaphoid function as a bridge or connecting row
- ▶ Movement in the proximal row occurs secondary to signals from the distal row
- ▶ Flexion/ extension occurs between the 2 rows (Midcarpal) and the radial/ulnar deviation through the articulation of the Scaphoid with the Radius (Radiocarpal)

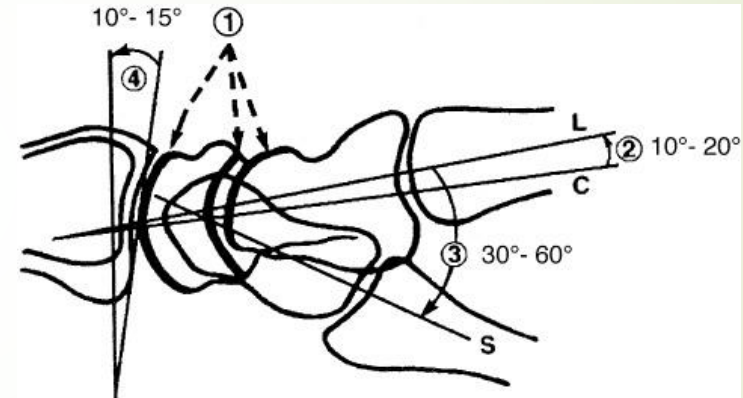
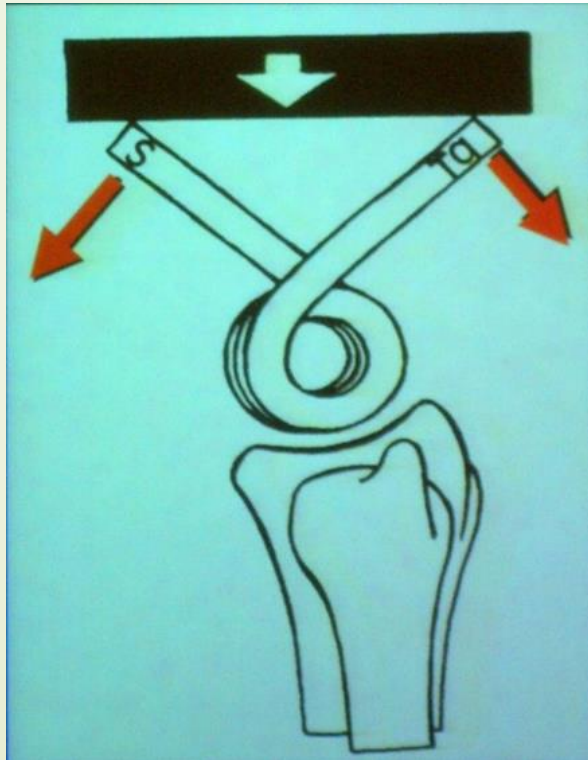
Column Theory (Navario 1921)

- ▶ Radial Column (Scaphoid, Trapezium and Trapezoid)
- ▶ Central Column (Capitate, Hamate and Lunate)
- ▶ Ulnar Column (Triquetrum)
- ▶ Flexion & extension occurs in the central column
- ▶ Radial/Ulnar Deviation occur through rotation of the Scaphoid and Triquetrum about the central column.



WRIST KINEMATICS (Garcia-Elias theory 1997)

- The distal scaphoid pole naturally rotates in a volar manner.
- The lunate is neutral.
- The triquetrum naturally rotates in a dorsal manner.
- These three bones are bound together by the SL and the LT ligaments which therefore limit the degree of rotation that the triquetrum and scaphoid can undergo and also maintains the neutral position of the lunate.



Stages of Scapholunate Instability

- **Predynamic Instability:** Partial tear. Normal X-Ray. Grade I-II arthroscopically.
- **Dynamic Instability:** SLIL tear dorsal and volar. 2ry stabilizers maintained. Stress X-rays may show changes. Grade III.
- **Static Instability:** SLIL tear volar, dorsal and 2nd stabilizers. SL gap >3 mm, SL angle >70°. Grade IV.
- **Fixed Static:** SLIL complete tear. Rotation deformity of the Scaphoid. RL angle >15°, CL angle >-15°. Grade IV.
- **SLAC:** SLIL complete tear, Arthritic changes at styloid and/or scaphoid fossa, Chondromalacia and arthritis.

	STAGES	TREATMENT
Partial SL ligament injury	1	K wires +/- Dorsal Capsulodesis
Complete SL lig. injury with a reparable Dorsal SL lig.	2	Trans-osseous or anchors sutures
Complete Non reparaible SL lig. injury with a normally aligned scaphoid	3	Ligament Reconstruction (3LT)
Complete SL lig. Injury with non repairable reducible rotary subluxation of scaphoid	4	Ligament reconstruction (3LT, 3-ligament tenodesis)
Complete SL lig. Injury with irreducible malalignment, but normal cartilage	5	Partial Fusion (STT, SC)
Complete SL lig. Injury with irreducible malalignment and cartilage degeneration	6	Proximal row carpectectomy. Four corners Fusion, RL Fusion.





Results

- **The goal of those procedures is to decrease pain and arrest progressive degenerative changes.**
- **But substantial wrist motion is sacrificed, and progressive degenerative arthritis is delayed, but not prevented.**
- **Proving that there is vast room for improvement in the treatment, early detection and prevention of degenerative changes**
- **Over last century have been developed different models to describe and explain wrist function.**

Treatment

- **Casting & immobilization:** for 4-6 weeks in the acute stage may give good results but is unreliable and some author believe is insufficient and may waste the ideal period of ligament repair.
- **Sometime failure to recognize the earlier injury may delay the treatment.**



The PRP has an inherent capacity to produce elevated amounts of growth factors and chemokines that significantly improve the vascularity of the injury site through angiogenesis.

This improvement in vascularity in the wrist coupled with the immobilization in a cast can certainly provide an ideal environment for successful ligament healing.

Results



PRP Effects in Ligament Injuries

	Combine d TFCC and SLIL	TFCC	SLIL
Patients	7	10	7
Recovered	6	10	5
Lost for F/U	1		
Complications		1 need two 2 inj	2 need surg

None have developed any abnormal systemic or adverse reactions to the PRP treatment

GEISSLER ARTHROSCOPIC CLASSIFICATION

GRADE 1 : Attenuation or hemorrhage of interosseous ligament seen from the RC space. No incongruency of carpal alignment in midcarpal space.

GRADE 2 : Attenuation or hemorrhage of interosseous ligament seen from the RC space. Incongruency or step-off seen in midcarpal space. There may be a slight gap (less than width of probe) between carpal bones.

GRADE 3 : Incongruency or step-off of carpal alignment seen from both RC and midcarpal space. Probe may be passed through gap between carpal bones.

GRADE 4 : Incongruency or step-off of carpal alignment seen from both RC and midcarpal space. There is gross instability with manipulation a 2.7 mm arthroscope may be passed through gap between carpal bones.

Lindau Classification of SLIL rupture

Grades	RC appearance	Mid-carpal Diastasis (mm)	Step-off (mm)
1	Haematoma or distension	0	0
2	As above and/or partial tear	0-1	<2
3	Partial or complete tear	1-2	<2
4	Complete tear	>2	>2



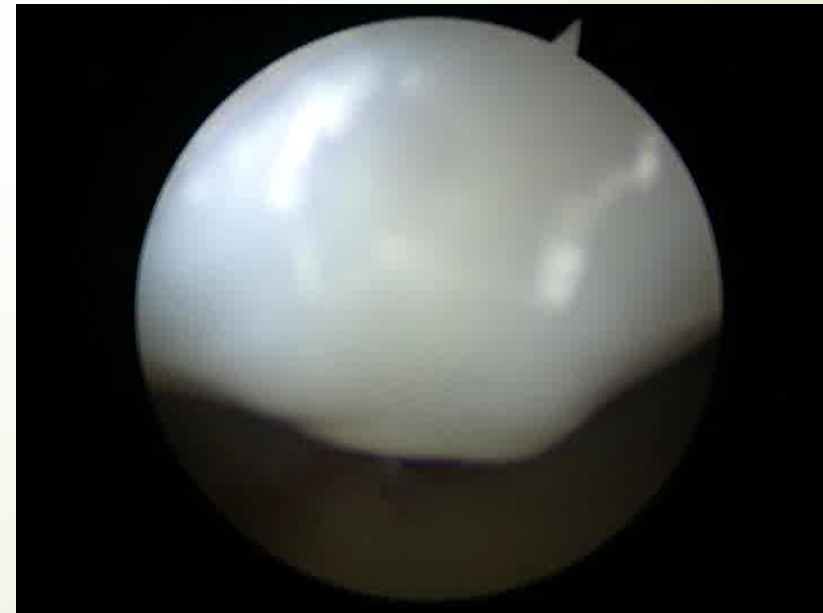
Prof. Lindau, suggested that the grade 1 & 2 should be done arthroscopically, but the 3 & 4 should be done openly.

Those type 1 & 2 were termed by Watson as pre-dynamic or occult instability stage.

He also consider arthroscopy technique as a Gold standard for diagnosis and understanding carpal instability, but weak evidence for the effectiveness in the actual treatment.

Arthroscopy Treatment

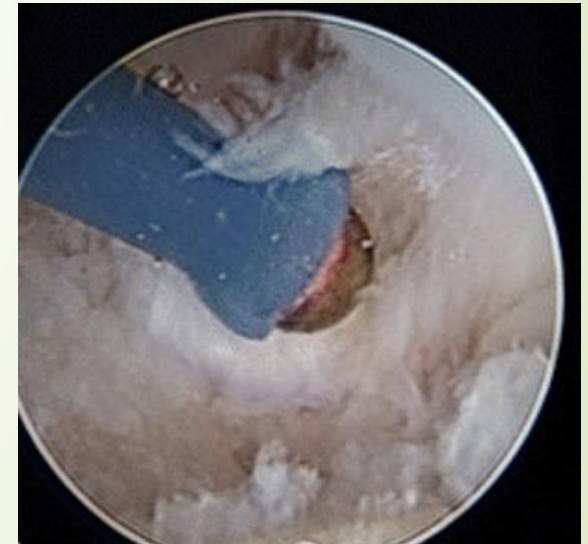
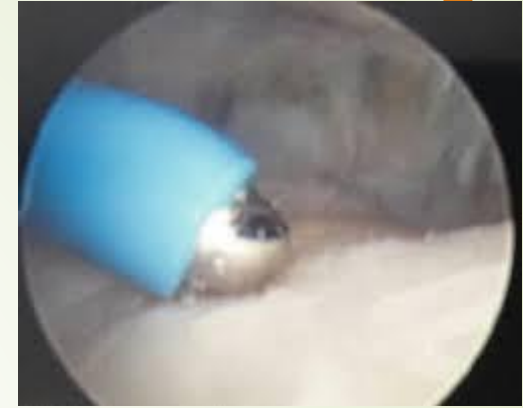
- ▶ **Indication: Partial SL tears involving the membranous (proximal) and volar part of the ligament.**
- ▶ **Lesions are debrided and treated with thermal shrinkage using a bipolar radiofrequency probe.**
- ▶ **Follow by percutaneous K wires fixation.**
- ▶ **Less optimal clinical outcome in complete tears .**



Wrist thermal capsulorrhaphy

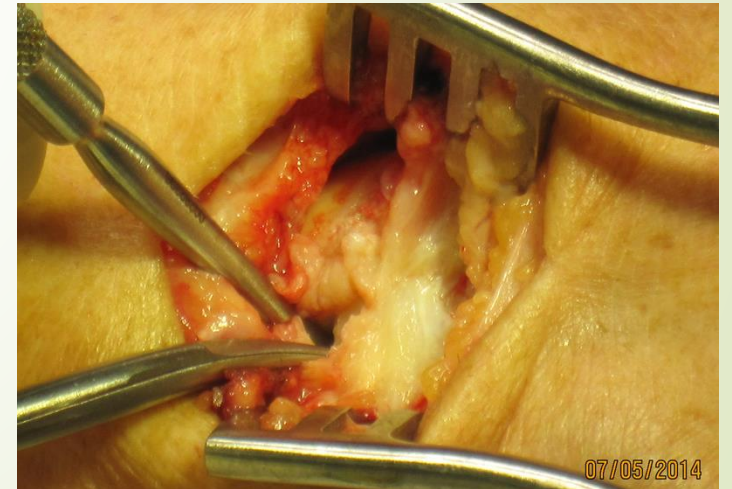
Arthroscopic capsular shrinkage should be performed to the palmar and dorsal capsules of the radiocarpal and midcarpal joint for carpal instability.

The treatment of those cases is by thermal shrinkage with a bipolar radiofrequency probe with the intention that healing will occur by contraction of the ligament, the temperature required is 70-80°C and not exceed 100°C, but is contraindicated in patients presenting static carpal instability with repairable ligament tear or with post-traumatic arthritis.

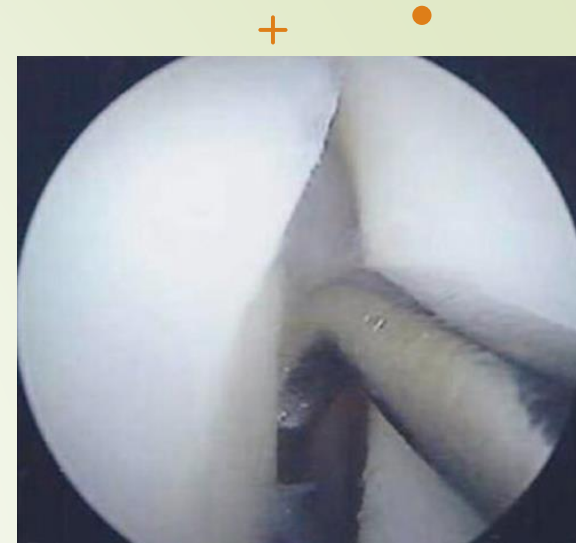


Grade 2 & 3

- ▶ Debridement aggressively down to bleeding bone combined or not with K wire fixation for 4-8 weeks in stage 3 of Geissler seems to give a variable grade of good results, but it is associated to reduction of range of motion and reduction of 30% of grip strength.
- ▶ On my opinion grade 3 and 4 are contraindication for arthroscopic treatment, keeping in mind the good results prove with open surgery and direct fixation.

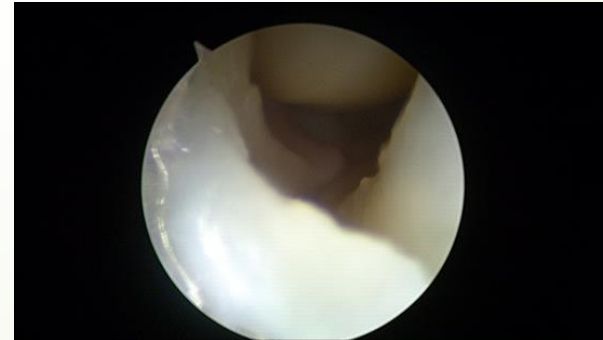


Grade 4



Debridement not enough.

Small dorsal incision, reduction of lunate, 2 mini-anchors and 2 K wires for 6 weeks



Complete rupture SLIL
Seen the Capitate from the Radiocarpal joint



OPEN LIGAMENT REPAIR

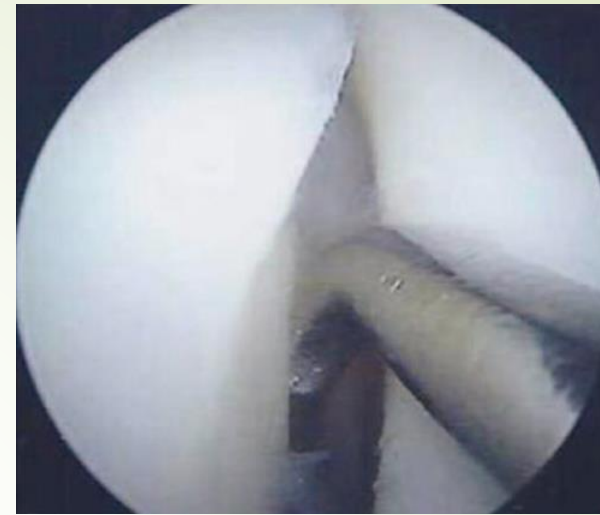
Drill holes are created with a 2-mm drill, and a 2-0 absorbable or nonabsorbable suture is placed through the SLIL.

Once reduction of the scapholunate interval is ensured, a K-wire is advanced from the scaphoid into the lunate.

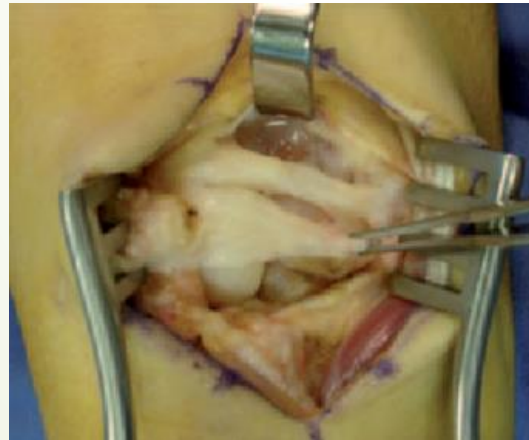
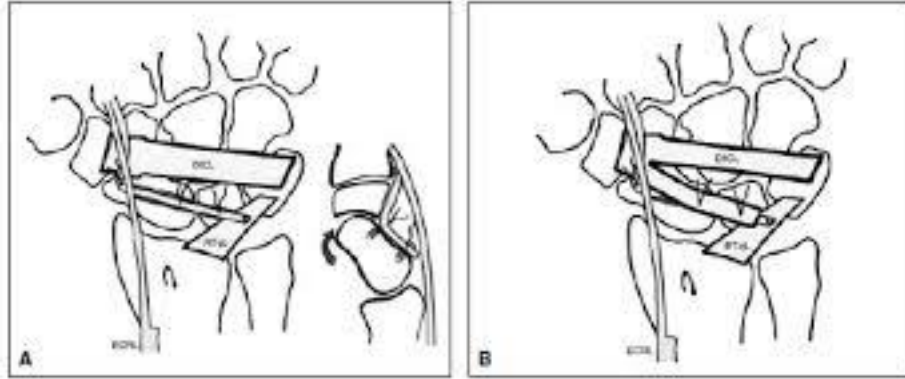
A second wire is passed from the mid-waist region of the scaphoid into the waist of the capitate.

Once the reduced SL interval is secured, the sutures may be tied.

Mathoulin described results of arthroscopic dorsal capsuloligamentous repair with cast for 8/52 and removal K wires at the same time



BLATT Dorsal Capsulodesis



- After repair of the SLI leg. Temporary Kirschner wire fixation of the scaphoid to the capitate and the lunate.
- The dorsal intercarpal ligament is identified and its middle third is dissected and elevated from the triquetrum remaining attached to the distal scaphoid pole.
- The ulnar end of the elevated part of the dorsal intercarpal ligament is pulled through a split in the dorsal radiotriquetral ligament and fixed to itself, or fix to the distal Radius.
- Follow by closure of the proximal and distal third of the DIC ligament.

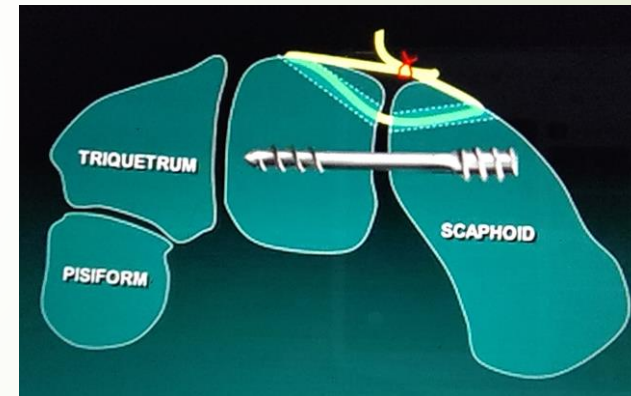
RASL Procedure

► Reduction Association Scaphoid Lunate



“..with majority of patients experiencing early radiographic failure of the procedure in the short term, the RASL procedure should be abandoned”

Larson & Stern. J Hand Surg 39A:2168-2674, 2014



Only indicated in high Energy trauma for early mobilization

Results

- Residual pain in 35% of cases
- Reduction of flexion of 12-20° due to long period of immobilization
- Reduction grip strength
- Pin tract infection
- Pin migration

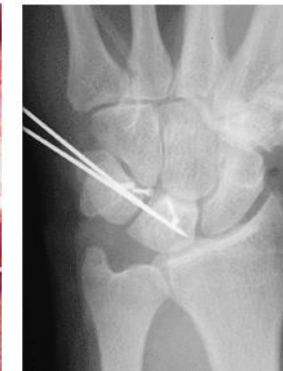
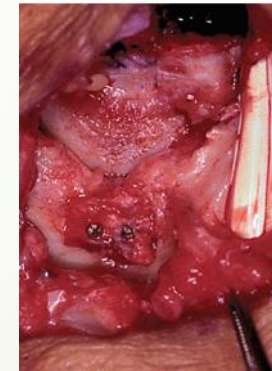
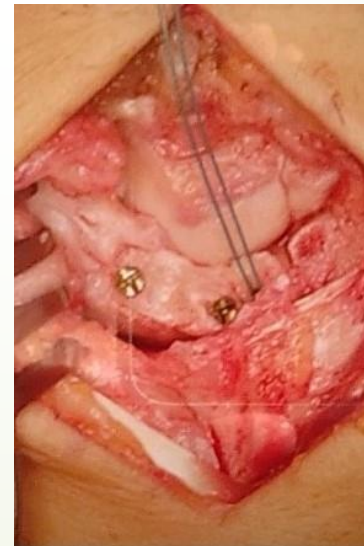
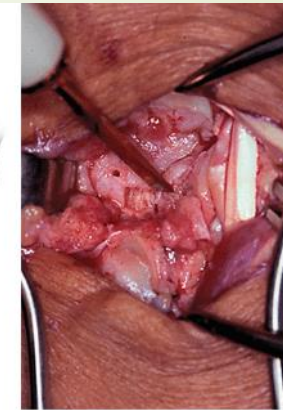
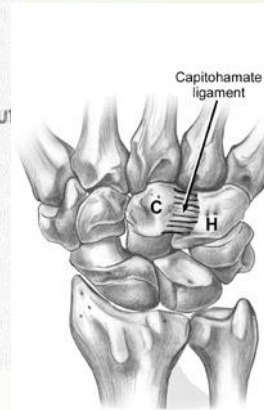
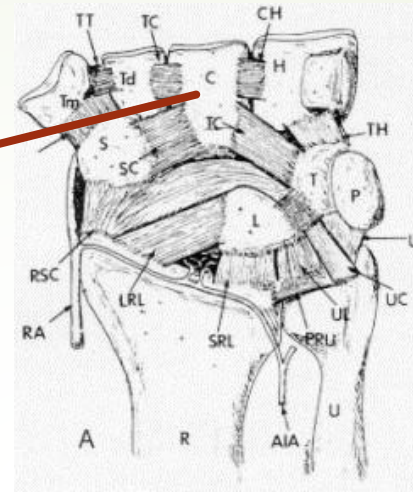
Own Protocol

- Volar cast for 4-6 days.
 - Removable splint, and gentle range-of-motion exercises for 6 weeks, remove.
 - K wires at 6-7 weeks and aggressive physiotherapy for 2 months, depending on patients' job.
- Full activity is not renewed until 3-4 months post-surgery.
- No reduction of flexion or grip strength



BONE-RETINACULUM-BONE AUTOGRAFT

- Tends to produce wrist stiffness.
- The Capitate-to-Trapezoid ligament closely approximated the load to failure and stiffness of the dorsal SLIL, whereas the Trapezoid-to-Second MC ligament was significantly stronger and stiffer than the dorsal SLIL.
- These 2 intra-carpal bone-ligament-bone grafts share similar mechanical properties with the dorsal component of the SLI ligament and might be used clinically to replace it.
- Long term results are not published.

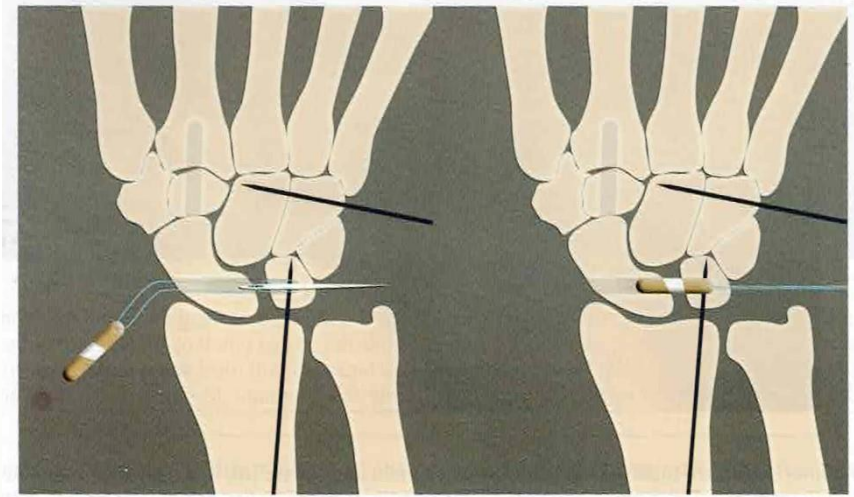
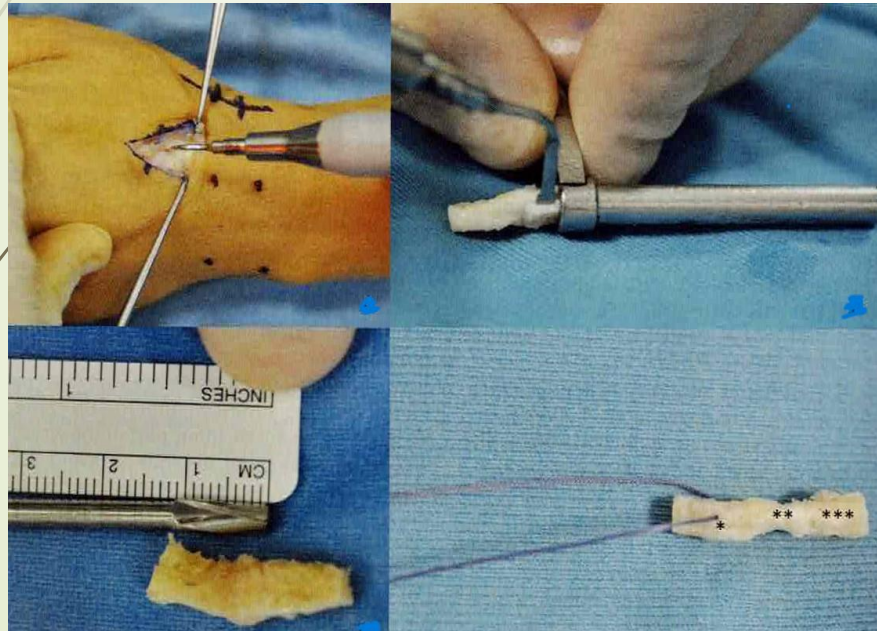


"In our experience, a successful bone-ligament-bone graft does not achieve better function than a radiocarpal fusion"

(Merle & Dautel, 1997)

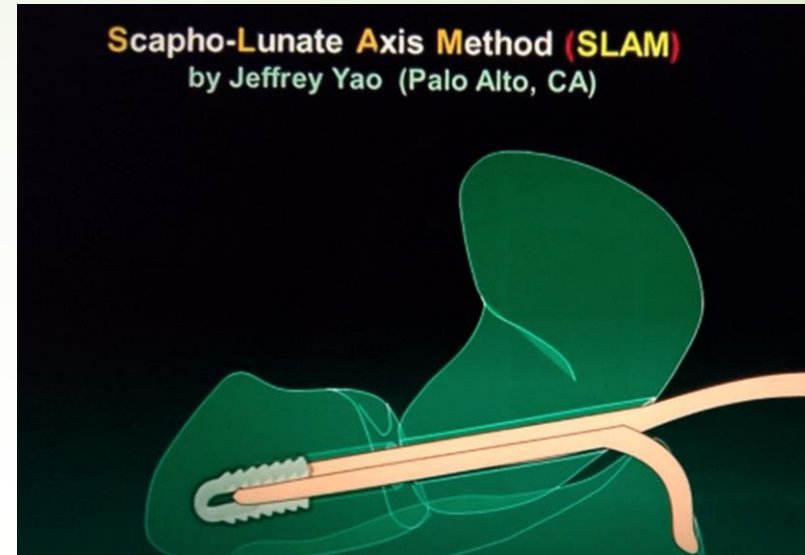
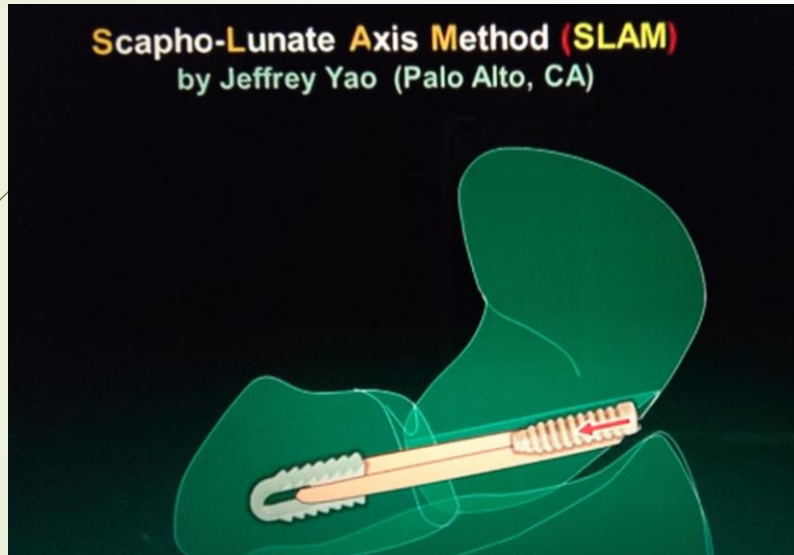
Bone-Retinaculum-Bone

Trapezoid to 2nd MC

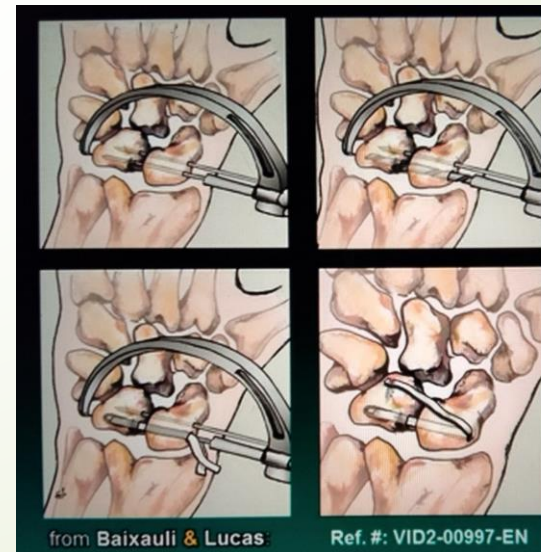


SLAM

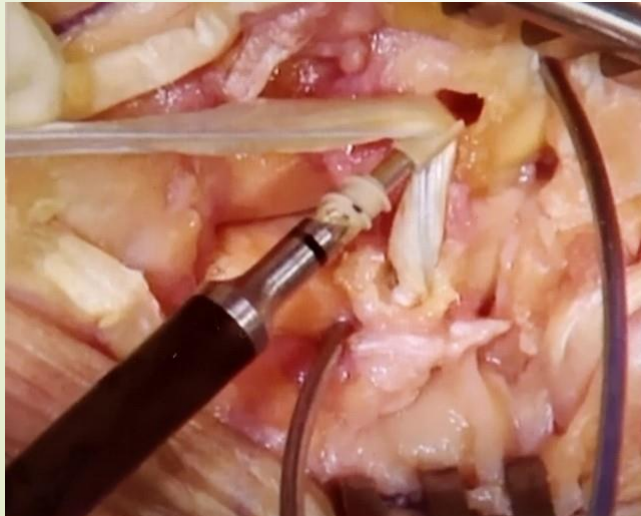
➔ Scapho-Lunate Axis Method



Not published long term results yet



SL Reconstruction with Internal Brace, Ligament Augmentation



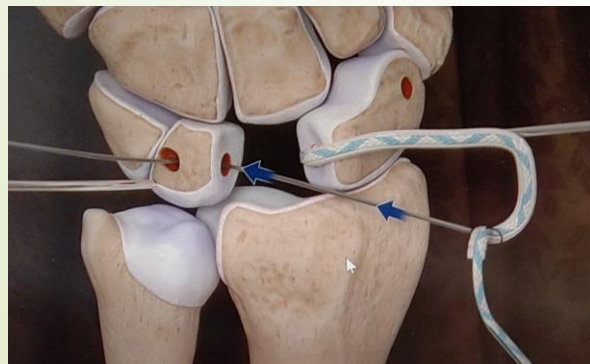
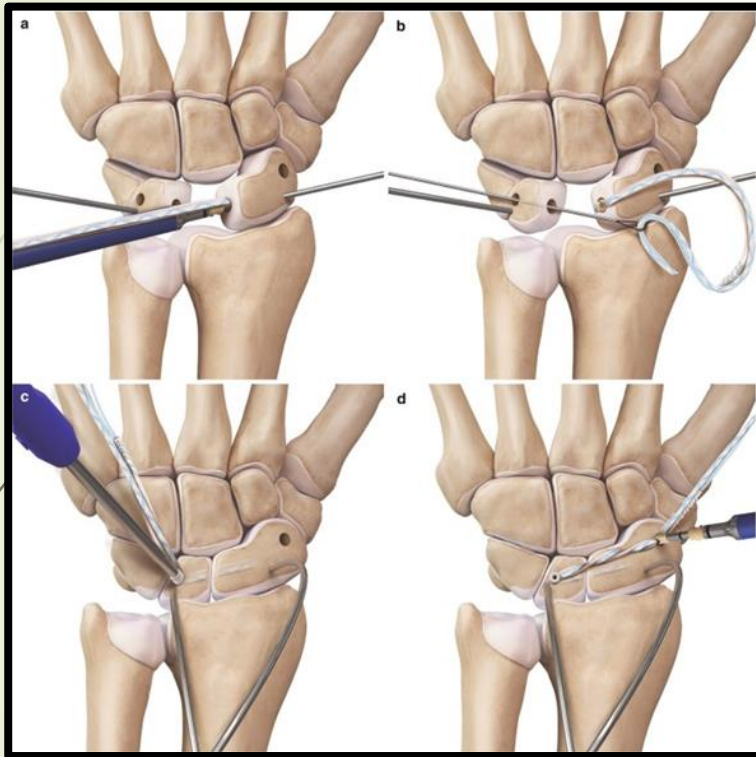
Internal bracing (IB) is an augmentation method using high-strength nonabsorbable tape.

- For Dorsal reconstruction, with preserve volar and central component.
- Tendon graft and Brace augmentation
- 2mm by 10 cm length graft of ECRB
- With 3.5 mm SwiveLock Anchors
- 1.3 mm suture tape.
- Prox. pole Scaphoid, then Lunate and Distal pole

[Suture tape augmentation for scapholunate ligament repair: a biomechanical study.](#)
J Hand Surg Am. 2020;S0363-5023(20)30376-2. doi:10.1016/j.jhsa.2020.06.017

- This study compared an all-dorsal scapholunate repair with and without SutureTape augmentation.
- Specimens that received an *Internal*Brace augment had a max load to failure twice that of the specimens without an augment (135 N vs 68 N, respectively).
- “Acute SL ligament injuries may benefit from suture tape augmentation by increasing the stability of the primary repair. This may prove beneficial in higher-demand patients.”

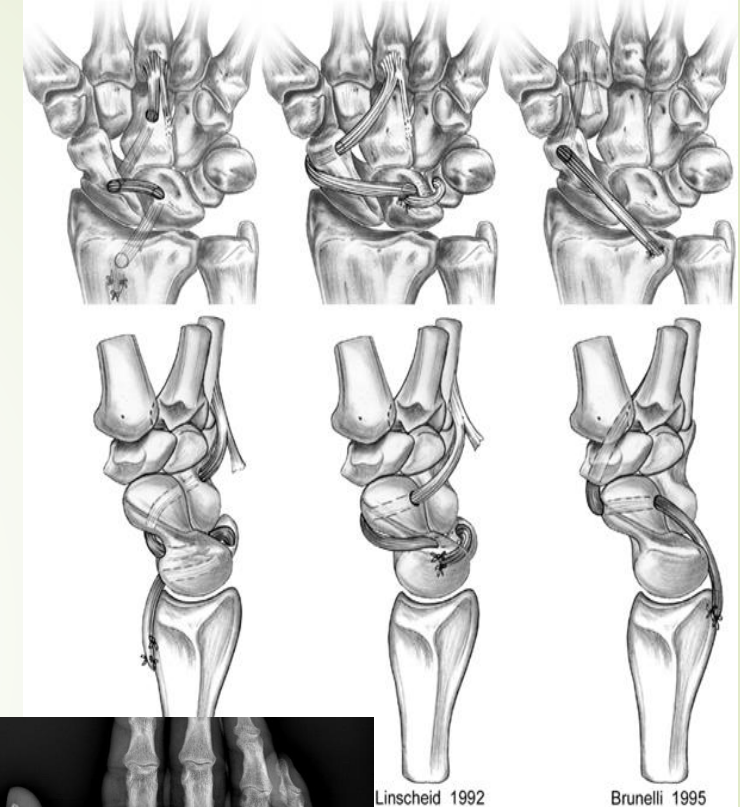
Interosseous Scapholunate Reconstruction

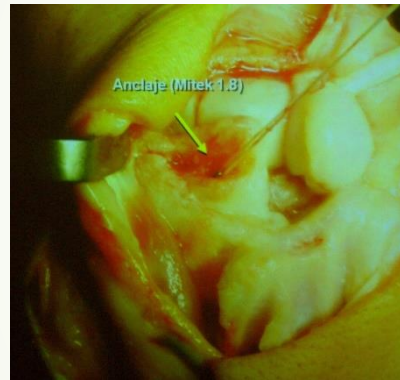
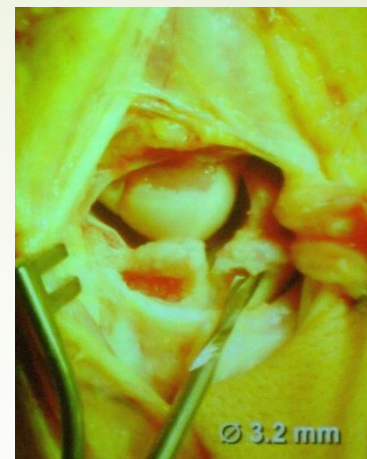


- Is indicated for tears of all 3 components of the SLIL
- 2-2.5 mm graft of ECRB by 10 cm long.
- Drill only 1 cm deep tunnel.
- An outside-in tunnel is made in the lunate starting from the dorsal-ulnar corner of the lunate and at a 45° angle toward the central inside tunnel.
- Another tunnel is drilled in the distal pole of the Scaphoid
- 3.5 mm SwiveLock Anchors & 1.3 mm tape.
- Start for the Scaphoid, pass into the Lunate and end in distal pole Scaphoid.
- A 3 mm x 8 mm Tenodesis Screw is used to secure the tendon graft and SutureTape in the Lunate hole.

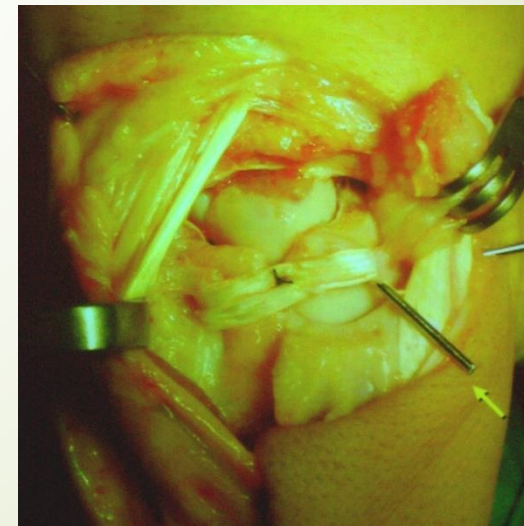
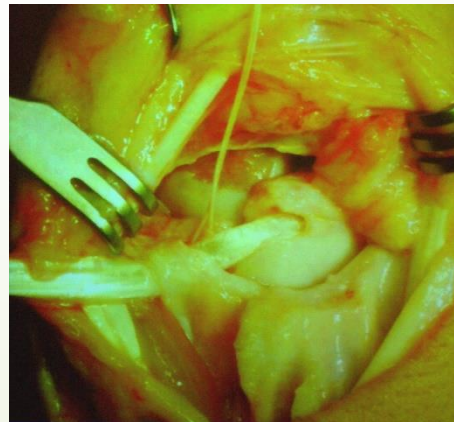
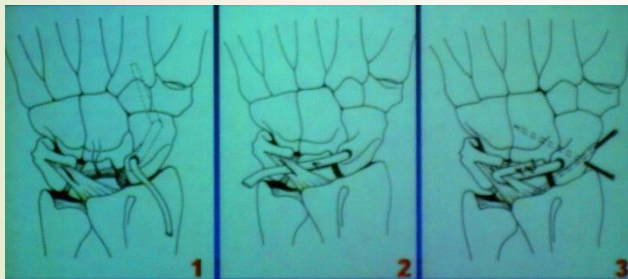
BRUNELLI & MODIFIED TECHNIQUE

- ▶ In 1995, Brunelli described a tenodesis technique using a slip of the FCR tendon that is tunneled through the distal portion of the scaphoid and attached to the distal radius to correct the abnormal scaphoid flexion deformity and to stabilize the SL interval
- ▶ Modifications of Brunelli's original procedure have been described by Van Den Abbeele and Garcia-Elias.
- ▶ This modified technique involves tunneling the FCR tendon through the scaphoid from the distal pole to the dorsal tuberosity, in contrast to Brunelli's original description, in which the FCR is passed parallel to the STT joint surface. The tendon is passed through the dorsal radiocarpal ligament. The distal end of the tendon is flipped back and secured to itself and the underlying lunate.

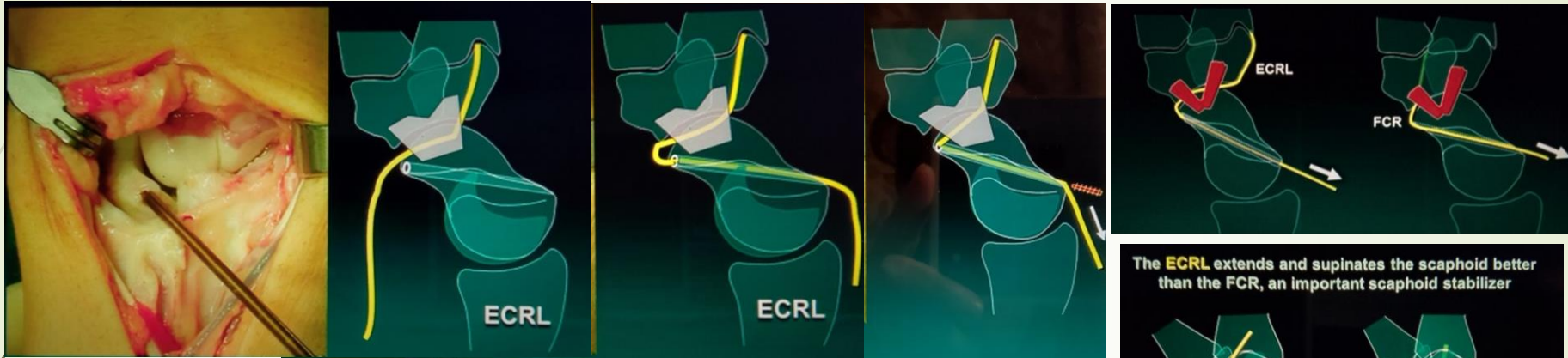




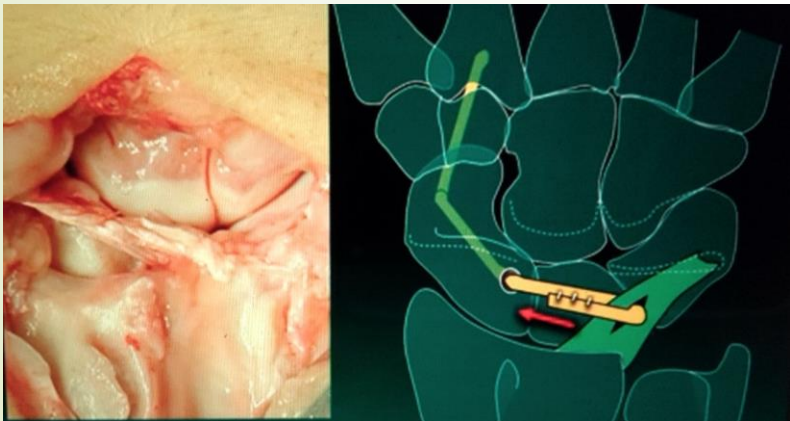
Tenodesis 3TL



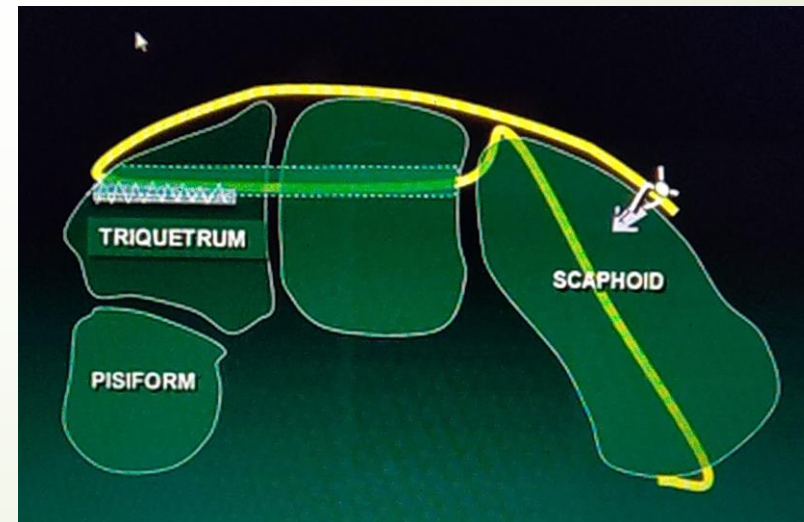
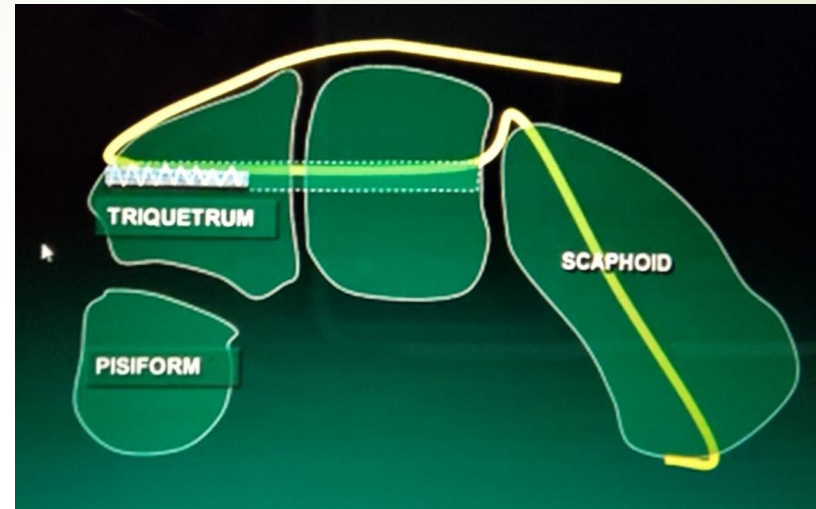
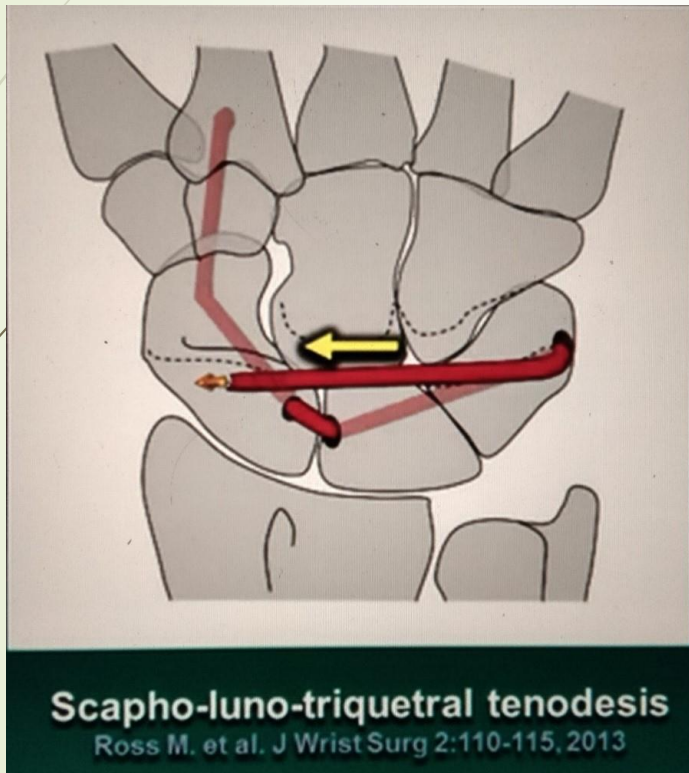
Evolution of the 3 LT technique or Anti-pronation ligamentoplasty (Garcia-Elias)



The **ECRL** extends and supinates the scaphoid better than the **FCR**, an important scaphoid stabilizer



Marc Ross' Technique





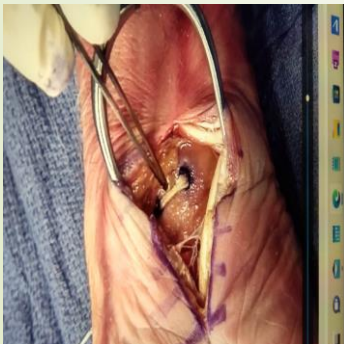
Results

- ▶ Technically demanding procedures.
- ▶ The modulus of elasticity of the original ligament is much greater than that of any tendon graft producing a stiffening of the normal intercarpal kinematic.
- ▶ With the Brunelli's technique there is a loss of flexion at Radiocarpal joint and even extension is reduced by 10°.
- ▶ Long period of immobilization
- ▶ Pin tract infection
- ▶ Pin migration

Increase interest in address the volar SL

- ▶ Volar Capsulodesis
- ▶ Circumferential graft around Scaphoid and Lunate:
 - ▶ - **Chee** reported results with a strip of FCR passing from volar to dorsal through Scaphoid and dorsal to volar through Triquetrum in an antipronation tenodesis “Circumferential Wrap”
 - ▶ - **Ho** reported results with arthroscopy assisted technique of reconstructing the volar and dorsal SL, using Palmaris Longus graft
 - ▶ - **Henry** does a volar and dorsal repair with FCR tendon, associated to 10-12/52 of immobilization and K wires removal at 8/52
- ▶ Concept of SLITT procedure (360° tenodesis to SL with and internal brace) provide resistance to load along multiple planes and prevent Scaphoid flexion. No need of wires and early motion at 4/52.
- ▶ In cases of ulnar translocation of the Lunate, the Long Radio-Lunate ligament can be reconstructed using the volar tail of the tendon graft with the internal brace and being tethered to the volar distal Radius.

360° SLIL Reconstruction



- Dorsal and volar approach
- Median Nerve mobilized and protected
- 2.5 mm hole in the Scaphoid and 3 mm hole in the Lunate
- Drill Lunate from dorsal to volar
- Scaphoid from dorsal distal to palmar proximal to be able to extend the scaphoid
- 15 cm of Palmaris Longus as a graft
- Pass 1st across Lunate (dorsal to volar), then to Scaphoid (volar to dorsal) and back to Lunate (dorsal to volar)
- Block with 3 by 8 tenodesis screws
- Suture tape across the holes of the screws from dorsal to volar. Tight in the volar side with at least 5 knots.



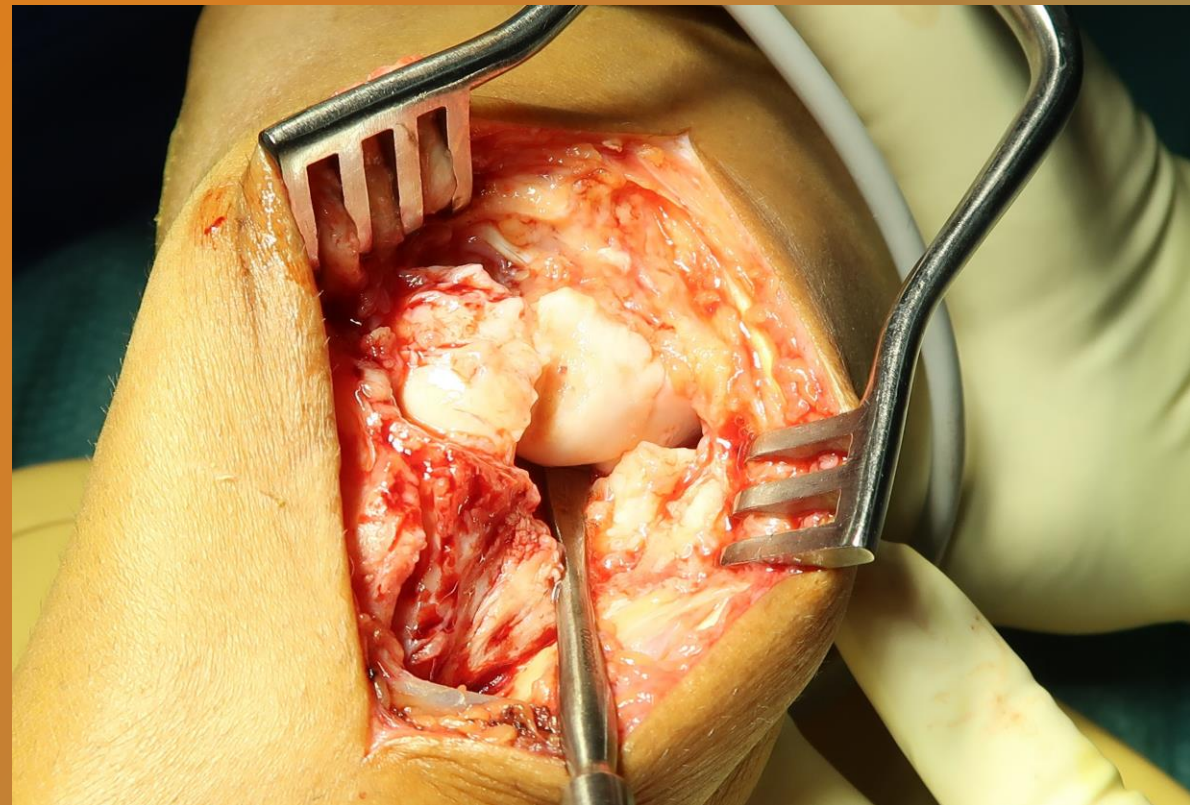
Summary

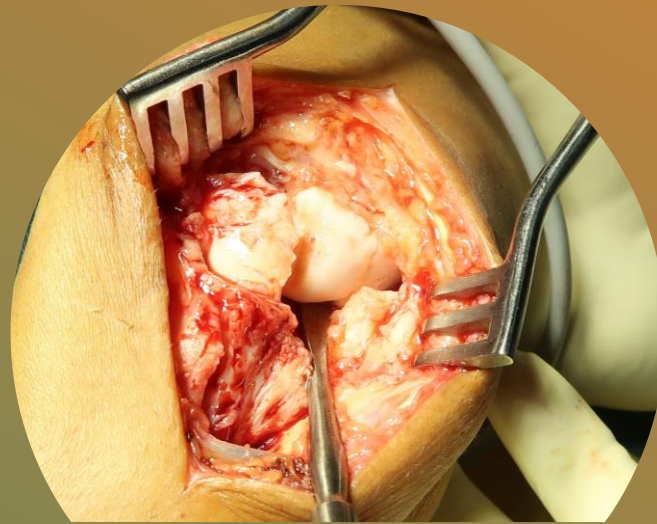
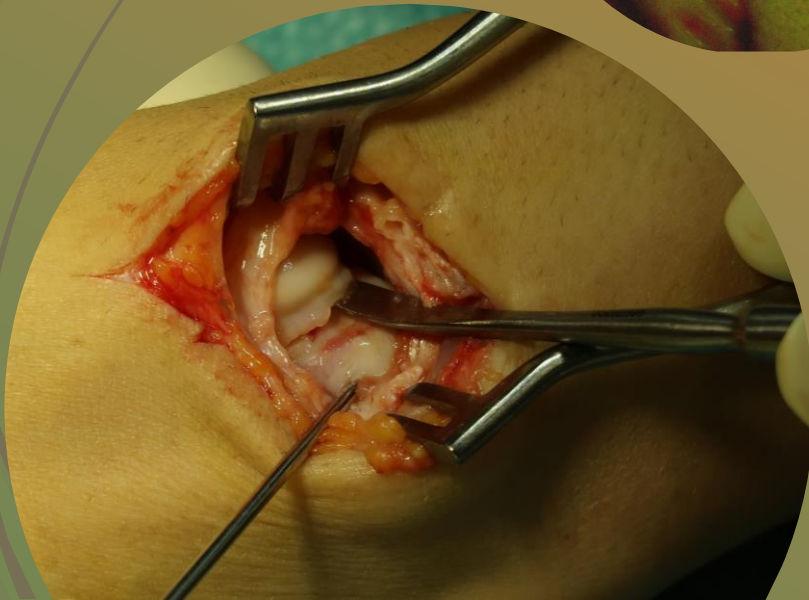
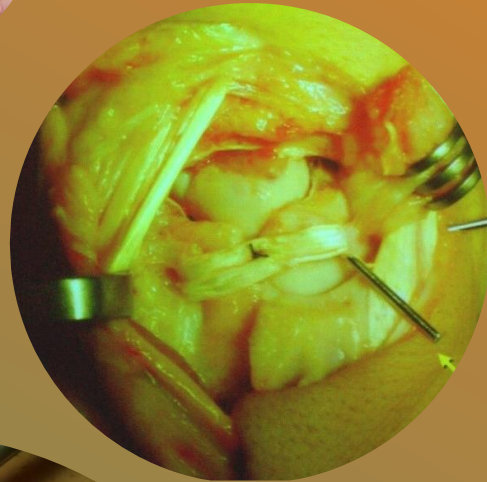
-SLIL should be repair as early as possible.

-Still not fully understand the Kinematic of the Carpus and their ligaments.

-The stronger the ligament and the fixation, the sooner we could start with rehabilitation and restore wrist function.

-360° (SLITT procedures) seems so far to be the one addressing better the carpal kinematic.





THANK YOU

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