Retrospective Comparative Analysis of Hallux Interphalangeal Joint Fusion Fixation Constructs: Single 4.0 Intramedullary Screw Versus Double 3.0 Headless Intramedullary Screws

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Our disclosures are in the Final AOFAS Mobile App. There is a potential conflict with this presentation due to: Consultant, Wright Medical Technologies, Inc. (CFH)
Background

Statement of Purpose: to determine whether fixation technique affects fusion rates of the IPJ following hallux IPJ arthrodesis.

Study Aims:
1. Calculate IPJ fusion rates (versus the rate of nonunions) among patients receiving one-screw intramedullary fixation and two-screw fixation via radiographic examination. Time to fusion for patients who fused between the two surgical groups was also completed.
2. Evaluate the rates of other clinical outcomes of interest (e.g. infection, nonunion, delayed union, rate of hardware removal) at specific follow-up time-points between the two surgical groups.

Hypothesis: the fusion rates will be similar for one-screw fixation compared to two-screw fixation.
Literature Review

• Fusion of hallux IPJ is indicated in presence of IPJ deformity and arthrosis

• Deformities commonly occur when an imbalance exists between the flexors and extensors about the metatarsophalangeal joint\textsuperscript{1,4}

• Surgical treatment for a painful, deformed IPJ of hallux is arthrodesis of the joint
  – Arthrodesis primary goal: create a stable, pain-free lever for effective flexor and extensor functioning\textsuperscript{1,4}
Fixation Techniques

• Monofilament wire, Kirschner wires, single and crossed screws, staples and external fixation

• Screw fixation offers compression:
  – **Intramedullary screw complications**: proximal screw migration, distal hardware sensitivity, distal hallux scar tissue formation, and/or poor cancellous bone hardware purchase
  – **Alternatives**: bicortical, diagonal screw fixation

• Techniques routinely used:
  1. single 4.0-mm screw
  2. two 3.0-mm headless screws

• Debate exists over rotational stability of single screw versus double screw fixation regarding fusion rate
Study Methods

Inclusion criteria:
1. ≥18 years
2. Hallux IPJ pathology requiring IPJ arthrodesis using one or two screw fixation

Exclusion criteria:
1. Concomitant procedures affecting postoperative weight-bearing
2. Other forms of fixation beyond one or two screw
3. Suspected or diagnosed osteomyelitis of the hallux

Radiographic parameters:
1. IPJ position
2. Percent of consolidation of fusion site
3. Migration or rotation of hardware

Methods:
- Retrospective chart review of patients (n=39) requiring IPJ arthrodesis was performed between January 2008 and January 2014
- Three senior attending surgeons (C.H., T.P., and G.B.) performed all surgeries using standard IPJ arthrodesis technique
- Patient follow-up examinations at 5-10 days, 4-6 wks, 8-12 wks, 6 mos and 1 yr; weight-bear as indicated at 1 wk postoperatively

Data Analysis:
- Data extracted from EMR
- Imaging data manually reviewed via plain films
- Postoperative complications, including infection, nonunion, delayed union, rate of hardware removal, were recorded
Figure 1 (left): AP radiograph of a single 4.0-mm screw
Figure 2 (middle): AP radiograph of two 3.0-mm headless screws
Figure 3 (above): Lateral radiograph of two 3.0-mm headless screws
## Results

**Table 1**: Demographic and Clinical Characteristics of Patients who Required Hallux IPJ Arthrodesis with One 4.0-mm Screw or Two 3.0-mm Screw Fixation

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Overall (n=39)</th>
<th>Single Screw Fixation (n=7)</th>
<th>Two Screw Fixation (n=32)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, n (%)</td>
<td></td>
<td></td>
<td></td>
<td>0.475</td>
</tr>
<tr>
<td>Female</td>
<td>26 (66.7)</td>
<td>6 (85.7)</td>
<td>20 (62.5)</td>
<td>-</td>
</tr>
<tr>
<td>Male</td>
<td>13 (33.3)</td>
<td>1 (14.3)</td>
<td>12 (37.5)</td>
<td>-</td>
</tr>
<tr>
<td>Age, mean (SD)</td>
<td>58.6 (14.2)</td>
<td>64.7 (10.9)</td>
<td>57.3 (14.7)</td>
<td>0.216</td>
</tr>
<tr>
<td>BMI, mean (SD)</td>
<td>28.3 (6.5)</td>
<td>25.5 (5.6)</td>
<td>28.9 (6.6)</td>
<td>0.218</td>
</tr>
<tr>
<td>Laterality, n (%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.547</td>
</tr>
<tr>
<td>Left</td>
<td>21 (53.9)</td>
<td>5 (71.4)</td>
<td>16 (50.0)</td>
<td>-</td>
</tr>
<tr>
<td>Right</td>
<td>18 (46.2)</td>
<td>2 (28.6)</td>
<td>16 (50.0)</td>
<td>-</td>
</tr>
<tr>
<td>Diabetic, n (%)</td>
<td>9 (23.1)</td>
<td>0 (0.0)</td>
<td>9 (28.1)</td>
<td>0.265</td>
</tr>
<tr>
<td>Osteoporosis, n (%)</td>
<td>9 (23.1)</td>
<td>3 (42.9)</td>
<td>6 (18.8)</td>
<td>0.373</td>
</tr>
<tr>
<td>Smoking status, n (%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.274</td>
</tr>
<tr>
<td>Never</td>
<td>31 (79.5)</td>
<td>4 (57.1)</td>
<td>27 (84.4)</td>
<td>-</td>
</tr>
<tr>
<td>Former</td>
<td>3 (7.7)</td>
<td>1 (14.3)</td>
<td>2 (6.3)</td>
<td>-</td>
</tr>
<tr>
<td>Current</td>
<td>5 (12.8)</td>
<td>2 (28.6)</td>
<td>3 (9.4)</td>
<td>-</td>
</tr>
</tbody>
</table>
## Results

Table 2: Outcomes of Patients who Required Hallux IPJ Arthrodesis with One 4.0-mm Screw or Two 3.0-mm Screw Fixation

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Overall (n=39)</th>
<th>Single Screw Fixation (n=7)</th>
<th>Two Screw Fixation (n=32)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fusion, n (%)</td>
<td></td>
<td>5 (71.4)</td>
<td>25 (78.1)</td>
<td>&gt;0.999</td>
</tr>
<tr>
<td>Achieved complete fusion</td>
<td>30 (76.9)</td>
<td>2 (28.6)</td>
<td>4 (12.5)</td>
<td>0.580</td>
</tr>
<tr>
<td>Achieved partial fusion</td>
<td>4 (10.3)</td>
<td>1 (14.3)</td>
<td>3 (9.4)</td>
<td></td>
</tr>
<tr>
<td>Revision/hardware removal before fusion</td>
<td>4 (10.3)</td>
<td>1 (14.3)</td>
<td>3 (9.4)</td>
<td></td>
</tr>
<tr>
<td>Loss to follow up</td>
<td>1 (2.6)</td>
<td>0 (0.0)</td>
<td>1 (3.1)</td>
<td></td>
</tr>
<tr>
<td>Time to complete fusion, in weeks, median (range)</td>
<td>15.6 (4.7 - 90.9)</td>
<td>36.7 (11.0 - 83.9)</td>
<td>13.1 (4.7 - 90.9)</td>
<td>0.164</td>
</tr>
<tr>
<td>Hardware removal, n (%)</td>
<td>7 (18.0)</td>
<td>1 (14.3)</td>
<td>6 (18.8)</td>
<td>&gt;0.999</td>
</tr>
<tr>
<td>Revisional hallux IPJ arthrodesis, n (%)</td>
<td>4 (10.3)</td>
<td>1 (14.3)</td>
<td>3 (9.4)</td>
<td>&gt;0.999</td>
</tr>
<tr>
<td>Infection, n (%)</td>
<td>6 (15.4)</td>
<td>2 (28.6)</td>
<td>4 (12.5)</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

• **Hypothesis supported**: no difference in radiographic fusion rate between one versus two screw fixation groups (n=39)

• IPJ fusion rates: 90-98% for two groups
  - Only 2-10% of arthrodesis sites showed <50% radiographic fusion at one year
    • Shrives and Johnson: pseudoarthrosis in 10% of patients utilizing single intramedullary screw fixation\(^5\)
    • Langford and Fenton: no healing problems in 28 patients utilizing single intramedullary screw fixation; radiographic union rates not specified\(^1\).
    • Derner and Meyr: good results with single oblique screw fixation; arthrodesis rate not specified\(^7\)

• 7 of the 39 total patients underwent the single screw fixation
  - Minimal number due to evolution of technique to include a second point of fixation
    • Frankel et al. discussed similar progression of single Kirschner wire fixation and associated problems leading to double Kirshner wire fixation\(^2\)

• Two screw (v. single) fixation has higher fusion rate (not statistically significant)

• Similar rates of hardware removal, fusion revision, and infection, between groups
  - Suggests no difference in procedure technique
Conclusions

Limitations:

• Small sample size (underpowered study)
• Isolated hallux interphalangeal joint arthrodesis is not common; it is used in combination with other procedures to correct forefoot deformities, which decreased number of patients who fit study inclusion criteria

Future Considerations:

• Larger sample size and equitable patient groups (e.g. single and two screw fixation)
• Prospective randomized control study comparing the two fixation techniques, including both radiographic and clinical outcomes to determine if the fixation differences have an impact on function
References


