PRIMER ON CARPAL KINEMATICS

PATHO-MECHANICS OF THE SLAC WRIST:
The Importance of the Midcarpal Joint

THE “INTERCALATED SEGMENT”

Wrist hemiarthroplasty is not FDA approved for use in the United States.

Dr. Wolfe has consulting and/or royalty agreements with:
- TriMed, Inc.
- Conventus, Inc.
- Elsevier, Inc.
- Extremity Medical, Inc.
THE “INTERCALATED SEGMENT”

- No tendon insertions
- Motion initiated by mechanical articulations in midcarpal joint
- Limited by ligamentous constraints

The “Intercalated Segment” Ligament Anatomy

KINEMATICS: Flexion - Extension

Proximal row motion in synchrony, guided by scaphoid

KINEMATICS

Scaphoid pulls proximal row into flexion


Triquetrum pushes proximal row into extension

Hamate

“Helicoidal” surface

Triquetrum "engaged"

Triquetrum

Pathomechanics, Spectrum and Treatment of Carpal Instability

Scott W. Wolfe, MD
March 12, 2017

**MIDCARPAL JOINT IS INHERENTLY UNSTABLE**
Scaphoid is a connecting rod

When the scaphoid’s not happy, the midcarpal joint is not happy.

- Gilford, 1942; Fisk, 1970

**Proximal row motion is in synchrony throughout F/E and RUD, and is guided by scaphoid**

**KINEMATICS:**
- **SL Dissociation**

- **Disi**
  - Dissociation
  - Diastasis

What causes degenerative change, and how can we prevent it?

Answer: Disruption of the midcarpal joint
What causes degenerative change, and how can we prevent it?

23 y.o. RHD male 7 months post basketball injury

What causes degenerative change, and how can we prevent it?

23 y.o. RHD male 7 months post basketball injury

Rotatory subluxation? or DISI?

gap?

56 yo ♀ physical therapist; no known injury, 10m of mild wrist pain, FROM GAP DISI

Rotatory subluxation

56 yo ♀ physical therapist; no known injury, 10m of mild wrist pain, FROM GAP DISI

COMPLETE SLIL FAILURE

Scaphoid mal-rotation and gap may not be sufficient for DJD

• 6 cases
• Xrays judged by 2 surgeons to be nl
• MRI interpreted as SLAC II

...but she is highly functional and has minimal discomfort.
**Scaphoid dorsal translation**

- SLIL incompetence allows dorsal translation of scaphoid (p<0.05)
- Perching of scaphoid on dorsal rim paradoxically increases RS joint space

Dorsal rim loading causes scaphoid DJD

**Scaphoid dorsal translation**

- We question Watson’s analogy of “nested spoons”
- Symptomatic patients have more than rotatory instability
- “Unhinged” scaphoid allows capitate to drift dorsal
- Disrupts integrity of midcarpal joint ➔ DJD

21 confirmed SLIL ruptures compared to 21 normal wrists
p < 0.001

**Dorsal translation may be a predictive parameter for repair outcomes**

63 yo male 4 mos after HE injury

63 yo male 8 wks postop modified Brunelli

63 yo male 9 mos postop modified Brunelli
Dorsal translation may be a predictive parameter for repair outcomes

HYPOTHESIS
Abnormal scaphoid sagittal alignment disrupts midcarpal kinematics and leads to degenerative arthritis

63 yo male 4 yrs postop modified Brunelli

The midcarpal joint is critical to complex (coupled) wrist motion

In Vivo Radiocarpal Kinematics and the Dart Thrower’s Motion

JHSH 2015

Can the scaphoid be dynamically stabilized?

Scaphoid-friendly carpal supination muscles:
LUCMÍABES

Her midcarpal joint is only minimally maligned

56 yo ♀ physical therapist; no known injury, 10m of mild wrist pain, FROM

Can she dynamically stabilize her scaphoid?

What is the role of therapy to strengthen the "friendly" muscles of anti-pronation?
The primary goal of SLIL repair or reconstruction is to preserve midcarpal architecture and function.

Yet we continue to struggle with outcomes of SLIL repair and reconstruction.

NEW CONCEPTS: “DOUBLE ROW” REPAIR

- 51 cadavers, 3 repairs
  - Double loaded, single loaded, transosseous
  - MTS machine, load to failure, cyclic load
  - Double loaded >> Transosseous > single
  - Higher number of cycles to failure

Yet we continue to struggle with outcomes of SLIL repair and reconstruction.

SURGICAL OPTIONS

The primary goal of SLIL repair or reconstruction is to preserve midcarpal architecture and function.

MUST CORRECT DORSAL TRANSLATION!
NEW CONCEPTS:

- GRAFT AUGMENTATION

Novel idea. No data. No distal scaphoid support. Loosening may lead to rotation/translation.
What’s new in chronic SLIL reconstruction?

- 20 patients prospective study; good outcome scores 3y
- Increased coronal gap in most
- Progressive DJD in 20%

Long term studies show slow decline in radiographic outcomes

- Mid-term results of ligament tenodesis in treatment of scapholunate dissociation: a retrospective study of 20 patients
  20 patients prospective study; good outcome scores 2y
  - VAS 3, DASH 29; ROM reduced by average 33 degrees
  - OA progression 15%; converted to 4CF

Long term studies show slow decline in radiographic outcomes

- 20 patients prospective study; good outcome scores 2y
- VAS 3, DASH 29; ROM reduced by average 33 degrees
- OA progression 15%; converted to 4CF

Back to the future?

- Original technique followed 38 month followup
- DASH 15, PRWE 26
- 5/8 radiographic failures

Biomechanical feasibility study vs. Blatt Capulodesis, TLT.

- Early results, 11m
  - 13 patients
    - 1 failure
    - 2.1mm SL gap
    - 59º SL angle
    - 102 deg F/E
    - 55lb grip (62%)
- Longer term results necessary
- Large implant
Necessary components of an ideal SLIL reconstruction

- Address entire SLIL
- Correct rotation and translation
- Restore midcarpal kinematics to prevent DJD
- Sufficient strength to allow earlier wrist motion
- Durable

SLT procedure

- Innovative technique
- Transosseous tunnels
- No screw
- 11 wrists
- 12 months follow-up
- Improved grip, PRWE
- Maintained SL closure

SLT 2016

- More than 100 SLT repairs
- Indication > 6wks
- Reducible, no arthritis
- Minimal use of K-wires
- DTM and limited arc F/E begun at 2-3 weeks

Mark Ross and Greg Couzen, Brisbane
Spiral Tenodesis

Anteropulsion Spiral Tenodesis—A Surgical Technique for the Treatment of Perilunate Instability

- Marc Garcia-Elias
- 1 case reported
- Cautious but optimistic approach
- May be indicated for acute SLIL

What’s new in early SLAC disease?

- Maintain the midcarpal joint!
- Few outcome studies of RSL fusion
- Technically difficult to align MC joint
- Progressive DJD in 20%

What’s new in arthroplasty?

- Midcarpal hemiarthroplasty
  - Replaces proximal carpal row
  - Preserves carpal height
  - Anatomic midcarpal geometry
  - Ligament sparing

MIDCARPAL HEMIARTHROPLASTY FOR WRIST ARTHRITIS: 4y UPDATE

Scott Wolfe, MD,
Greg Packer, FRCS(Orth); Joseph J. Crisco, MD

METHODS

- 22 patients followed prospectively
- SLAC (13), OA (3) PT OA (2)
- Inflammatory arthritis (3)
- Kienböck’s (1)
- Avg age 50.8 yrs (range, 23-74)
- Mayo, DASH, ROM, grip, xrays
- Mean follow-up 4y (range 3.4 – 5.5)
Pathomechanics, Spectrum and Treatment of Carpal Instability

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No other SLAC wrist procedure or arthroplasty demonstrates increased ROM post-operatively

<table>
<thead>
<tr>
<th>Pre-Op</th>
<th>Post-Op</th>
<th>Significance</th>
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<tbody>
<tr>
<td>Mayo Score</td>
<td>34.2</td>
<td>59.7</td>
</tr>
<tr>
<td>DASH</td>
<td>50.3</td>
<td>25.9</td>
</tr>
<tr>
<td>F-E Arc (Degrees)</td>
<td>63</td>
<td>99.2</td>
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<tr>
<td>R-U Arc (Degrees)</td>
<td>22.4</td>
<td>34.5</td>
</tr>
<tr>
<td>Grip (KG)</td>
<td>14.1</td>
<td>20.7</td>
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<tr>
<td>Grip (% Opposite Side)</td>
<td>66.3%</td>
<td>96.3%</td>
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</tbody>
</table>

Pioneering wrist op has got Tim back in the swing

Patient #1 5.5y
DASH 0.0 Grip 85% FE 82%

KinematX Total Midcarpal Wrist Replacement

- Replicates midcarpal joint
- Modular components
- Long stem fixation of distal component
- FDA submission 2017

Exciting times for wrist reconstruction and rehabilitation

- Preservation of midcarpal joint function
  - Reduce dorsal translation
  - Stronger repairs
- Prevention of degenerative arthritis
- Maintenance of carpal kinematics

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