1 Carpal Instabilities

- Bernard F. Hearon, M.D.
- January 24 & 31, 2017

2 Definition by IFSSH

Wrist is unstable only if it exhibits

- symptomatic dysfunction
- inability to bear loads
- abnormal carpal kinematics

3 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)

4 Mayo Classification

Wright, JHS (Br) 1994

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

5 CID – Dissociative

Instability within carpal row usually due to intrinsic ligament injury

- Scapholunate dissociation
- Lunotriquetral dissociation
- Scaphoid fracture

6 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

7 CIA – Adaptive

Extra-carpal derangement causing carpal malalignment

- CIND – Volar Intercalated Segment Instability (VISI)
- CIND – Dorsal Intercalated Segment Instability (DISI)
- Combined CIND

8 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

9 Lichtman Classification

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

10 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

17 Perilunate Dislocations & Transscaphoid Perilunate Fx-Disl: 10-Year Follow-Up. Forli et al., JHS 2010 35A: 62-68.

- 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 malignment 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

35 Partial SLIL Injuries Rx With Arthroscopic Debridement and Thermal Shrinkage. Darlis et al., JHS 2005; 30A: 908-14.

- 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)

40 RASL: Long-term Follow-up of Recon Technique for Chronic SL Dissociation. White et al., ASSH 2010.

- 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)

42 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)

43 Brunelli Reconstruction

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

44 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

45 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

46 SLIL Anatomic Reconstruction

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

47 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

48 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

49 Intracarpal Soft Tissue Lesions Associated with Intra-Articular Distal Radius Fractures. Geissler et al., JBJS 1996; 78A: 357-65.

- 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

50 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

51 Intracarpal Ligament Injuries Associated with Distal Radius Fractures. Forward et al., JBJS 2007; 89A: 2334-40.

- 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)

52 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

53 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

54 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

55 Clinical Findings

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

56 LT Ballottement Test

- Stabilize lunate btwn 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 Kirschenbaum 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

63 Treatment of isolated LT injuries ligament: Arthrodesis, ligament repair or reconstruction. Shin et al., JBJS 2001; 83B: 1023-28.
- 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 extemes 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 triqetrum & 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

75 Arthroscopic Thermal Capsulorrhaphy for Palmar Midcarpal Instability. Mason et al., JHS 2007; 32E: 411-16.

- 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