Carpal Instabilities

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Definition by IFSSH

- Wrist is unstable only if it exhibits
  - symptomatic dysfunction
  - inability to bear loads
  - abnormal carpal kinematics

Carpal Instability is NOT

- Carpal malalignment (not a radiographic diagnosis only, e.g., a hyperlax joint may be malaligned but asymptomatic)
- Inability to bear physiologic loads without losing normal carpal alignment (implies force transfer alteration only)

Mayo Classification

Wright, JHS (Br) 1994

- Carpal Instability Dissociative (CID)
- Carpal Instability Non-Dissociative (CIND)
- Carpal Instability Adaptive (CIA)
- Carpal Instability Complex (CIC)

CID – Dissociative

- Instability within carpal row usually due to intrinsic ligament injury
  - Scapholunate dissociation
  - Lunotriquetral dissociation
  - Scaphoid fracture

CIND – Nondissociative

- Instability between carpal rows due to extrinsic ligament injury
  - CIND – Volar Intercalated Segment Instability (VISI)
  - CIND – Dorsal Intercalated Segment Instability (DISI)
  - Combined CIND

CIA – Adaptive

- Extra-carpal derangement causing carpal malalignment
  - CIND – Volar Intercalated Segment Instability (VISI)
  - CIND – Dorsal Intercalated Segment Instability (DISI)
  - Combined CIND

CIC – Complex

- Instability patterns with qualities of both CID and CIND patterns
  - Dorsal perilunate dislocations (lesser arc)
  - Dorsal perilunate fracture-dislocations (greater arc injuries)
  - Volar perilunate dislocations
  - Axial dislocations, fracture-dislocations

Lichtman Classification

- Perilunate Instabilities (CID)
- Midcarpal Instabilities (CIND)
- Proximal Carpal Instabilities
- Miscellaneous Instabilities

Carpal Instabilities – Topic Outline

- Perilunate instability
Scapholunate dissociation
Lunotriquetral dissociation
Midcarpal instability

11 Perilunate Dislocations
- Uncommon, 7% of all carpal injuries
- High-energy axial load (MVA, fall from height, contact sports)
- Mechanism – Hyperextension, ulnar deviation, intercarpal supination (Mayfield, 1980)
- Present w/wrist pain, swelling, limited motion
- Dx often missed, radiographs misinterpreted

12 Mayfield Classification – Progressive Perilunar Instability
- I – Rupture SLIL, RSCL
- II – CL dissociation
- III – Rupture LTIL, dorsal carpal dislocation
- IV – Palmar lunate dislocation (LRL & SRL ligaments intact)

13 Greater or Lesser Arc Injuries
- Perilunate injuries may involve bones, ligaments or both
- Greater arc injuries include fractures of scaphoid, capitate (slower force application)
- Lesser arc injuries involve ligaments only (more rapid force application)

14 Imaging
- PA XR – Disruption Gilula’s arcs
- Lateral XR – Loss of carpal colinearity
- CT scan to assess carpal fractures

15 Immediate Closed Reduction
- Prompt reduction to decompress median nerve in carpal canal
- IV sedation in emergency room setting
- Longitudinal traction for 5–10 minutes
- Dorsal-directed pressure on lunate with wrist palmar flexion

16 ORIF for Best Result – Volar, Dorsal or Combined Approach
- Volar – release carpal canal, reduce lunate, repair LTL and volar capsule (space of Poirier)
- Dorsal – restore carpal alignment, repair SLL, address carpal fractures, repair DRCL
- K–wire stabilization of SL, LT and midcarpal reductions
- Suture anchors for capsular repair, capsulodesis

- Retrospective review 18 pts, avg 13–yr F/U
- Mayo score – 5 exc, 3 good, 7 fair, 3 poor
- Radiographic arthrosis observed in 12 pts
- Post–traumatic arthrosis well–tolerated
- Therapeutic Level IV study (France)

18 Perilunate Summary
- Goal is stable wrist, minimal pain, functional arc of motion
- Most patients will not regain normal motion or grip strength
- If diagnosis missed in patient < 30 yrs, ORIF should be attempted
Older patients more than 4 wks post-injury should have salvage proximal row carpectomy

19 Scapholunate Interosseous Ligament
- Prime stabilizer SL joint
- C-shaped 3-part ligament. Dorsal is thickest, strongest. Palmar is thinner, weaker. Proximal is thin, weakest.
- Secondary stabilizers are RSC, DRC, DIC, ST ligaments

20 Natural History of SL Ligament Tear
- Secondary stabilizers stretch leading to DISI
- Lunate extends, scaphoid flexes with wrist RD
- Abn wrist mechanics over time leads to SLAC
- Radioscaphoid, then capitolunate arthrosis
- Timely rx SL dissociation may prevent SLAC

21 Acute Scapholunate Injury
- FOOSH mechanism with wrist in extension, ulnar deviation, supination
- Rarely present acutely < 6 weeks from injury
- Pain with wrist loading such as push-ups
- Focal swelling, tenderness at SL interval
- Positive scaphoid shift test (if tolerated)

22 Watson’s Scaphoid Shift Test
- Apply pressure to scaphoid tuberosity as wrist is moved from ulnar to radial deviation
- SLIL tear allows scaphoid proximal pole to subluxate dorsally wrt scaphoid fossa
- Release pressure, scaphoid reduces into scaphoid fossa with reduction “clunk”

23 Watson’s Caveats
- Unilateral wrist injury
- Examine both sides
- Beware ligamentous laxity
- Test reproduces wrist pain

24 Kinematics of the Scaphoid Shift Test
  Wolfe et al., JHS 1997; 22A: 801–06
- 25 uninjured subjects (50 wrists) examined
- 36% subjects had positive scaphoid shift test
- Dorsal and axial displacement correlated with positive test
- Positive test results should be confirmed by fluoroscopic exam

25 Imaging
- XR – PA, lateral, scaphoid views (UD)
- XR – bilateral clenched pencil views
- MRI – high-resolution, small-field technique

26 Radiographic Findings
- PA projection – SL interval widened (Terry Thomas sign), SL asymmetry, triangle lunate, scaphoid ring sign
- Lateral projection – Increased SL angle >70 degrees

27 Wrist Arthroscopy
- Gold standard for diagnosing SLIL injury
- Better sensitivity & specificity vs MRI, MRA
- Permits injury classification (Geissler)
- Allows diagnosis concomitant pathology
- Able to treat partial SLIL arthroscopically

28 Geissler Classification
- I - redundant ligament, no tear, occult instability
- II - partial tear (proximal, volar), minimal gap, predynamic
- III - partial tear, articular incongruence, moderate gap, dynamic instability
- IV - complete tear/dissociation, gross static instability

29 Geissler Classification – Arthroscopic Assessment of Intercarpal Ligament Tears
- I - Attenuation
- II - Slight gap, step-off
- III - Probe passes, incongruency
- IV - Scope passes, gross instability

30 Prognostic Factors
- Is the dorsal SLIL intact?
- If dorsal SLIL disrupted, can it be repaired? (mid-substance vs avulsion)
- Are the secondary scaphoid stabilizers intact? (rotatory subluxation)
- Is the carpal malalignment easily reduced?
- What is the status of the articular cartilage? (radiocarpal and midcarpal joints)

31 Basis for Treatment
- Symptom severity
- Degree of instability (predynamic, dynamic, static)
- Chronicity (acute, subacute, chronic)
- Arthroscopic findings (Geissler grade)

32 Treatment Options
- Benign neglect
- Intermittent splinting
- Arthroscopic debridement
- Arthroscopic thermal annealing
- Arthroscopic reduction & pinning
- Open reduction & repair
- Open reduction & capsulodesis
- Open reduction & association
- Open reduction & reconstruction
- Combined procedures

33 ARIF: Arthroscopic Reduction Internal Fixation
- Group I - < 3 months sx, < 3 mm increase SL interval – 83% improved
- Group II - > 3 months sx, > 3 mm increase in SL interval – 53% improved
- Worse prognosis for older injury, wider gap
- ARIF recommended for Group I patients

34 Arthroscopic Debridement Alone for Intercarpal Ligament Tears
Weiss et al., JHS 1997; 22A: 344–49
- 127 pts w/wrist pain had arthroscopic debridement of ICL tears, early wrist motion
- 85% w/partial SLIL tears improved, 66% with complete tears improved
- For LTIL, 100% w/partial, 78% w/complete tears improved
- Majority pts improve w/debridement alone
- 16 pts (mean age 34 yrs) w/partial SLIL tears
- Rx arthroscopic thermal shrinkage volar & proximal portions of ligament, early motion
- Mean F/U 19 months, 14 pts good pain relief, 2 were unchanged
- Longer follow–up needed to establish efficacy

36 Radiofrequency Thermal Shrinkage
- Thermal probe denatures collagen at 60°C
- Effective for rx Geissler I and II
- Long–term effect on instability unknown
- Outflow portal avoids thermal necrosis
- Contraindicated for pts w/pacemakers

37 Open Treatment of Acute SLIL Tear
- Dorsal approach, PIN neurectomy
- Plan for dorsal capsulodesis
- Create bed for SLIL repair on lunate
- Carpal reduction, K–wire stabilization
- SLIL repair, dorsal capsulodesis

38 Postoperative Protocol
- Short–arm splint/cast immobilization x 6 wks
- Removable short–arm orthosis x 6 wks
- Remove K–wires and allow motion at 12 wks
- Strengthening initiated at 4 to 4.5 months
- Unrestricted activity allowed at 6 months

39 Reduction–Association Scapho–Lunate (RASL) for Chronic Static SL Dissociation
- Preliminary scope to examine midcarpal joint. If normal, then RASL; if arthritic, then salvage.
- Two–incision technique, dorsal and radial
- Dorsal approach – Preserve DIC ligament, de–chondrify SL joint, reduce SL w/joy sticks
- Radial approach – Radial styloidectomy, guide pin & screw in SL rotation axis (or volar)

- 36 pts (1991–2008), avg age 50 yrs, F/U 6.4 yrs
- Majority reported improved pain, function
- Flexion–extension arc 80% preserved
- Grip & pinch strength comparable other side
- XR – decreased SL gap and SL angle vs preop

41 RASL: Short–Term Clinical and Radiologic Outcomes
Larson & Stern, JHS 2014; 39A: 2168–74
- 7 pts (8 wrists), avg age 41 yrs, avg F/U 38 mo
- Clinical outcomes were judged satisfactory
- All pts had loss of SL reduction, avg 4.5 mm SL gap (preop 2.9 mm); one had RCJ arthrosis
- Abandon RASL, does not improve SL stability
- Therapeutic Level IV study (Univ Cincinnati)

### Long-Term Results of Bone–Retinaculum–Bone Autograft for Scapholunate Instability. Soong et al., JHS 2013; 28A: 504–08.
- 14 pts had BRB SLIL recon, avg F/U 11.9 yrs
- Clinical, radiologic outcomes deteriorated
- 3 failures required salvage; 2 lost to F/U
- BRB results were similar to other techniques
- Therapeutic Level IV study (Brown Univ)

### Brunelli Reconstruction
- Dorsal & volar approaches
- Distally-based one-half FCR slip
- Mobilize scaphoid at STT
- Tunnel through scaphoid
- Fix graft to dorsoulnar radius

### Three-Ligament Tenodesis for Scapholunate Dissociation
- Garcia–Elias et al., JHS 2006; 31A: 125–34
- 38 pts mean age 31 yrs, mean F/U 46 months
- 28 of 38 pts had pain relief at rest
- DF 52°, VF 51°, grip strenth 65% normal side
- 2 pts carpal collapse, 7 pts arthrosis
- No second surgery required thusfar

### Contraindications to Three–Ligament Tenodesis
- SL subluxation NOT easily reduced
- Lunate is NOT stable (carpal ulnar translocation)
- Cartilage is NOT normal
- Surgeon is NOT experienced
- Patient is manual laborer

### SLIL Anatomic Reconstruction
- Distally-based one-half FCR autograft
- Through tunnels in scaphoid, lunate
- Reconstructs dorsal, volar portions SLIL

### Treatment Algorithm for SL Dissociation (Sotereanos, 2015)
- I – Thermal annealing or shrinkage
- II – Debridement, thermal shrinkage
- III acute – Arthroscopic debridement, pinning
- III chronic – Capsulodesis vs reconstruction
- IV acute – Open reduction, pinning, repair
- IV chronic – Reconstruction vs arthrodesis

### SLIL Tears and DRFx
- Isolated SLIL tears rarely present < 6 wks
- Prevalence of SLIL tears assoc w/DRFx = 40%
- Radial styloid or lunate facet fx should raise suspicion for SLIL tear
- High–grade SLIL tears are problematic
- Operative treatment of both DRFx and SLIL tear should be considered
- Multi-center study 60 DRFx rx w/manipulation, redux, fixation w/fluoro & arthroscopic control
- 26 pts (43%) had TFC tears, 19 pts (32%) had SLIL tears, 9 pts (15%) had LTIL tears
- Soft tissue injuries (found in 41 of 60 pts or 68%) were most often associated w/ lunate facet DRFx

Can Cast Immobilization Successfully Treat SL Dissociation Associated with DRFx?. Tang et al., JHS 1996; 21A: 583–90.
- Answer is NO! Consider early operative rx.
- 20 of 424 consecutive pts w/DRFx had SL dissociation on traction flouroscopy
- At 1–yr F/U, study group had worse function than control group w/mean SL gap = 3.8 mm
- 8 of 20 pts required operation for SL symptoms

- Prospective study 51 pts w/displaced DRFx who had standard rx & wrist arthroscopy, 1–yr F/U
- Radial shortening >2mm = 4x increase SLIL tear
- Geissler grade III pts had greater likelihood of wrist pain, wider SL dissociation, higher SL angle
- Prognostic Level I study (UK)

Lunotriquetral Interosseous Ligament
- Primary stabilizer of the LT joint
- C–shaped, 3–part ligament. Palmar is strongest vs translation. Dorsal is strongest vs rotation. Proximal is thin membraneous part.
- Secondary LT stabilizers are ulnar volar arcuate ligament, DRC, DIC

Acute LTIL Injuries
- Trauma in contact sport athletes
- Ulnar–sided wrist pain, grasp weakness
- Prominent distal ulna, volar ulnar carpal sag, LT tenderness, positive ballottement test
- With LTIL tear, lunate flexes with intact SLIL
- Attenuation secondary stabilizers leads to VISI

A kinematic study of luno–triquetral dissociations
Horii et al., JHS 1991; 16A: 355–62
- Cadaver study after sectioning primary and secondary LT stabilizers
- Dividing LTIL resulted in abnormal LT motion likely to cause wrist pain, cartilage wear
- Static VISI deformity required division of DIC, DRC ligaments in addition to LTIL

Clinical Findings
- Ulnar wrist zig–zag deformity
- Limited wrist range of motion
- Decreased grip strength
- Tenderness at ulnar snuff box

LT Ballottement Test
Stabilize lunate between thumb, index finger
With other hand, translate triquetrum & pisiform dorsal & volar
Pain on shear stress indicates LTL tear

57 Reverse Perilunate Mechanism of Injury
- Fall onto hypothenar eminence
- Wrist DF, RD, pronated
- LT, then LC, then SL dissociation

58 Imaging
- PA XR – Break in Gilula’s arcs, LT overlap, no gap
- Lateral XR – VISI deformity (late)
- Arthrography – 13% normal wrists have LTIL tear

59 Other Diagnostics
- Fluroscopy – may see abnormal carpal motion
- MRI – unreliable unless done with contrast
- Arthroscopy is gold standard for dx LTIL tear

60 Treatment Algorithm for Acute LTIL Injuries
- Geissler I – Arthroscopic debridement, thermal annealing
- II & III – Debridement, closed pinning, 8 wks wrist immobilization
- IV – Open repair, pinning, capsulodesis, LAC 6–8 wks, pins removed at 10 wks

61 Chronic LTIL Tears
- Reconstruction with slip of ECU
- LT arthrodesis with screw or K–wire fixation

62 Chronic Lunotriquetral Instability: Diagnosis and Treatment
Kirschbaum et al., JHS 1993; 18A: 1107–12
- 14 pts w/LT instability had LT fusion, F/U 27 mo
- 12 pts fused, 2 pseudarthrosis (1 revised), one had persistent pain
- Wrist flex–ext 85% normal, grip strength 93%
- LT arthrodesis relieves pain, preserves function

- Outcomes of 57 pts w/LT injuries, F/U 9.5 yrs
- Mean age 30.7 yrs, 98% subacute or chronic
- 27 repairs, 22 arthrodeses, 8 reconstructions
- LT fusions – 41% nonunions, 23% UC impaction
- Pain relief, satisfaction, motion, strength all better for repair or recon than for fusion

64 Midcarpal Instability – Many Terms, Few Cases
- 1981 – Ulnar Midcarpal Instability (UMCI)
- 1984 – Capitolunate Instability Pattern (CLIP)
- 1986 – Chronic Capitolunate Instability (CCI)
- 1993 – Palmar Midcarpal Instability (PMCI)
- 1994 – CIND–VISI and CIND–DISI
- 2001 – Radial Midcarpal Instability (RMCI)

65 Dart Thrower’s Motion at Midcarpal Joint
- Extension / radial deviation
- Flexion / ulnar deviation
• Primarily midcarpal motion

66 Midcarpal Instability
• Proximal carpal row instability under load
• Typical patient is 20–30 yrs c/o clunking with wrist twisting, at extremes of motion
• Post-traumatic or congenital ligamentous laxity
• Proximal row sags into volar flexion due to volar arcuate, DRC ligament incompetence

67 Physical Exam
• Volar sag ulnar carpus
• Ulnar–sided tenderness
• Audible clunk w/ulnar deviation reduces volar sag
• Positive midcarpal shift test reproduces wrist pain
• Dorsal pressure on pisiform eliminates the clunk

68 Midcarpal Shift Test and “Catch–Up Clunk”
• Extrinsic ligament (THCL, STL) attenuation leads to CIND–VISI
• Proximal row remains volar–flexed during ulnar deviation
• Hamate abuts triquetrum & proximal row abruptly extends with clunk

69 Diagnosis
• History & exam – raise suspicion
• XR – may be normal or show VISI
• Videofluoroscopy – diagnostic
• Lateral view – VISI to DISI jump with wrist ulnar deviation

70 Nonsurgical Treatment
• NSAIDs
• Activity modification
• 3–point dynamic orthosis loading pisiform dorsally
• Proprioceptive training

71 Surgical Options
• Reefing or reconstruction of volar arcuate, DRC ligaments
• Thermal capsulorrhaphy
• Midcarpal arthrodesis (CL, TH or four–corner)

72 Palmar Midcarpal Instability: Results of Surgical Reconstruction
Lichtman et al., JHS 1993; 18A: 307–15
• 13 pts, 15 operations for palmar MCI, F/U 4 yrs
• All 6 limited midcarpal fusions improved
• 6 of 9 soft tissue procedures failed to improve
• Limited midcarpal fusion better than recon

73 Carpal Instability Non–Dissociative
Wright et al., JHS 1994; 19B: 763–73
• 45 pts w/wrist pain, weakness, CIND, F/U 5.8 yrs
• 7 pts rx non–operatively, 38 pts operatively, 34 pts had soft tissue stabilization procedures
• Good & excellent results were 56%, patient satisfaction 77%, wrist pain relief 73%
• Soft tissue reconstruction unpredictable

74 Palmar Midcarpal Instability: Results of Treatment With 4–Corner Arthrodesis. Goldfarb et al., JHS 2004; 29A: 258–63.
• 8 pts w/PMCI over 10 yrs rx w/4-corner fusion
• 7 pts were satisfied, 6 had no pain or mild pain
• Flex–ext arc decreased to 75° from 135°
• Grip strength increased from 20 kg to 32 kg
• Four-corner arthrodesis reasonable option

• 13 pts, 15 wrists had thermal rx w/monopolar radiofrequency probe for PMCI
• Mean F/U 42 months (range 14 to 67)
• All pts improved (4 resolved, 11 near complete)
• DASH scores improved from 38 to 17
• Thermal capsulorrhaphy is effective w/short F/U

76 Carpal Instability – Summary Comments
• Injuries resulting in carpal instability are rare
• Acute injuries may be missed, so be vigilant. Reduction, pinning, ligament repair indicated.
• Chronic injuries are difficult to classify, treat. Outcome comparisons may not be valid.
• Conservative treatment, benign neglect, arthroscopic options are preferred
• Be aware of narrow surgical indications for soft tissue procedures
• Limited intercarpal arthrodeses may be most reliable method to achieve stability