Hallux Rigidus

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Normal function first MTP joint

- Cam-shaped condylar hinged joint
- Alignment varies 5 degrees varus to 15 degrees valgus
- Normal range of motion
  - 40-100 degrees dorsiflexion
  - 3-45 degrees plantarflexion
Hallux Rigidus Definition

- Arthritic condition characterized by stiff painful 1st MTP joint
- Early stages – involvement dorsal aspect articular cartilage with prominent dorsal osteophyte
- Later stages – central and plantar aspects of articular cartilage involved

X-rays – Almost always underestimate the extent of disease
Pathogenesis: Hallux Rigidus

- **Traumatic**: intra-articular fracture, crush, direct jamming to MTP joint
- **Idiopathic**: predisposing factors may cause increased joint stresses with subsequent swelling, synovitis, joint degeneration
  - Metatarsus elevatus
  - OCD
  - Long first ray
  - Pes planus
Clinical Features H.R.

- Painful, stiff MTP joint
- Shoewear difficult due to dorsal osteophytes
- Difficulty with pushoff during gait
- Dorsiflexion impingement occurs at spur with pain and stiffness
- Painful plantarflexion
- Stress transfer (transfer metatarsalgia) with first ray unloading
- Dorsal skin irritation due to spur
Hallux Rigidus

- Localized first MTP arthritis
- Decreased range of motion (DF), deformity, pain
Grading (Hattrup & Johnson)

- Grade I
  - Joint space maintained
  - Minimal osteophytes

- Grade II
  - Larger osteophytes
  - Subchondral sclerosis

- Grade III
  - Complete loss of visible joint space
  - Subchondral cysts
  - Osteophytes
  - Hypertrophy of sesamoids
Grading (Coughlin & Shurnas)

- **Grade 0**
  - 40-60 degrees dorsiflexion or 10% to 20% less DF than opposite side
  - Normal x-rays
  - No pain, only stiffness

- **Grade 1**
  - 30-40 degrees dorsiflexion or 20% to 50% less DF than opposite side
  - Dorsal osteophytes
  - Minimal narrowing
  - Periarticular sclerosis or head flattening
  - Mild or occasional pain at extremes of motion
Grade 2
- 10-30 degrees dorsiflexion or 50% to 70% less than opposite side
- Dorsal, lateral, +/- medial osteophytes
- Less than 25% of dorsal joint space involved
- Mild-to-moderate joint space narrowing
- Moderate-to-severe pain at extremes of motion
Grade 3
- <10 degrees of dorsiflexion or 75% to 100% loss
- Sustantial joint space narrowing
- Periarticular cysts
- >25% of joint involved
- Constant pain and substantial stiffness at extremes but not midrange of motion

Grade 4
- Same criteria as grade 3 but with pain at mid-range of motion
Grading - Regnauld

- **Grade I** – functional limitation of MTP joint, no radiographic degenerative changes
- **Grade II** – flattening of MT head, osteochondral defect, pain on end ROM, mild dorsal prominence
- **Grade III** – severe flattening of MT head, osteophyte formation, narrowing of joint space, articular degeneration, pain on full ROM
- **Grade IV** – obliteration of joint space, osteophytes + loose bodies, less than 10 degrees ROM, deformity
Radiographic Features of HR

- **Early** – x-rays may be normal, soft-tissue swelling and dorsal osteophytes on oblique view
- **Moderate** – squaring of MT head, dorsal osteophytes, narrowed dorsal joint space
- **Advanced** – minimal joint space, osteophytes, asymmetric joint narrowing, subchondral cysts
Treatment

- **Nonoperative**
- **Operative**: four basic types
  - Debridement/cheilectomy
  - Osteotomy
  - Arthroplasty (soft-tissue, implant)
  - Arthrodesis
Evidence for decision-making: Problematic

- Lack of high quality studies
- Different grading scales employed for both preoperative severity and postoperative function
  - Preoperative Scales
    - Hattrup & Johnson
    - Coughlin & Shurnas
    - Regnauld
  - Postoperative Function
    - Patient satisfaction
    - VAS
    - AOFAS score
# AOFAS MTP Scale

<table>
<thead>
<tr>
<th>Hallux Metatarsophalangeal-Interphalangeal Scale</th>
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</thead>
<tbody>
<tr>
<td><strong>Pain (40 points)</strong></td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>Mild, occasional</td>
</tr>
<tr>
<td>Moderate, daily</td>
</tr>
<tr>
<td>Severe, almost always present</td>
</tr>
<tr>
<td><strong>Function (45 points)</strong></td>
</tr>
<tr>
<td><em>Activity limitations</em></td>
</tr>
<tr>
<td>No limitations</td>
</tr>
<tr>
<td>No limitation of daily activities, such as employment</td>
</tr>
<tr>
<td>Limited daily and recreational activities</td>
</tr>
<tr>
<td>Severe limitation of daily and recreational activities</td>
</tr>
<tr>
<td><em>Footwear requirements</em></td>
</tr>
<tr>
<td>Fashionable, conventional shoes, no insert required</td>
</tr>
<tr>
<td>Comfort footwear, shoe insert</td>
</tr>
<tr>
<td>Modified shoes or brace</td>
</tr>
<tr>
<td><em>MTP joint motion (dorsiflexion plus plantarflexion)</em></td>
</tr>
<tr>
<td>Normal or mild restriction (75° or more)</td>
</tr>
<tr>
<td>Moderate restriction (30°-74°)</td>
</tr>
<tr>
<td>Severe restriction (less than 30°)</td>
</tr>
<tr>
<td><em>IP joint motion (plantarflexion)</em></td>
</tr>
<tr>
<td>No restriction</td>
</tr>
<tr>
<td>Severe restriction (less than 10°)</td>
</tr>
<tr>
<td><em>MTP-IP stability (all directions)</em></td>
</tr>
<tr>
<td>Stable</td>
</tr>
<tr>
<td>Definitely unstable or able to dislocate</td>
</tr>
<tr>
<td><em>Callus related to hallux MTP-IP</em></td>
</tr>
<tr>
<td>No callus or asymptomatic callus</td>
</tr>
<tr>
<td>Callus, symptomatic</td>
</tr>
<tr>
<td><strong>Alignment (15 points)</strong></td>
</tr>
<tr>
<td>Good, hallux well aligned</td>
</tr>
<tr>
<td>Fair, some degree of hallux malalignment observed, no symptoms</td>
</tr>
<tr>
<td>Poor, obvious symptomatic malalignment</td>
</tr>
</tbody>
</table>

Total = 100
Non-Operative Treatment

- Rocker bottom/shoe mods
- Orthotics with medial forefoot stiffness
- Activity mods: Avoid kneeling or extremes of DF at 1st MTP joint
Surgical Options
Cheilectomy

- Involves excision of spurs that limit motion (DF)
- Goal is to achieve at least 90 degrees DF intra-operatively
- Free up any Contracted scar/adhesions
- Indicated for mild/moderate xray changes
Cheilectomy results

- 3.8 year F/U of grade 1, 2 and 3 treated with cheilectomy
- Footwear selection greatly improved in patients with grade 1 and 2, but not 3
- Significant improvements in pain, ROM, tiptoe and activity level - all patients
Cheilecetomy: Indications

- Most authors recommend:
  - Mild/moderate xray changes
  - Young or active patients
  - Less than 50% articular cartilage loss (dorsal)
Débridement/Cheilectomy

- Grade I or II involvement
- Simple procedure
- Quick recovery
- Usually not a permanent solution*
- 2010 systematic literature review
  - Cheilectomy revision rates
    - Grade I – 20%
    - Grade II – 15%
    - Grade III – 9%
    - Grade IV – 56%
Cheilectomy: Contraindications
(Coughlin & Shurnas)

- Extensive degenerative arthritis of first MTP joint
-Articular cartilage degeneration >50% of metatarsal head
Osteotomy: phalangeal/metatarsal

- Reshaping orientation creates more joint space (joint “decompression”)
- Longer recovery
- Complications – residual pain, reduced push-off strength, transfer of forces laterally
- 2010 systematic review of the literature
  - 73% of patients satisfied
  - 23% required revision
  - 31% developed metatarsalgia or stress fracture
  - Authors recommendations “…should be used with caution or not at all.”
- 2005 study – phalangeal and MT osteotomies
  - 54% satisfaction with MT osteotomies, 65% with phalangeal osteotomies
Moberg (proximal phalanx) Osteotomy

- Closing wedge dorsal osteotomy of proximal phalanx
- Increased DF by translating the arc of motion from PF to DF
- Increases functional ROM of MTP to more dorsal position
- **Requires adequate preoperative PF**
Moberg Indications?

- Running athletes? (Inc DF Needs)
- Intra-op cheilectomy that has not achieved adequate DF on O.R. table
Moberg Osteotomy: Complications

- Decreased push-off power
- Accelerated progression of DJD
- Nonunion, malunion
- Elevated resting position of 1\textsuperscript{st} toe
Metatarsal Osteotomies for Hallux Rigidus

Not indicated

- High rates of joint contracture
- Stress fractures
- Transfer lesions
- Acceleration of DJD
Arthrodesis of 1st MTP Joint

- Eliminates pain
- Allows weight bearing on first MT
- Long recovery/Non-union rate
- Permanent loss of motion
- Limited shoe wear selection (no high heels)
Arthrodesis: Contraindications (Coughlin & Shurnas)

- Patient in whom absence of MTP joint motion is unacceptable!!!
- Severe osteopenia that prevents adequate internal fixation
- Less severe hallux rigidus with >50% of MT head articular cartilage remaining
Arthrodesis Complications

- Nonunion (5-10%)
- Malposition ("Malunion")
  - Excess DF at fusion site causes IP joint flexion
  - Excess PF at fusion site causes IP joint hyperextension
- Accelerated arthritis at IP and TMT joints
- Shorter step length
- Less ankle power/torque
Arthroplasty - Interpositional

- 2011 study – satisfactory results in 75% of 25 feet with grade III/IV hallux rigidus
- Weakness, transfer of forces laterally
- Osteophyte recurrence?
Excisional/Interpositional Arthroplasty

Literature review → Numerous complications

- Floppy big toe
- Hallux weakness/push-off weakness
- Transfer lesions under 2\textsuperscript{nd} MTP
- Elevation/clawing/shortened 1\textsuperscript{st} toe
Silicone Interpositional Arthroplasty

- Silicone does not possess adequate structural durability to withstand severe shear and tension stresses/ambulation
- Severe synovitis and osteolysis at 1st MTP
- Silicone granulomatous disease
Arthroplasty - Implant Evolution

- **1st generation**: material – silicone, design – hemi and total
- **2nd generation**: material – improved silicone, design – hemi and total with grommets
- **3rd generation**: material – metallic, design – hemi and total press fit
- **4th generation**: material – metallic, design – hemi and total with threaded stem
1\textsuperscript{ST} MTP Total Joint Arthroplasty - Implants

- **Biomet total toe system** - 83% excellent results subjectively – but no postop ROM or length of follow-up reported (Koenig & Horwitz)

- **Bio-Action** great toe implant – areas of bone resorption indicative of early loosening (Olms & Dietz)

- **ReFlexion** – 60% satisfactory results – malalignment, stiffness, revision (Ess et al.)
Hemiarthroplasty - Implants

- Few studies with sufficient numbers, follow-up
- Significant lack of comparative studies
- Criteria for grading results mixed: objective vs subjective
Hemiarthroplasty - Implant

- **Biopro** – longest follow-up, largest numbers
- Implant *loosening and plantar cutout* commonly reported
- Wrong side of joint?
- Osteophyte recurrence?
Bioprol Implant
HemiCAP DF(Arthrosurface) – new form 1st MTP hemiarthroplasty
Addresses side of joint most affected

- "Patient matching" of mtp anatomy with cobalt chrome articular implants -
- Central fixation component
- Instrumentation used to map the native joint surface, prepare the joint/bone and implant the prosthesis.
- Precise alignment of surface of implant to the contour of the patient’s articular surface
Screw Fixation Design

Titanium screw coated with plasma spray for bony ingrowth
Bone ingrowth to prosthetic interface – (basic science pics)
Contraindications: HemiCap

- Hx of septic joint/Active infection/Osteomyelitis
- Neuropathic Joint
- Systemic Arthritis
- Severe Sesamoid - Metatarsal arthritic disease
- Nickel Allergy
- Unrealistic Patient Expectations
Design Rationale

- Based on anatomy and unique kinematics of the 1st MTP joint
- **Dorsal flange with receding dorsal slope**
- “Great toe dorsal roll-back”
DF Implant: Advantages

- **For the patient**
  - Designed for patients who live longer, are more active
  - Outstanding pain relief, rapid recovery
  - Outpatient procedure
  - Preserves joint and surrounding bone
  - Maintains joint biomechanics
Toe DF Design

Build on successes of first product offering:

- Excellent pain relief
- Excellent long term fixation
- No history of implant loosening
Toe DF Design

Address observations noted in clinical results of first product offering:

- Dorsal Osteophyte causing loss of motion
- Soft Tissue causing loss of motion
Toe DF Design

1. Created dorsal flange geometry on articular component that covers dorsal aspect of met head preventing osteophyte formation

2. Create compound curve articular surface that is continuous and increases joint space with increasing dorsiflexion
Toe DF Design

- Compound articular curvature based on clinical literature
- Changing center of curvature along articular surface
- Dorsal curve segment is tangent to neutral curve segment at approximately 12 degrees of dorsal flexion
Technical Pearls/Musts for Successful DF Surgery

- ACHIEVE 90 DEGREES OF DF ON OPERATING ROOM TABLE
- ADEQUATE SOFT TISSUE RELEASE**
  
  this is a contracted tight scarred ankylosed joint
  
  Dr Hasselman TKA –TIGHT SOFT TISSUE POST CAPSULE
  FLEXION CONTRACTURE ANALOGY

TAKE DOWN JT ADHESIONS SUBPERIOSTEALLY
COLLATERALS, SCARRING AT SESAMOIDS ETC

IF STILL NOT 90 DEGREES  SUBPERIOSTEAL FLEXOR HALLICUS
BREVIS ETC
FLEXOR HALLICUS BREVIS
• CENTER YOUR ALIGNMENT OF THE IMPLANT / ARTICULAR SURFACE INTERFACE ON THE INFERIOR PORTION OF THE MET HEAD SO IN DORSIFLEXION THE SESAMOIDS WONT CLICK OR RUB AT INTERFACE OF METAL/CARTILAGE
FAVOR VIGOROUS AND ADEQUATE SOFT TISSUE RELEASE OVER DECOMPRESSION

Iatrogenic shortening
transfer metatarsalgia

Employ soft tissue interposition on proximal phalanx articular surface if required (use of redundant dorsal capsule /ecrb)

Aggressive rom and joint mobilization of MTP joint in 1st postoperative week
• Perform adequate resection of dorsal spur of 1st metatarsal head

New DF has a bit of “idiot-proofing” appreciated in Austin Texas
Classic vs DF
HemiCAP DF: Advantages

- For the surgeon
  - Short learning curve
  - Procedure intuitive, reproducible
  - Outpatient procedure, approx. 1 hour
  - Maintains soft-tissue envelope, joint mechanics – preserves future surgical/options
  - Bail out (fusion) would be good success
  - Precision instrumentation
CLINICAL RESULTS
Arthrosurface
HemiCap Classic
Giovanni 86 patients/97 implants
8-month follow-up
94% excellent to good results
64% improvement in AOFAS scores
No revisions
2010 Carpenter et al 32 patients with avg 27 months f/u
No failures and all pts satisfied

AOFAS scores avg 89.31

Grade 3 pts : AOFAS score 91.43 vs Grade 2 at 83.89
Hasselman/Shields 2008  25 patients at avg of 20 months f/u

All patients satisfied and avg AOFAS score of 82.1

Range of motion increase an avg of 42 degrees

No loosening or subsidence

88% survivorship at 5 yrs, rest same/more satisfied

Converted pts  would still go thru resurfacing again
Summary HemiCap

- Addresses side of joint most affected
- Only implant with Morse taper screw interlock design does not show loosening like typical stemmed/pegged implant
- Only implant that factors in the changing radii curvature of dorsal articular surface, allows prox. phalanx to glide with “dorsal roll-back”
- High patient satisfaction – pain relief, improvement in motion
Thank you
32 implants/30 patients
Grade II and III hallux rigidus
Average follow-up 23 months
All patients happy with outcome
Mean AOFAS score improved by 58.5 points
No implants revised or removed
Giovanni 36 pts at an avg of 45 months f/u
80% pt satisfaction w/ avg 26 degrees ROM increase
No loosening, superior results vs other hemi’s