Midfoot Arthrodesis: Indications and Applications

Paul A. Stasko, DPM, FACFAS
Rochester Regional Health-Fingerlakes Bone and Joint Center
Fellowship trained Foot and Ankle Surgeon
Disclosures

• Arthrex
Objectives

- Anatomy
- Planning
- Indications
- Techniques
- Fixation options
- Cases
Overview

• Introduction
• Anatomy
• Indications/Goals of Midfoot Arthrodesis
  • Deformity
  • Arthritis
• Types of Midfoot fusions
  • Tarsometatarsal
  • Navicular Cuneiform
• Technique for fusions
  • Preparation
  • Grafting
• Fixation
• Conclusion
Introduction

• Careful evaluation of patient
  • Cause
  • Clinical exam
• Conservative/Nonsurgical treatments attempted first
• Imaging evaluation
  • Plain X Ray
  • CT
  • MRI
• Appropriate patient selection for appropriate procedure
  • Medical History
  • Social History
Anatomy-Soft tissue

- **Arteries**
  - Dorsalis Pedis
- **Nerves**
  - Deep Peroneal
  - Cutaneous Nerves
- **Tendons**
  - Tibialis Anterior
  - Posterior Tibial
  - EDL
  - EHL
- **Ligaments**
  - Lisfranc
Cause of Midfoot Arthritis

- Post Traumatic
  - Lisfranc injuries
  - Medial column trauma
  - Navicular Cuneiform dislocations

- Pre existing deformity
  - HAV
  - Metadductus
  - Cavus foot
  - Pes planus

- Rheumatologic
  - RA

- Neuroarthropathy
  - Diabetic Charcot
  - Alcoholic
Progression

Trauma (compressive forces) → Intra-articular fractures → Painful/Disabling arthritis
Midfoot Arthrodesis

Initial injury is often missed acutely:

- Polytrauma setting
- Underdiagnosed "sprain"
- be aware of Lisfranc complex
Symptoms

• Localized pain
• Lateral impingement pain
• Notable positional changes
  • Arch collapse
  • Abduction at midfoot level
• Deep peroneal nerve irritation
• Complaints of shoe wear problems
• Functional loss
  • pain
Physical Exam

• Decreased arch height “progressive” flatfoot
• Deformity (Abd/DF)
• Plantar-medial eminence
• Uneven loading of forefoot (callosities)
• Shoe wear pattern
• Flexible vs rigid
• Compare uninjured side
Non Operative Therapy

- NSAID’s
- Shoe therapy
- Orthoses
- Rocker bottom soles
- Solid ankle cushion heel (SACH)
- Activity modification
Indications for arthrodesis

- Deformity
  - Calluses
  - Ulcerations
- Painful Joint Secondary to Arthritis
  - Arthritic pain
  - Nerve irritation
- Instability
  - Chronic
- Functional Loss
Goals

- Union of Arthrodesis
- Resolution/Improvement of Symptoms
- Realignment
  - Obtain correction, maintain correction
- Stability
- Function
Treatment Options

• Conservative/Non surgical
  • Nsaids
  • Injections
  • Orthotics
  • Shoe gear modification
    • Rocker bottom
    • SACH
  • Activity/Lifestyle modification

• Surgical
  • Exostectomy procedures
  • Arthrodesis procedures
    • TMT
    • NC
    • Intercuneiform
    • Lisfranc
Midfoot Arthrodesis

Key Issues:

• Selection of joints to perform arthrodesis
• Avoid rendering midfoot unnecessarily rigid
• Type of arthrodesis (in situ vs realignment)
Midfoot Arthrodesis

Salvage of Tarsometatarsal Joint by Arthrodesis

- 69% good to excellent results
- Accurate reduction and early treatment had a significant positive relationship with outcome
- Fusion of lateral two rays was not a significant factor to determine outcome

Midfoot Arthrodesis

Preoperative Considerations:

- Contralateral X-rays (weightbearing)
- Extent of arthrodesis
- Timing of surgery
- Skin condition
- Degree of deformity
Midfoot Arthrodesis

Determining Extent of Arthrodesis:

1. X-rays
2. Passive manipulation
3. Diagnostic injections (using fluoroscopy)
4. Bone scans (high resolution)
5. Advanced imaging (CT, MR)
Midfoot Arthrodesis

Surgical Goals:

1. Pain relief
2. Deformity correction (anatomical alignment)
3. Preservation of function
4. Solid arthrodesis
Although tarsometatarsal arthrodesis may be necessary to manage persistent pain, complete relief of symptoms, even after fusion, may not occur."

Evidence Based Medicine

• Nemec et al, FAI, 2011
  • Outcomes following Midfoot Arthrodesis for Primary Arthritis
    • 68 patients, 74 feet following midfoot arthrodesis
    • Union in 92% of patients
    • AOFAS scores improved from 32 to 79
    • 90% satisfaction
    • Complications documented
Evidence Based Medicine

- Gougoulias, Foot and Ankle Surgery, 2016
  - 30 patients with midfoot arthrodesis
  - Union in 93.3% of patients
  - 14/30 excellent results
  - 13/30 good results
  - 3/30 fair
  - Orthotics needed in 34% of patients post operatively
Midfoot Arthrodesis

Complications:

- Inadequate correction
- Stress fractures
- Wound dehiscence
- Nerve entrapment
  - Deep vs Cutaneous
- Stiffness
- Nonunion
Midfoot Arthrodesis

Special situations:

1. Diabetic Neuroarthropathy
2. Alcoholic Neuropathy
Midfoot Arthrodesis

Diabetic Neuroarthropathy-Indications:

- Severe midfoot deformity
- Gross instability
- Instability with Ulceration failing nonoperative care
- Failed ostectomy
Types of Midfoot Fusions

• Metatarsal Cuneiform
  • 1st, 2nd, 3rd

• Intercuneiform
  • Medial-Intermediate

• Navicular Cuneiform

• Lisfranc
Pre Operative Considerations

- Contralateral x rays
- Extent of Arthritis
- Timing of surgery
- Medical conditions
- Skin condition
- Smoker?
- Deformity
Deformity Planning

A

1st IMA = 8°
(6°–10°)

4th IMA = 9°
(6°–12°)

TCA
(Kite angle) =
21° (15°–27°)

Normal values
(range ± 1 SD)

MPPA = 95°
(91°–99°)

LDHA = 88°
(84°–92°)

MPHA = 95°
(92°–98°)

LDM = 90°
(87°–93°)

JLCA = 1° (0°–2°)
open medially

JLCA = 3° (1°–5°)
open medially

Normal MAD = 4 mm lateral
(2–6 mm lateral)

B

MAA = 11°
(6°–16°)

MPPA = 95°
(91°–99°)

LDHA = 88°
(84°–92°)

MPHA = 95°
(92°–98°)

LDM = 90°
(87°–93°)

JLCA = 1° (0°–2°)
open medially

1/2

1/2

Bisector line of
the midfoot

C

D

HAA = 8°
(4°–12°)

HIA = 11°
(7°–15°)

Metatarsal
parabola
angle = 140°
(135°–145°)

AP Meary's
angle = 7° (3°–11°)
Deformity Planning

Lamm, Stasko, JFAS, 2016
Pre Operative Considerations-Determining extent of arthritis

- Plain films
- Passive manipulation
- Diagnostic/Therapeutic injections
  - Fluoroscopic
- Bone Scans
- Advanced Imaging
  - MRI
  - CT
Joint Preparation

- Shape of Joint
  - Flat TMT
  - Curved NC
  - Multiple joints
- Currettage
- Sagittal Saw
  - Planing
  - Avoid **Thermal necrosis**
- Fish scaling
  - Osteotome
- Drill Subchondral plate
- Pineapple Burr
  - Avoid thermal necrosis
Joint Preparation

- Bone Grafting
  - DBM
  - Stem Cell
  - Cortical fibers
  - Mixed allograft/Calcium phosphate
- **USE ON COMPROMISED PATIENTS, REVISIONS, DEFECTS**
Joint Preparation

- Johnson et al, JFAS, 2009
  - Evaluation of joint curettage technique for arthrodesis
  - Histological examination
  - Layer of non calcified cartilage in arthrodesis sites

- Withey et al, JFAS, 2014
  - Tarsometatarsal Joint Arthrodesis with Trephine Joint Resection and Dowel Calcaneal Bone Graft
  - Calcaneal autograft with locking plate as useful technique

- Ray et al, JFAS, 1998
  - Maintaining subchondral plate allow greater load to failure

- Yu, 1993/Coetzee, 2004/Patel, 2004
  - Evaluated subchondral drilling and fish scaling for arthrodesis

- Eriksson, Acta Orthop Scan, 1984
  - Evaluated thermal necrosis in cortical bone
  - Temperature measure in vivo
Types of Fusions- 1st Metatarsal Cuneiform

- Severe HAV
- Isolated DJD
- Balance Medial Column
  - Dorsiflexion
  - Plantarflexion
  - Shorten
  - Lengthen
- Deep Joint
- Multiple fixation options
  - Lag screw, partially threatened cannulated
  - Plates, non locking vs. locking
    - Eccentric compression
  - Combination
  - Mini Rail external fixation
Literature

• Cottom et al. JFAS 2013
  • Fixation of Lapidus Arthrodesis with a Plantar Interfragmentary Screw and Medial Locking Plate: A Report of 88 Cases
  • Studied lag screw for compression with plating
  • Plantar to dorsal compression screw
  • Favorable results
Technique

- Dorsal Medial Incision
- Tibialis Anterior Tendon
- Avoid Extensive Periosteal Stripping
- Cut flat surfaces
  - Plantar aspect of joint
  - Adavistic joint or flat in situ
- Adequate joint preparation
- Provisional fixation
  - .062 K wire
- Lag screw fixation dorsal to plantar
- Low profile Non locking plate
Literature

• Drummond et al, Foot Ankle Surg, 2018
  • Stability of Locking plate and compression screws for Lapidus arthrodesis: A Biomechanical comparison of plate position
  • 3 plate positions-dorsal, medial, plantar
  • Stiffness, yield force, displacement at yield, ultimate force, displacement at ultimate force
  • Medial and plantar plating superior
Types of Fusion- 2\textsuperscript{nd} and 3\textsuperscript{rd} TMT

- Small, Deep joints
- Post traumatic vs Adaptive
  - Intra=articular fractures
- 2\textsuperscript{nd}
  - Keystone
  - Vault of the foot
- 3\textsuperscript{rd}
  - Less function than 2\textsuperscript{nd}
- Fixation options
  - Small multi hole plates
    - Eccentric compression
    - Locking
  - Cannulated screws
  - Mini Rail Ex fix
Literature

• Sangeorzani et al, Foot & Ankle, 1990
  • Salvage of Tarsometatarsal Joint by Arthrodesis
  • 69% good to excellent results
  • Accurate reduction and early treatment had a significant positive relationship with outcome
  • Fusion of lateral two rays was not a significant factor to determine outcome
2nd Tarsometatarsal Arthrodesis
2\textsuperscript{nd} Tarsometatarsal Arthrodesis
Do not shorten excessively
Adjective Procedures

- Equinus-TAL vs. Gastroc
  - Rockerbottom
- Ostectomy
- More Proximal Arthrodesis
- Repair of adjacent bone cysts
- Metatarsal Osteotomies
- Use of Bone Graft
- PRP, BMA
Lisfranc Arthrodesis

- Keystone of the foot
- Medial cuneiform to 2nd met base with 2nd TMT fusion
  - Intercuneiform fusion
- Post traumatic
- Stabilize midfoot
- Evaluate 1st TMT pre operatively
Technique

- Dorsal Insision
- Be aware of vital structures
  - Tendons
  - DP
  - Deep peroneal N.
- Dissect through thick ligaments
- Joint Preparation
  - Currettage
  - Saw
- Dorsal plate
- Interfragmentary Screws
Trauma application

- Traditionally used as secondary staged procedure after ORIF
- Primary Arthrodesis in select cases
  - Primary fusion offers single stage predictable alternative
  - Ligamentous injuries
Lisfranc Arthrodesis
Literature

- Gait analysis and functional outcome in patients after lisfanc injury treatment
  - Van Hoeve et al, Foot Ankle Surg, 2017
- 19 patients ORIF vs Primary arthrodesis vs healthy patients
- Lowered walking speed
- Decreased ROM in the sagittal plane (push off phase)
- BMI a predicting factor
Navicular Cuneiform Fusion

- Medial Column Breakdown
  - Charcot
  - OA
  - Post traumatic
- Sagittal Plane deformity
- Dorsal spurring
- Goals:
  - Restore alignment
  - Restore Function
- Joint preparation
  - Very important
  - Multi-facet preparation
- Fixation
  - Lag screw fixation (multiple)
  - Plate augmentation
Literature

• Ajis et al. FAI 2014
  • NC fusion safe and predictable procedure
  • Augment flatfoot correction
  • 97% fusion rate
  • 32 of 33 patients happy with procedure
Case

- 57 year old female
- Pain midfoot
  - CT scan NC and 2\textsuperscript{nd}, 3\textsuperscript{rd} tmt DJD
- Active
Procedure

- NC arthrodesis
- 2\textsuperscript{nd} and 3\textsuperscript{rd} TMT arthrodesis
Combined Arthrodesis-1\textsuperscript{st} and 2\textsuperscript{nd}

Caused by Hypermobility of the medial column, applying increased pressure to the 2\textsuperscript{nd} TMT
Combined 1st and 2nd
Combined 1st and 2nd
Case

- 64 year old male
- Diabetes, non smoker
- Progressive foot deformity x 6 months
- No injury
- Left midfoot pain
Case
Case

- CT Scan shows severe midfoot arthritis
- Deformity at tarsometatarsal joints
- Procedure: Evans calcaneal osteotomy, Gastrocnemius Recession, Medial Column arthrodesis (1\textsuperscript{st} TMT, NC, TN), 2\textsuperscript{nd} TMT arthrodesis
Case
Conclusion

• Recognize deformity
• Recognize the cause, the “why”
• Consider more fixation in obese, and diabetics
• Careful assessment of which joints to fuse
  • DO NOT WANT TO MAKE THE MIDFOOT TOO RIGID
• Restore deformity and function