Hammer Digit Syndrome: An Evidence Based Approach

By

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RCPS (Glasg)
Disclosures - None
Trepel et al. JFAS 1999
Preferred Practice Guideline:
Hammer Toe Syndrome
Defining Terminology

Hammer Toe

Claw Toe

Mallet Toe
Defining Terminology

Overlapping 5th Toe

Digitii Quinti Varus

Clinodactyly
Goals and Objectives of Treatment

- Relive Pain In & Out of Shoes
- Improve Function
- Prevent Morbidity
- Reduce Deformity
- Prevent Deformity Progression

Goals of Diagnosing & Treating HDS
Physician’s Objectives to Accomplish Goals of Diagnosing and Treating HDS

1. Accurately Diagnose HDS
2. Determine the etiologic factors contributing to, and/or exacerbating the deformity
3. Inform and educate the patient regarding treatment options
4. Determine and initiate the optimal treatment plan, with consideration of overall patient status and needs
5. Obtain appropriate consultation when indicated
6. Provide appropriate follow-up and rehabilitation, as necessary
Incidence of HDS

4-14 y/o
M = F
W: 1:3800
B: 1:700

15-30 y/o
F 9:M 1
W: 1:100
B: 1:33

31-60 y/o
F 2.5:M 1
W: 1:15
B: 1:5

60 + y/o
F 3:M 1
W: 1:10
B: 1:9
Risk Factors

- Pes Cavus
- Pes Planus
- Equinus
- Abnormal Metatarsal and/or Digital Length or Position
- Neuromuscular Dysfunction
- Arthritides
- Trauma
- Pressure or Deforming Force From Adjacent Digits (i.e. HAV)
- Metatarsus Adductus
- Hereditary Factors
- Biomechanical Dysfunction
- Improperly Fitted Shoes and/or Hosiery
**Flexor Stabilization**
1. Most common etiology
2. Flexors tendons are supinators of RF
3. Pronation – fire earlier & longer to stabilize MTJ/STJ
4. Late stance phase FDL > Interossei (inefficient in pronated foot)
5. Clinically – excessive gripping of toes in stance with hammering/clawing, adducto-varus 5\textsuperscript{th}/4\textsuperscript{th} digits

**Flexor Substitution**
1. Least common etiology
2. FDL > Interossei when deep posterior lateral muscles substitute for a weak GSC (Achilles Insufficiency)

**Non-mechanical**
1. Isolated HDS is usually static not dynamic
2. Long toe with retrograde shoe pressure, hallux under riding adjacent 2\textsuperscript{nd} toe, ill-fitting shoes, female, advancing age

**Extensor Substitution**
1. EDL > Lumbricales during swing resulting in deformity
2. Pes Cavus, Neuromuscular Disease
3. Normal 30° DF at MPJ during swing increases to 90°-130°
4. Equinus – FF PF RF EDLs fire earlier & longer during HO
5. Clinically – EDLs bowstring prior to HO, toes are always clawed without varus rotation
Diagnosis & Evaluation

History
1. PMHx
2. Surgical Hx
3. FSHx
4. Medications
5. Allergies
6. HPI – NALDOCATs
7. Type of shoe gear & hosiery

Diagnostic Exams
1. X-rays – 3 WB views to assess deformity
2. Laboratory Tests – metabolic, inflammatory or infectious
3. NCVs/EMG – NM disease
4. Lower Extremity Arterial Exam

Physical Examination
1. Comprehensive Lower Extremity Exam
   a. Lesions/Ulcers/Erythema/Infection
   b. Flexible/Semi-Reducible/Non-Reducible Deformity
   c. Secondary Pathology
2. Comprehensive Biomechanical Exam – WB/NWB
Sequelae of Non-Treatment

- Progression of deformities from flexible to rigid
- Pain
- Digital Clavi
- Toenail deformities
- Sub MTH HPK
- Bursitis/Synovitis
- Tendinitis
- Gait abnormalities with proximal structural symptoms
- Shoe gear limitations
- Degenerative joint disease
- Ulceration possibly leading to infection
Indications for Treatment

- Digital deformity with or without pain
- Associated lesion or finding
  - HPK
  - Adventitious Bursae
  - Ulceration
  - Erythema
  - Infections
  - Interdigital maceration/helloma
- Biomechanical instability of the toe and adjacent MPJ
- Arthrosis of toe and/or related MPJ
Treatment of HDS

Non-Surgical

1. Symptoms controlled conservatively
2. Patient does not desire Sx
3. Poor Sx candidate

- Routine HPK debridement
- Orthodigita
- Modification of shoe gear/hosiery
- Corticosteroid injections/NSAIDs/Oral Steroids
- Topical Keraotlytics
- Orthosis
- Monitoring & Living With Deformity
Treatment of HDS

Surgical Indications

- Conservative care unsuccessful, undesirable or impractical
- Pain/deformity/altered function affecting daily life
- Deformity involving any combination of MPJ, PIPJ and/or DIPJ documented by radiographs and/or physical examination
- Informed consent of the patient
Complications Associated with HDS Surgery

- Persistent edema
- Recurrence of deformity
- Residual pain
- Excessive stiffness
- Less common complications:
  - Numbness
  - Flail toe
  - Symptomatic osseous regrowth
  - Malposition
  - Malunion/nonunion
  - Implant fatigue/failure/intolerance
  - Infection
  - Vascular impairment
  - Gangrene
Flexor Digitorum Longus Transfer: Flexible/Semi-Flexible/Semi-Rigid HDS Deformities
Losa Iglesias et al. JAPMA 2012
Meta-analysis of Flexor Tendon Transfer for the Correction of Lesser Toe Deformities

**Methods**

1. 203 citations → 112 articles reviewed → 17 articles met study criteria
2. 515 procedures
3. Mean F/U = 54.21 mos. ± 20.64 mos.
4. Mean age = 51.01 ± 9.76

**Results**

1. Crude patient satisfaction = 86.7% (95% confidence interval, 81.7%-90.5%)
2. Low grade of heterogeneity - no influence of individual study

**Results**

1. High quality adjusted study patient satisfaction = 91.8% (NS)
2. Priori source heterogeneity adjustments → NS

FDL transfer rationale – substitutes for lost intrinsic muscle function restoring digital function while removing deforming force of FDL

Primary Complication - stiffness (up to 60% reported by Pyper (alone did not detract from patient overall satisfaction); other reasons for poor results (excessive PIPJ/MPJ contracture, marked cavus deformity, RA and Pes Planus)
Bayod et al. JAPMA 2013
Stress at the Second Metatarsal Bone After Correction of Hammertoe and Claw Toe Deformity: A Finite Element Using an Anatomical Model

Table 1. Traction Stresses in the Second Metatarsal Bone When Performing Surgical Correction of Hammertoe and Claw Toe Deformities

<table>
<thead>
<tr>
<th>Traction Stresses (MPa)(^a)</th>
<th>NOF</th>
<th>FDLT</th>
<th>FDBT</th>
<th>PIPJA</th>
<th>P Value</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.36 ± 2.22</td>
<td>1.54 ± 2.49</td>
<td>1.54 ± 2.49</td>
<td>1.71 ± 2.83</td>
<td>&lt;.01, NOF versus PIPJA</td>
<td>1. There are significantly higher traction stresses in PIPJA versus NOF</td>
</tr>
<tr>
<td></td>
<td>(-7.86 to 28.55)</td>
<td>(-15.36 to 40.24)</td>
<td>(-17.77 to 32.44)</td>
<td>(-15.68 to 37.28)</td>
<td>&lt;.01, NOF versus FDLT</td>
<td>2. There are increased traction stresses in FDLT and FDBT versus NOF but lower than in PIPJA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;.01, NOF versus FDBT</td>
<td>3. There are the same traction stresses in FDLT versus FDBT</td>
</tr>
</tbody>
</table>

Note: \( P < .01\), 99% confidence interval. The mesh was composed of 797,753 tetrahedral elements.
Abbreviations: FDBT, flexor digitorum brevis tendon transfer; FDLT, flexor digitorum longus tendon transfer; NOF, nonoperated foot; PIPJA, proximal interphalangeal joint arthrodesis.

\(^a\)Data are given as mean ± SD (range).
Bayod et al. JAPMA 2013
Stress at the Second Metatarsal Bone After Correction of Hammertoe and Claw Toe Deformity: A Finite Element Using an Anatomical Model

Table 2. Compressive Stresses in the Second Metatarsal Bone When Performing Surgical Correction of Hammertoe and Claw Toe Deformities

<table>
<thead>
<tr>
<th>Compression Stresses (MPa)</th>
<th>NOF</th>
<th>FDLT</th>
<th>FDBT</th>
<th>PIPJA</th>
<th>( P ) Value</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(-3.10 \pm 4.90)</td>
<td>(-4.25 \pm 7.15)</td>
<td>(-4.25 \pm 6.92)</td>
<td>(-4.35 \pm 7.05)</td>
<td>&lt;.01, NOF versus PIPJA</td>
<td>1. There are significantly higher compressive stresses in PIPJA versus NOF</td>
</tr>
<tr>
<td></td>
<td>((-101.04 to 0.08))</td>
<td>((-158.29 to 0.11))</td>
<td>((-136.34 to 0.12))</td>
<td>((-148.81 to 0.10))</td>
<td>&lt;.01, NOF versus FDLT</td>
<td>2. There are increased compressive stresses in FDLT and FDBT vs NOF but lower than in PIPJA</td>
</tr>
<tr>
<td></td>
<td>&lt;.290, FDLT versus FDBT</td>
<td>3. There are the same compressive stresses in FDLT versus FDBT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: \( P < .01 \), 99% confidence interval. The mesh was composed of 797,753 tetrahedral elements.
Abbreviations: FDBT, flexor digitorum brevis tendon transfer; FDLT, flexor digitorum longus tendon transfer; NOF, nonoperated foot; PIPJA, proximal interphalangeal joint arthrodesis.
\(^a\)Data are given as mean ± SD (range).

“There is a biomechanical advantage to performing FDLT or FDBT instead of PIPJA to surgically treat a hammertoe or claw toe deformity. In addition, tensile strain at the dorsal aspect of the second metatarsal bone when performing PIPJA increases the risk of metatarsalgia or stress fracture in patients at risk.”
Arthroplasty vs. Arthrodesis: Semi-Rigid/Rigid HDS Deformities
Schrier et al. FAI 2016
Lesser Toe PIP Joint Resection Versus PIP Joint Fusion: A Randomized Clinical Trial

Table 1. Demographic Data.

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>PIPJ Resection</th>
<th>PIPJ Fusion</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>55</td>
<td>26</td>
<td>29</td>
<td>.83</td>
</tr>
<tr>
<td>Gender (male/female)</td>
<td>12/43</td>
<td>6/20</td>
<td>6/23</td>
<td>.83</td>
</tr>
<tr>
<td>Age (y), M (SD)</td>
<td>62 (9)</td>
<td>61 (9)</td>
<td>63 (9)</td>
<td>.50</td>
</tr>
<tr>
<td>Height (cm), M (SD)</td>
<td>170 (10)</td>
<td>172 (11)</td>
<td>169 (11)</td>
<td>.31</td>
</tr>
<tr>
<td>Weight (kg), M (SD)</td>
<td>80 (15)</td>
<td>86 (12)</td>
<td>75 (12)</td>
<td>.004</td>
</tr>
<tr>
<td>Side (left/right)</td>
<td>25/30</td>
<td>12/14</td>
<td>13/16</td>
<td>.80</td>
</tr>
<tr>
<td>ASA classification (I), (II/III)</td>
<td>22/28/5</td>
<td>8/16/2</td>
<td>14/12/3</td>
<td>.33</td>
</tr>
</tbody>
</table>

Abbreviations: ASA, American Society of Anesthesiologists; M, mean; PIPJ, proximal interphalangeal joint; SD, standard deviation.

- Level of Evidence: Level II, lesser quality RCT or prospective comparative study
- Both groups had K-wire fixation across MPJ x 4-6 weeks
- Both groups P/O FWB in surgical shoe
Schrier et al. FAI 2016
Lesser Toe PIP Joint Resection Versus PIP Joint Fusion: A Randomized Clinical Trial

Significant improvement in all categories pre-op to 3/12 months P/O

No significant difference between 3 months & 12 months P/O

No main effect between groups could be detected

No interaction effects could be demonstrated

Figure 1. The course of the different outcome scores within time and comparison between the 2 groups. In parentheses is the number of patients per group (resection/fusion) with complete follow-up data per specific outcome score.
Schrier et al. FAI 2016
Lesser Toe PIP Joint Resection Versus PIP Joint Fusion: A Randomized Clinical Trial

Significant main effect with hallux in FFI B but not FFI C

No main effect for VAS pain or AOFAS groups with hallux

Patients with 1st ray correction had ↑ FFI B & FFI C scores to those w/o

This 1st ray correction effect was equal between the 2 groups

Figure 2. The course of the different outcome scores within time and comparison between the 2 groups, with influence of hallux correction or no hallux correction.
Lesser Toe PIP Joint Resection Versus PIP Joint Fusion: A Randomized Clinical Trial

Complications
- 12/26 Resection
- 18/29 Fusion
Total 30 of 55

11 K-wire related – no difference b/w groups

- 6 Floating toes (4 resection)
- 6 Maligned toes (4 resection)

- 1 Pseudo-Arthrosis
- 1 Superficial skin necrosis

- 2 Sensory deficit
- 1 Infection
- 1 Recurrence
- 1 Infection
- 1 Recurrence

Superficial skin necrosis
Schrier et al. FAI 2016
Lesser Toe PIP Joint Resection Versus PIP Joint Fusion: A Randomized Clinical Trial

➢ PIPJ fusion resulted in a better alignment on the sagittal view, compared to PIPJ resection
➢ Second PIPJ alignment in an AP view, no significant effects were found
➢ 7 of 29 fusions resulted in nonunion with 1 symptomatic
➢ MPJ release did not influence of outcome of SP P/O PIPJ alignment

Table 2. Pre- and Postoperative Radiologic Toe Alignment.

| Alignment of PIPJ of Measured Toe | Preoperation | | | 1 Year Postoperation | |
|-----------------------------------|--------------|--------------|----------------------|----------------------|
|                                   |              | PIPJ Resection (degrees) | PIPJ Fusion (degrees) | PIPJ Resection (degrees) | PIPJ Fusion (degrees) |
| Sagittal (n = 47), M (SD)          | 63 (20)      | 60 (16)      | 30 (15)              | 15 (15)              |
| Anteroposterior (n = 51), M (SD)   | 3 (12)       | -2 (13)      | 4 (11)               | 2 (8)                |

Abbreviations: M, mean; SD, standard deviation.
Sung et al. Foot & Ankle Specialist 2014
Retrospective Comparative Study of Operative Repair of Hammer Deformity

Figure 1.
Patient Inclusion Flow Chart.

1. Consecutive patients from July 1998 to December 2008
2. CPT code 28285
   - 2087
3. Included patients who had 2nd digit arthroplasty, arthrodesis, or interpositional implant arthroplasty at the PIP joint
   - 1294
4. Included patients with post-operative follow-up of at least 12 months with complete medical and radiographic records
   - 518
5. Included only patients whose operating surgeon was one of the two senior authors
   - 226
6. Included patients without a history of previous surgery to second digit, ulceration, local infection at time of surgery, or neuromuscular disease
   - 114 patients (136 toes)
Sung et al. Foot & Ankle Specialist 2014
Retrospective Comparative Study of Operative Repair of
Hammer Deformity

Figure 2.
A Second Toe Preoperative Anterior-Posterior View.

Figure 3.
A Second Toe Arthroplasty Postoperative Anterior-Posterior View.

Figure 4.
A Second Toe Preoperative Lateral View.

Figure 5.
A Second Toe Postoperative Lateral View After the Arthroplasty Procedure.
Sung et al. Foot & Ankle Specialist Specialist 2014
Retrospective Comparative Study of Operative Repair of Hammer Deformity

Average age = 60.0 ± 11.4
Average F/U = 53.8 mos. ± 32 mos.

125 other HDS repairs
53 lesser MT osteotomies
48 HAV corrections

7 TB Sxs
4 neuromas
2 – 1st MPJ implants
1 – 1st MPJ arthrodesis

43 cases MPJ releases, extensor tenotomy and/or MT osteotomy

Table 1.
VAS Scores by Group.

<table>
<thead>
<tr>
<th>VAS</th>
<th>Mean Preoperative VAS (SD)</th>
<th>Mean Postoperative VAS (SD)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthroplasty (n = 45)</td>
<td>7.1 (2.1)</td>
<td>1.0 (1.2)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Arthrodesis (n = 43)</td>
<td>8.0 (2.0)</td>
<td>1.9 (1.6)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Implant (n = 48)</td>
<td>8.2 (1.8)</td>
<td>1.3 (1.4)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Not enough variance</td>
<td>Not enough variance</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: VAS, Visual Analog Scale; SD, standard deviation.
Table 2.
Radiographic Values in the Sagittal Plane by Group.

<table>
<thead>
<tr>
<th>Sagittal</th>
<th>Mean Preoperative LAT (SD)</th>
<th>Mean Postoperative LAT (SD)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthroplasty (n = 45)</td>
<td>46.9 (17.8)</td>
<td>31.5 (11.7)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Arthrodesis (n = 43)</td>
<td>46.4 (17.1)</td>
<td>24.7 (14.1)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Implant (n = 48)</td>
<td>49.1 (14.3)</td>
<td>24.2 (5.7)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Not enough variance</td>
<td>Not enough variance</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: LAT, lateral angle; SD, standard deviation.

Table 3.
Radiographic Values in the Axial Plane by Group.

<table>
<thead>
<tr>
<th>Axial</th>
<th>Mean Preoperative AP (SD)</th>
<th>Mean Postoperative AP (SD)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthroplasty (n = 45)</td>
<td>8.2 (7.9)</td>
<td>11.4 (7.7)</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Arthrodesis (n = 43)</td>
<td>7.2 (7.8)</td>
<td>5.4 (8.0)</td>
<td>.59</td>
</tr>
<tr>
<td>Implant (n = 48)</td>
<td>7.8 (7.9)</td>
<td>2.9 (5.5)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Not enough variance</td>
<td>Significant variance</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: AP, anterior-posterior angle; SD, standard deviation.
Methods of Fixation
Kramer et al. FAI 2015
Hammer Toe Correction With K-Wire Fixation

Table 1. Associated Diagnoses and Observed Recurrence and Revision.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>No. (% of Total)</th>
<th>Observed Recurrence/ Malalignment, No. (%)</th>
<th>Observed Revisions, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total no. of toes</td>
<td>2698</td>
<td>205 (7.6)</td>
<td>94 (3.5)</td>
</tr>
<tr>
<td>Gross</td>
<td>296 (11.0)</td>
<td>13 (4.4)</td>
<td>4 (1.4)</td>
</tr>
<tr>
<td>Metatarsophalangeal instability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous hammertoe surgery</td>
<td>266 (9.9)</td>
<td>40 (15.0)</td>
<td>18 (6.8)</td>
</tr>
<tr>
<td>Medial or lateral deviation</td>
<td>264 (9.8)</td>
<td>34 (12.9)</td>
<td>14 (5.3)</td>
</tr>
<tr>
<td>Metatarsophalangeal dislocation</td>
<td>229 (8.5)</td>
<td>11 (4.8)</td>
<td>3 (1.3)</td>
</tr>
<tr>
<td>Crossover toe deformity</td>
<td>107 (4.0)</td>
<td>12 (11.2)</td>
<td>5 (4.7)</td>
</tr>
</tbody>
</table>

709 F : 167 M
Average age = 57.5 y/o
Average F/U = 20.8 mos.

2nd – 1011
3rd – 650
4th – 561
5th – 476
Kramer et al. FAI 2015
Hammer Toe Correction With K-Wire Fixation

Table 2. Additional Lesser Toe Procedures.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No. (% of Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total no. of toes</td>
<td>2698</td>
</tr>
<tr>
<td>Metatarsophalangeal capsulotomy</td>
<td>1198 (44.4)</td>
</tr>
<tr>
<td>Metatarsal head excision</td>
<td>645 (23.9)</td>
</tr>
<tr>
<td>Extensor tenotomy</td>
<td>602 (22.3)</td>
</tr>
<tr>
<td>Shortening metatarsal osteotomy</td>
<td>131 (4.9)</td>
</tr>
<tr>
<td>Flexor tenotomy</td>
<td>49 (1.8)</td>
</tr>
</tbody>
</table>

393 HV corrections (35.2%)
213 1st MPJ fusions (19.1%)
89 Kellers (8.0%)
45 Hallux IPJ fusions (4.0%)
22 HL Sx (2.0%)

67 TB Sx (6.0%)
31 Flatfoot Sx (2.8%)
31 Cavovarus Sx (2.8%)
26 Midfoot fusions (2.3%)
21 Triple arthrodesis (1.9%)
Figure 4. Number of toes, of 100, expected to need revision procedures in a given year for each subgroup. *P values less than .05 were considered statistically significant and are marked with asterisks.
Kramer et al. FAI 2015
Hammer Toe Correction With K-Wire Fixation

- K-wires left in average of 39.2 days
- 118 (4.4%) K-wires required early removal
- 150 (5.6%) symptomatic recurrence of HDS with 94 (3.5%) requiring revisional Sx
- Asymptomatic or minimally symptomatic malalignment was noted in 55 toes (2.0%) at final follow-up
- 9 pin tract infections (0.3%)
- P/O Abx required in 124 of 1115 (11.1%)
- Vascular compromise occurred in 16 toes (0.6%) with 10 (0.4%) requiring amputation (8 additional amputations for other reasons)
- 2 toes with broken pins (0.1%), pin migration 94 toes (3.5%) with 59 (2.9%) completely extruded
- The expected rates and rate ratios (RRs) of patients requiring revision hammertoe correction, compared with the study population as a whole, were statistically significantly higher in patients who underwent an metatarsophalangeal joint capsulotomy (3.10 vs 0.97; RR, 3.20) and those who experienced K-wire-related complications (5.10 vs 1.80, RR, 2.84)
- No attempt to formally repair plantar plate in those toes with MTP dislocation – 6-weeks of joint immobilization with K-wire allows sufficient scarring and stabilization of soft tissues
- The cost of newer permanent toe implants can range from $500 to $1500 per implant. A K-wire typically costs between $10 and $40.
<table>
<thead>
<tr>
<th>List of 68 digital fusion devices (compiled February 1, 2014)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Acumed® Biotrak Pin</td>
</tr>
<tr>
<td>2. Acumed® Acutrak 2 Micro™</td>
</tr>
<tr>
<td>3. Acumed® Acutrak Fusion™</td>
</tr>
<tr>
<td>4. Acumed® AcuTwist Compression Screw™</td>
</tr>
<tr>
<td>5. Acumed® Biotrak Mini Compression Screw™</td>
</tr>
<tr>
<td>6. Acumed® Biotrak Pin™</td>
</tr>
<tr>
<td>7. Acumed® Hamartmoe Fusion Set™</td>
</tr>
<tr>
<td>8. Arrowhead® ARROW-LOK Hybrid™</td>
</tr>
<tr>
<td>9. Arrowhead® ARROW-LOK™</td>
</tr>
<tr>
<td>10. Arthrex® Trim-IT Drill Pin™</td>
</tr>
<tr>
<td>11. Arthrex® Trim-IT Spin Pin™</td>
</tr>
<tr>
<td>12. Biomet® Sports Medicine ReUnite</td>
</tr>
<tr>
<td>13. Biomet® Sports Medicine Well-Barrier</td>
</tr>
<tr>
<td>14. BioPro® Digital Compression Screw™</td>
</tr>
<tr>
<td>15. BioPro® Memory Staple™</td>
</tr>
<tr>
<td>16. BME® Barbed OSStaple (BOSS™)</td>
</tr>
<tr>
<td>17. BME® HammerLock DIP™</td>
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<tr>
<td>18. BME® OSStaple™</td>
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<tr>
<td>19. BME® Speed™ Continuous Active</td>
</tr>
<tr>
<td>20. Conmed® Linvatec 1.5 Bone Fixation Kit™</td>
</tr>
<tr>
<td>21. Conmed® Linvatec SmartPin™</td>
</tr>
<tr>
<td>22. Depuy® Orthopaedics RFS® Basic Screw</td>
</tr>
<tr>
<td>23. Depuy® Orthopaedics RFS® S.O.C. Pin™</td>
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<tr>
<td>24. Depuy® Orthopaedics Orthosorb Pin™</td>
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<tr>
<td>25. Inion® OTPS Biodegradable Pins™</td>
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<tr>
<td>26. Integra® Aeon Staple</td>
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<tr>
<td>27. Integra® Capture Digital Screw™</td>
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<tr>
<td>28. Integra® Tac Pin (threaded and compression)</td>
</tr>
<tr>
<td>29. Integra® IPP-ON® PIP Fusion System</td>
</tr>
<tr>
<td>30. Konza Med® Memodyne Clips</td>
</tr>
<tr>
<td>31. Merete® Medical MetaTite™ Endosorb™</td>
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<tr>
<td>32. Metasurg® Digifuse™</td>
</tr>
<tr>
<td>33. Metasurg® Ti6 DS-Series Screw™</td>
</tr>
<tr>
<td>34. Metasurg® Ti6 DS-Series Screw™</td>
</tr>
<tr>
<td>35. Minifragmentary Plating</td>
</tr>
<tr>
<td>36. MTM™ ALLOFIX Cortical Pins</td>
</tr>
<tr>
<td>37. Nexxtreme Solutions® Nextra™ Hammertoe Correction System™</td>
</tr>
<tr>
<td>38. OrthoHelix® Intrasosseous Fixation</td>
</tr>
<tr>
<td>39. Orthopediatrics® Scwire™</td>
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<tr>
<td>40. Orthopediatrics® Scwire™</td>
</tr>
<tr>
<td>41. OrthoPro® Cannulated Screw System</td>
</tr>
<tr>
<td>42. OrthoPro® Phalynx System</td>
</tr>
<tr>
<td>43. OrthoPro® Orthoflex Toe Implant</td>
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<tr>
<td>44. Osteomed® ExtremiFix™ Lesser Digit Arthrodesis</td>
</tr>
<tr>
<td>45. Osteomed® ExtremiFuse Hammertoe Fixation</td>
</tr>
<tr>
<td>46. Osteomed® InterPhlex™ Flexible Stabilization</td>
</tr>
<tr>
<td>47. Osteomed® Inion OTPS™ Biodegradable Pins</td>
</tr>
<tr>
<td>48. SBI® PercuFix™ Break-Away Pin</td>
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<tr>
<td>49. SBI® StatFIX™ Staple</td>
</tr>
<tr>
<td>50. Smith &amp; Nephew® Drill Wire Module</td>
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<tr>
<td>51. Solana Surgical® TenFUSE™ PIP Allograft</td>
</tr>
<tr>
<td>52. Stryker® Smart Toe™</td>
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<tr>
<td>53. Stryker® Smart Toe™ DIP</td>
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<tr>
<td>54. Stryker® X-Fuse™</td>
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<tr>
<td>55. Synchro Medical® Toegrip™</td>
</tr>
<tr>
<td>56. Tornier® Futura™ Flexible Digital Implant</td>
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<tr>
<td>57. Tornier® NexFix™ Compression Pin</td>
</tr>
<tr>
<td>58. Tornier® StayFuse™ Intermedullary Fusion</td>
</tr>
<tr>
<td>59. Tornier® The RFS™</td>
</tr>
<tr>
<td>60. Traditional Screws (Osteomed®, Stryker®, Synthes®, Vilex®, etc)</td>
</tr>
<tr>
<td>61. Trilliant Surgical Tiger Cannulated Screws™</td>
</tr>
<tr>
<td>62. Trilliant Surgical Two-Step Hammer Toe Implant</td>
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<tr>
<td>63. Vilex® Digit Fusion Toe Implant</td>
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<tr>
<td>64. Vilex® Extra Long Fusion Screws</td>
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<tr>
<td>65. Wright Medical™ CHARLOTTE® Quick</td>
</tr>
<tr>
<td>66. Wright Medical™ Pro-Toe V™</td>
</tr>
<tr>
<td>67. Wright Medical™ Well Hammertoe Implant™</td>
</tr>
<tr>
<td>68. Wright Medical™ MiToe™</td>
</tr>
</tbody>
</table>

Listing of the manufacturers of the devices in order of appearance: Acumed, Hillsboro, OR; Arrowhead Medical Device Technologies, Collierville, TN; Arthrex, Naples, FL; Biomet, Warsaw, IN; BioPro, Port Huron, MI; BioPro, Port Huron, MI; BioMedical Enterprises, San Antonio, TX; ConMed, Utica, NY; DePuy International, Leeds, UK; Integra LifeSciences, Plainsboro, NJ; Konza Medical, Wichita, KS; Merete Medical, New Windsor, NY; MTM, Edison, NJ; Nexxtreme Solutions, Warsaw, IN; Nexxtreme Solutions, Warsaw, IN; Orthopediatrics, Warsaw, IN; OrthoPro, Salt Lake City, UT; OsteMed, Addison, TX; Small Bone Innovations, Morrisville, PA; Smith & Nephew, Largo, FL; Solana Surgical, Memphis, TN; Stryker, Kalamazoo, MI; Synchro Medical, Wettolsheim les Erlen, France; Tornier, Amsterdam, The Netherlands; Trilliant Surgical, Houston, TX; Vilex, McMinnville, TN; Wright Medical Technology, Arlington, TN.
A Simple Method of Intramedullary Fixation for Proximal Interphalangeal Arthrodesis
A Simple Method of Intramedullary Fixation for Proximal Interphalangeal Arthrodesis

Canales et al. JFAS 2014
Canales et al. JFAS 2014

A Simple Method of Intramedullary Fixation for Proximal Interphalangeal Arthrodesis
A Simple Method of Intramedullary Fixation for Proximal Interphalangeal Arthrodesis
Hood et al. Foot & Ankle Specialist
Diverging Dual Intramedullary Kirschner Wire Technique for Arthrodesis of the Proximal Interphalangeal Joint in Hammertoe Correction

**Figure 2.**
Dorsoplantar schematic view of the digital PIPJ. In the proximal phalanx the 2 KWs are stacked with a slightly divergent trajectory that is seen in the middle phalanx. Reproduced with permission from Miller et al.³

![Image 1](image1)

**Figure 3.**
Lateral schematic view of the digital PIPJ. In the proximal and middle phalanx the 2 KWs appear stacked and parallel to one another. Reproduced with permission from Miller et al.³

![Image 2](image2)
Hood et al. Foot & Ankle Specialist
Diverging Dual Intramedullary Kirschner Wire Technique for Arthrodesis of the Proximal Interphalangeal Joint in Hammertoe Correction

Figure 6.
Postoperation radiographs AP (left), lateral (central), and medial oblique (right) at 12 months. IMKW technique implemented across PIPJs.
Prospective Study of Hammertoe Correction With an Intramedullary Implant

Catena et al. FAI 2014

- 29 patients
- 53 toes (29-2nd, 15-3rd, 9-4th) – Smart Toe Implants
- Mean age = 63 y/o
- 21 F : 8 M
- Mean F/U – 12 mos.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Preoperative (avg/pt)</th>
<th>Postoperative (avg/pt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain scale</td>
<td>5.7 (range, 2-10)</td>
<td>1.0 (range, 0-5)</td>
</tr>
<tr>
<td>AOFAS</td>
<td>52 (range, 24-87)</td>
<td>71 (range, 42-95)</td>
</tr>
</tbody>
</table>

A study by Lehman et al. (FAI 1995) after PIPJ fusion defined a satisfied patient as one with an overall AOFAS score of 80 or higher.

- 5 patients were lost to F/U
- K-wire inserted across PIPJ and MPJ in 34 toes and PIPJ only in 8 toes
- Weil osteotomy 74% (31/42) toes
- MT resection 14% (6/42) toes
### Table 2. Clinical Parameters Pre- and Postoperative.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Preoperative % (n/24 patients)</th>
<th>Postoperative % (n/24 patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsal pain</td>
<td>79 (19)</td>
<td>16 (4)</td>
</tr>
<tr>
<td>Tip toe pain</td>
<td>54 (13)</td>
<td>3 (1)</td>
</tr>
<tr>
<td>Alignment (good/excellent)</td>
<td>0 (0)</td>
<td>100 (24)</td>
</tr>
<tr>
<td>Fashionable shoes</td>
<td>3 (1)</td>
<td>58 (14)</td>
</tr>
</tbody>
</table>

### Table 3. Radiographic Axial Alignment.

<table>
<thead>
<tr>
<th>Axial alignment (medial/lateral)</th>
<th>Preoperative % (n/42)</th>
<th>Postoperative % (n/42)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>81 (34)</td>
<td>100 (42)</td>
</tr>
<tr>
<td>Fair</td>
<td>13 (5)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Poor</td>
<td>7 (3)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>
Catena et al. FAI 2014
Prospective Study of Hammertoe Correction With an Intramedullary Implant

<table>
<thead>
<tr>
<th>Table 4. Radiographic Evaluation of Proximal Interphalangeal Joint.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiographic parameter</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>Bony union</td>
</tr>
<tr>
<td>Fibrous union</td>
</tr>
<tr>
<td>Stable implant</td>
</tr>
<tr>
<td>Migration of implant</td>
</tr>
<tr>
<td>Broken implant</td>
</tr>
<tr>
<td>Bone changes (osteolysis, bone necrosis)</td>
</tr>
<tr>
<td>Cortical disruption</td>
</tr>
</tbody>
</table>
Role of MPJ Release
Correction of hammer toe with an extended release of the metatarsophalangeal joint

Fig. 3
Diagram showing the lateral view of the toe after the plantar plate has been reduced.

Fig. 4
Diagram of the anteroposterior view of the toe showing release of the extensor tendon and collateral ligaments.
Dhukaram et al. JBJS (Br) 2002
Correction of hammer toe with an extended release of the metatarsophalangeal joint

Methods
1. 84 patients (179 toes)
2. Type 2 toes
3. 69 patients for F/U
4. Mean F/U = 28 mos.

Results
1. AOFAS mean P/O = 83 (87% score > 60)
2. 83% satisfied
3. 17% dissatisfied
   a) MTPJ pain 11/78 feet (14%)

Results
a) 2 MTPJ instability (3%)
   b) 7 callus formation (9%)
   c) Poor alignment 10 (13%)

Table 1. Classification of deformities of the toes. The PIPJ is tested in 20° plantar flexion in order to relax the long flexor tendon

<table>
<thead>
<tr>
<th>Type</th>
<th>MTPJ</th>
<th>PIPJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flexible</td>
<td>Flexible</td>
</tr>
<tr>
<td>2</td>
<td>Flexible</td>
<td>Rigid</td>
</tr>
<tr>
<td>3</td>
<td>Subluxed/dislocated and irreducible</td>
<td>Fixed</td>
</tr>
</tbody>
</table>
Dhukaram et al. JBJS (Br) 2002
Correction of hammer toe with an extended release of the metatarsophalangeal joint

AOFAS < 55 y/o = 80
AOFAS > 55 y/o = 85

Male AOFAS = 80.5
Female AOFAS = 85

49 (71%) satisfied, 8 (12%) satisfied with reservations, 12 (17%) dissatisfied
48 (70%) recommend, 5 (7%) recommend with reservations, 16 (23%) wouldn’t

HAV correction
AOFAS = 81.5
Isolated HDS
AOFAS = 83

AOFAS < 2 years F/U = 83 & > 2 years F/U = 82

Histograms showing a) the subjective b) objective and c) total AOFAS scores for the 78 feet after hammer-toe correction with an extended MTPJ release.
Scan QR Code image

**iPhone**: Open camera app and position onto the image

**Android**: Open camera app and position onto image while holding down the ‘home’ button

**Some Android phones require the use of a QR Reader app, such as ‘QR and Barcode Scanner’ (by Gamma Play)**

Download the PDF file of this lecture from Dropbox (you do not need to have a Dropbox account).

Save the link to the file on your phone or email it to yourself.
Thank You

DO GOOD wherever you are.

#PayItForward  #GiveItUpForGood

padeheer@apma.org