Scaphoid Non-union

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Introduction

- Scaphoid fracture incidence: 8-38/100,000
- Non-union 5% (0-22%)
- Adams and Leonard (1928)
  - first described operative treatment of the scaphoid nonunion by bone grafting.
More history

- Fisk (1980). Described goal of the treatment with wedge graft:
  - restoration of normal scaphoid anatomy
  - reestablish the normal tension in the palmar radiocarpal ligaments

- Fernandez (1984) modified the original Fisk procedure with:
  - (1) use of a preoperative plan based on Xrays of the opposite wrist
  - (2) the use of a palmar approach
  - (3) the resection of the nonunion site and insertion of an iliac graft
  - (4) the use of internal fixation

- Zaidemberg et al. (1991) Vascular bone grafting
  - Work horse till today
  - Distal radius graft between 1\textsuperscript{st} and 2\textsuperscript{nd} extensor compartment
  - 1,2-intercompartmental supraretinacular artery
Wedge Grafting: Fernandez

Preoperatively use X-ray of uninjured wrist as a guide:
- calculate the amount of resection
- size of graft
- angular deformity

Approach:
- between the flexor carpi radialis and the radial artery
- incise the palmar capsule of the wrist longitudinally
- if signs of AVN of the proximal fragment are apparent, place multiple 1-mm drill holes within the sclerotic cancellous bone

- Shape the corticocancellous graft from the iliac crest to fit the defect and restore anatomy
- Orient the graft so that its cortical part is palmar
- The scaphoid is fixed with two or three 1.2-mm Kirschner wires

Figure 66-25 Preoperative planning. Top, Tracing of uninjured wrist and measurement of scaphoid length and SL angle. Middle, Calculation of size of resection area and form of graft. Bottom, Definitive diagram of operation. (Redrawn from Fernandez DL: J Hand Surg 9A:733, 1984.)
Vascular bone graft
Zaidenberg

Approach:
• Dorsoradial incision centered on the radiocarpal joint
• Incise extensor retinaculum of the first dorsal extensor compartment
• Identify the longitudinal course of the ascending irrigating branch of the radial artery
• Design a bone graft with the longitudinal vessel as its center.
• Burr the sclerotic bone ends of scaphoid
• Reduce the fracture. May have to use a second, palmar incision
• Make a 15- to 20-mm-long trough in the scaphoid parallel to its long axis.
• Harvest a bone graft from the distal radius, beneath the periosteal vessel.
• Transpose it to the defect in the scaphoid. Stabilize the bone graft with Kirschner wires.
Scaphoid non-union: Mack-Lichtman Classification

- I – stable, no significant changes
- II – unstable because of displacement > 1-2mm
- III – unstable with collapse and arthritis
- IV & V - unstable with advanced arthritis ± radiolunate changes (pancarpal arthritis)

- systematic quantitative meta-review of the literature for the treatment of scaphoid non-union

- 36 articles; 1,827 scaphoid non-union repairs

- Instability was defined as:
  - fracture displaced by 2 mm or a dorsal intercalated segment instability deformity (radiolunate angle >10°, or a scapholunate angle >60°)

- CT scan to verify non-unions
Unstable non-unions (6 studies, 125 patients):
  - Screw fixation with grafting: 94% union
  - K-wires and wedge grafting: 77% union

Immediate mobilization versus 6 weeks or more of casting showed the same union rate of 74% for internal fixation. (12 studies with 519 patients)

Avascular necrosis of the proximal fragment (7 studies, 64 patients):
  - Vascular graft: 88% union
  - Screw and wedge fixation: 47%

Delay to Surgery

<table>
<thead>
<tr>
<th>Delay (mo)</th>
<th>No. of Patients</th>
<th>No. of Studies</th>
<th>Average Rate of Union</th>
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<tbody>
<tr>
<td>&lt;12</td>
<td>253</td>
<td>15</td>
<td>90% (77% to 100%)</td>
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<tr>
<td>12–36</td>
<td>467</td>
<td>24</td>
<td>80% (65% to 100%)</td>
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<tr>
<td>37–60</td>
<td>288</td>
<td>10</td>
<td>79% (50% to 100%)</td>
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<tr>
<td>&gt;60</td>
<td>38</td>
<td>10</td>
<td>79% (0% to 100%)</td>
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Conclusion:

1. Unstable non-union: Screw and graft fixation
2. AVN: Vascular graft
3. No need for postoperative immobilization in patients with solid screw fixation.

- Review of literature from 1928 to 2003 for union rates, postoperative immobilization periods and complications of the different scaphoid bone grafting procedures.

- 147 articles, 5,246 scaphoid nonunions

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<thead>
<tr>
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<th>union rate</th>
<th>average immobilization period</th>
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<tbody>
<tr>
<td>1. nonvascularized bone grafting without internal fixation</td>
<td>80% (95% CI: 78–82)</td>
<td>15 weeks</td>
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<tr>
<td>2. nonvascularized bone grafting with internal fixation</td>
<td>84% (CI: 82–85) and</td>
<td>7 weeks</td>
</tr>
<tr>
<td>3. vascularized bone grafting with or without internal fixation</td>
<td>91% (CI: 87–94) and</td>
<td>10 weeks</td>
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More Vascular Grafts


What Else?


Case study
- A chronic nonunion of a proximal pole fracture of the scaphoid
- Treated by:
  - curettage of the nonunion
  - single K-wire fixation
  - implantation of 50 mg of human bone morphogenetic protein
- followed by 12 weeks of cast immobilization
- No corticocancellous bone grafting or rigid screw fixation
- Radiographs showed signs of bony healing by 12 weeks
- MRI scan 6 years after surgery showed no signs of avascular necrosis.
Take home points

- Unstable no AVN: bone graft + fixation
- Unstable and AVN: vascular graft
- More option on the horizon
  - E.g. BMP