End Stage Ankle Arthritis: 
TAA versus Fusion = 
Is a Paradigm Shift A Foot or 
Are We Crazy?

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**Disclosures**

I DO have a financial interest in commercial products or service presented in this lecture:

Research: *Wright Medical, Amniox*

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**Disclosures**

I have close friends that have known Dr Vail for some time…

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**Paradigm Shift**

- A [Paradigm Shift](#) as a change from one way of thinking to another
  - Revolution
  - Evolution

Thomas Kuhn
**Ankle Arthritis**

- 46 yr Male MD
- Former pro soccer player & runner
- Recurrent sprains x years
- Severe ankle pain x 4 yrs
- Now unable to WB for 30 min max

**Knee Arthritis**

- 68 yr female in Tennessee
- Gradual R & L knee pain x yrs
- Severe x 1 yr since waverunner crash, twisting both knees
Both are Lower Extremity Arthritis, but…

- …her life will return to what it was
- She’ll be able to do everything she wants to
- …his life will remain limited vs 8 yrs ago
- He won’t run or play soccer with his son

Factoid

- 2 Million+ - Number of annual physician-office visits due to ankle pain from arthritis or fracture

National Center for Health Statistics

The Impact of End Stage Ankle Arthritis

- Has only recently gained attention as treatment options (i.e. TAA) have evolved
- COFAS began studying this 9 years ago
  - Results presented at the 2007 AOFAS
  - Credit: Murray Penner MD for these statistics

Ankle Arthritis is a Unique Disease
What makes ESAA unique?

...relative to other lower extremity arthritis
- Age
- Gender
- Etiology
- Rare
- Treatment Issues

What are the implications?
- Most arthritis pts have symptoms & functional limitations for yrs before joint surgery
- ESHA & ESKA typically afflict people nearing retirement, in their 50’s-60’s
- ESAA afflicts people in their 30’s-40’s
- These are very different populations...

Age
- ESAA is a disease of the young(er)
- Mean age at time of ankle fusion (1995-2004): 55
  - 4705 ('95-'04) cases in CA, Soohoo et al, JBJS-A 2007
- Mean age at THA: 67.6
- Mean age at TKA: 68.0
  - CJRR 2006-7

Ankle Arthritis
- Raising family
- Playing sports

Hip & Knee Arthritis
- Wage earning
- Medical
- Travel

Leisure
**Effect of Age of Onset**

- US Life Expectancy in 2010 is 78 yrs
- Mean remainder after THA/TKA is 10 yrs
- Mean remainder after ankle fusion is ~25 yrs
- ESAA pts are afflicted for 25% more of their adult life (18-78) than ESHA/ESKA patients

**So, as a disease of the young, ESAA...**

- Affects patient’s ability to maximize goals in:
  - Career & earning
  - Family & personal activities
- Will affect ~50% of a patients’ adult lifetime
  - $$ to patient and health system for such a prolonged chronic disease state
- Treatments must be viewed over a long horizon
  - Sets very high demands on any treatment modality due to need for durability and functionality

**What makes ESAA unique?**

...relative to other lower extremity arthritis

- Age
- Gender
- Etiology
- Rate
- Treatment Issues

**Gender**

**Hip & Knee Arthritis**

- THA: 57% F - 43% M
  - Age standardized rate: 86 F, 76 M (per 100K pop)
- TKA: 61% F - 39% M
  - Age standardized rate: 148 F, 110 M (per 100K pop)
  - CJRR 2008-9 Annual Report

**Ankle Arthritis**

- Fusion: 48% F - 52% M
  - 4705 cases in CA, Soohoo et al, JBJSA 2007
- Ankle Arthritis:
  - 48.5% F - 51.5% M
  - 406 cases in SUI, Valcerrabano et al, CORR 2009
Gender & THA/TKA

- ESHA & ESKA have higher ratio of women
  - Lighter weight
  - Heavy physical labor less common?
- Demands placed on THA/TKA are lower, on average, than if greater percentage were male
- Makes these conditions more amenable to TJR

What makes ESAA unique?

…relative to other lower extremity arthritis

- Age
- Gender
- Etiology
- Rare
- Treatment Issues

Etiology: Hip Arthritis

- Almost all is primary OA
- “a genetic etiology…”, most likely causing “…an underlying defect in articular cartilage or bone that leads to the eventual development of OA”
  - Hoaglund & Steinbach, JAAOS 2001

Etiology: Knee Arthritis

- Most is primary OA
- PTOA – 9.8%
- Non-PTOA – 90.2%
  - Brown et al, J Orthop Trauma 2006
- Primary degenerative OA – 94%
  - CJRR 2006-7
Etiology: Ankle Arthritis

- PTOA – 79.5%
- Non-PTOA – 20.5%
  - Brown et al, JOT 2006
- PTOA – 78%
- Non-PTOA – 22%
  - Valderrabano et al, CORR 2008

Etiology: Implications

- Most pts with hip & knee OA have no major antecedent knee/hip problems
- Function just fine most of their adult life, only developing hip/knee limitations in last ~ 25% of their adult life

Ankle PTOA: Time to Develop

<table>
<thead>
<tr>
<th>Injury Type</th>
<th>Percentage of PTOA</th>
<th>Years from injury to ankle reconstruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malleolar fracture</td>
<td>49.5%</td>
<td>~ 25 (10-40)</td>
</tr>
<tr>
<td>Ligament instability</td>
<td>20.4%</td>
<td>~ 35 (25-45)</td>
</tr>
<tr>
<td>Pilon &amp; Talus fractures</td>
<td>21.0%</td>
<td>~ 4 (1-10)</td>
</tr>
<tr>
<td>Other</td>
<td>9.1%</td>
<td></td>
</tr>
</tbody>
</table>

From: Valderrabano et al, CORR 2008
From: Vancouver Ankle Recon Database, unpublished

Ankle OA Etiology: Implications

- In comparison, most ESAA pts had a major injury 25-35 yrs prior
- Many will have required Rx or Sx initially or ongoing
- These pts lives have often been affected by their ankles for very long, even before ESAA set in
What makes ESAA unique?

...relative to other lower extremity arthritis
- Age
- Gender
- Etiology
- Rare
- Treatment Issues

ESAA is Rare

- “The available information suggests that knee OA is 8-10x more common than ankle OA”
  - Saltzman, Surg of the F&A 2008

ESAA is Rare: Implications

- Familiarity of pts, PCPs, and society with ankle OA far below that for hip & knee OA
- Harder for pts to get Rx
  - 676K TKA vs. 29K Ankles (25K AF, 4K TAR)
  - TKA 23x as common, though only 8x as prevalent
- Less support for research to improve Rx

What makes ESAA unique?

...relative to other lower extremity arthritis
- Age
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- Etiology
- Rare
- Treatment Issues
Longevity of Treatment

- Survivorship of TAA well below TKA & THA currently
- Eventual Subtalar and Midfoot arthritis after ankle fusion, limiting longevity
  - “you’ll need a major operation every 10-15 years”
  - Dr. K. Wing

Deformity & Complexity in ESAA

- Only 37% of ESAA cases have normal alignment
  - Valderrabano et al, CORR 2009
- Major adjunct procedures required in 35-40% of cases
  - Penner, Hintegra TAR, AOFAS 2008
- Rarely ever required in 1° TKA or THA
- This makes treatment of ESAA more specialized
  - More difficult for patients to obtain
  - ? Less predictable outcomes

Postop Recovery

<table>
<thead>
<tr>
<th></th>
<th>THA / TKA</th>
<th>TAR or Ankle fusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Wt. bearing</td>
<td>0</td>
<td>6-8 weeks</td>
</tr>
<tr>
<td>Wound complications</td>
<td>Rare</td>
<td>Common</td>
</tr>
<tr>
<td>Cast or post-op boot</td>
<td>No</td>
<td>Yes (6-14 weeks)</td>
</tr>
<tr>
<td>Risk of early re-op</td>
<td>V. Low</td>
<td>AF – 5-10% nonunion</td>
</tr>
<tr>
<td>Begin physio/ROM</td>
<td>Day 1</td>
<td>6 – 14 weeks</td>
</tr>
<tr>
<td>Community teaching &amp;</td>
<td>Common</td>
<td>Rare</td>
</tr>
<tr>
<td>support programs</td>
<td></td>
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</tr>
</tbody>
</table>

- The TAR/ Ankle fusion patient experiences a much more challenging post-op recovery compared to THA/TKA patients

The Uniqueness of Ankle Arthritis

- Young
- M>F
- Post-traumatic
- Rare
- Treatment is challenging
  - Less “available”
  - Less durable
  - More complex
  - Harder recovery
Why Do Ankle Arthritis Patients See the Doctor?

Curr Opin Rheumatol. 2010
Nonmedicinal therapy in the management of ankle arthritis.
Rao S, Ellis SJ, Deland JT, Hillstrom H.
- Self-reported physical function in patients with ankle osteoarthritis is equivalent to or worse than that of patients with end stage kidney disease, congestive heart failure, or cervical-spine pain and radiculopathy.

Present Thought (A Paradigm??)

- Young = Ankle Fusion
- Old = TAA “young” and what is “old”???

Paradigm Shift???

- What really is the gold standard for treatment of ankle arthritis?
- What are our options to offer these difficult patients?
- Is TAA a viable alternative today?
- In contrast to the knee and hip, is it OK to use TAA as a bridge operation in this younger demographic?
  - Stage one?
- Are the answers to these questions available with today's knowledge base?

Treating Ankle Arthritis 2014

- Arthrodesis
  - Estimated 14,700 procedures per year
- Total Ankle Replacement
  - 3000 to 5,000 per and growing
- Distraction Arthroplasty
- Amputation

Self-reported physical function in patients with ankle osteoarthritis is equivalent to or worse than that of patients with end stage kidney disease, congestive heart failure, or cervical-spine pain and radiculopathy.
Arthrodesis = Tibiotalar Fusion

Pros
- Has been considered the gold standard of care due to early TAA failures
- Provides pain control (not painless), plantigrade, stable foot – predictable
- Fewer devastating complications compared to early TAAs
- Covered by insurance companies

Cons
- 10% Nonunion rate
- Adjacent joint arthritis – costly additional surgery
- Less ROM compared with TAAs
- Altered gait
- Decreased stride length
- Recent survey cited ankle fusion patients expressed lower rates of patient satisfaction (73%-74%) than ankle replacement patients (93%-94%)

Ankle Fusion: How good an operation?
- Clinical outcome of tibiotalar arthrodesis utilizing the chevron technique. Foot Ankle Int. 2004 Apr;25(4): Kopp FJ, Banks MA, Marcus RE.
- 29 of 41 good to excellent (avg 7.3 years postop)
- 12 patients greater than 10 years out
- Results bad with subtalar disease
- Bottomline = function bad, pain relief okay

Ankle Fusion: How good an operation?
- Ave 9.3 years, 48 patients, 73% good to excellent
- Worse if:
  - Plantarflexion malunion
  - Subtalar disease
- Take home: residual deformity or ipsilateral subtalar DJD results are bad
Ankle Arthritis and Assoc Hindfoot and Midfoot OA

- Authors reviewed pre-operative radiographs of 70 patients with ankle OA and found 68 of 70 patients with radiographic evidence of OA of adjacent hindfoot or midfoot joints prior to undergoing ankle fusion
  - Subtalar joint was the most commonly affected
  - Symptoms worsen after ankle fusion, often necessitating further fusions

Or... Ankle Fusion after Hindfoot Fusion

- TTC/pantalar fusions not great
- Probably the best indication for TAA – given appropriate age

Pantalar/TTC: Results

- *Foot Ankle Int. 2000*
- The results of a primary and staged pantalar arthrodesis and tibiotalocalcaneal arthrodesis in adult patients. *Acosta R, Ushiba J, Cracchiolo A*
- 23 patients. “However, when all parameters of our clinical rating scale were evaluated, only five patients had an excellent clinical result, nine were rated good, three were rated fair and six patients had a poor result.”
- BKA Better???
**TTC with Retrograde Nail**  
Hammett, R et al. FAI, Oct 2005

- 52 patients with avg 34 month f/u
- Results:
  - 3 intra-op complications (fx of tibia, medial mall, tibia)
  - 6 Non-unions, 2 amputations, 1 implant failure, 1 deep infection
  - 62% reported obvious or serious limp
  - Avg AOFAS score 63

**TTC Results**  
Chou & Mann et al. FAI. Oct 2000

- 55 pts s/p TTC, avg f/u 26 months
- 48 of 55 fused (87%), 6 wound infections
- 2 deg of DF, 5 deg PF
- 42 pts complained of persistent pain
- 40 pts req. modified shoes or orthotic devices
- 34 pts had a limp
- Avg AOFAS 66

**Is a Good TAA Always Preferable Over a Good TTC Fusion**

**Motion is Always Preferred**
While after TAA Gait is not Normal

- Benedetti et al:
  - Retrospective review of 10 pts w/ STAR or Agility w/ avg f/u of 34 months
  - Significantly reduced walking velocity & decreased ankle ROM
- Doets et al:
  - 10 pts w/ Buechel-Pappas w/ avg. 41.5 month f/u compared to 10 control pts found walking velocity significantly slower by 6%

TAA effect on Gait: Better than Preop

- Brodsky et al compared gait before and after & found a significant increase in velocity, stride length, and ankle ROM at 18 months post-op in STAR TAA

“I Don’t Feel Normal”

“This feeling of normalcy (functional outcome scores don’t capture this). Difference between fusion and TAR may be related to limits of the outcome instruments.”

Tim Daniels, Australia, 2010

TAA Studies to date...

- TAA gives you
  - More normal gait
  - More functional then TTC
  - Motion; protecting adjacent joints
  - Marketing
  - ? Longevity (92 % 5 years, 85% 10 YEARS)

BUT...

The evidence in support of TAA is almost exclusively level IV, with considerable variability in the methodology used to assess outcomes AND Designers’ results??!!##
Why Consider Implant Arthroplasty?

“Clearly, a pain-free mobile joint is preferable to a pain-free fused joint.”

John Kirkup, 1985

History of TAA

- “The rate of so-called clinical success often is a function of the duration of follow-up.”
  - Harold Kitaoka, 1996
- “There is nothing that hurts your good results more than having the fellows look them up”
  - Bill Hamilton

History: 1st Generation TAA

“In view of the high complication rate and the generally poor long-term results, we recommend arthrodesis as the treatment of choice for the painful, stiff arthritic ankle regardless of the underlying pathological process.”


This is ALWAYS quoted by the insurance companies

If We Could get It To Work: Implant Design – Goals

- Completely replace articulating surface
- Locate the correct axis of rotation on the talus
- Achieve functional ROM
  - talar component articulates fully during 35° ROM
- Maintain ligamentous stability
- Precision with reproducibility
- Stable fixation
- Longevity

*Sound familiar? Similar to the Total Knee experience…*
Current Implants

- All share 2 important features:
  - Semi-constrained
  - Often implanted without cement (off label)
- Often referred to as “Second Generation”
  - Improved instrumentation
  - Less resection of bone
  - “better respect for the anatomy, kinematics, alignment, and stability of the ankle joint”


Current TAA Implant Systems

- The options in the United States are limited but improving…
  - Wright Medical INBONE® I and II
  - STAR™
  - Salto Talaris™ Anatomic Ankle
  - Depuy Agility®

Current Total Ankles in the U.S.

- Agility- DePuy
  - 510k in March 2006 for Agility LP (newer design)
  - Agility has been on the market since the 70’s
  - No longer marketed

- INBONE- Wright
  - 510k in November 2005
  - Revised components in 2010

Current Total Ankles in the U.S.

- Salto – Tornier
  - 510k in November of 2006
  - 2 part in USA
  - Mobile bearing use declining in Europe

- S.T.A.R
  - FDA approval 5/2009
  - 1st mobile bearing ankle in U.S.
  - Only FDA approved “cementless”
Other Options/PMTs

- Zimmer
  - Lateral approach
  - Minimal resection
  - Trabecular metal

- Wright Infinity
  - Less resection

Case Example

- 68 y/o man
- Multiple sprains
- Progressive valgus, fixed equinas

Case Example

- InBone II

Case Example

- 45 y/o woman
- Post-trauma = pilon bilateral
- 2-stage TAA = ROH first
Case Example

- Bilateral TAA
- 3 years out
- Back to work and riding motorcycle

Case Example

- 49 y/o RA
- Failed Agility - out 7 yrs

I Defer to TAA when feasible because...

- No nonunions
- Protect adjacent joints
- Better gait
- Heel wear for women

Can we convert fusions to TAA?

- Bone Joint Surg Am. 2009 Apr. Conversion of painful ankle arthrodesis to total ankle arthroplasty. Hintermann B, Barg A, Krupp M, Valderrabano V. 28 patients. 30 months FU. Only 5 not painful but 76% better

Indications? Better?
Conversion of Prior Ankle Fusion

- We have done 9 of which 7 were nonunions
- All doing well at early follow-up

1st postop

1 year postop – 30 degrees motion

Non Unions to TAAs
(failed once, why try again?)

Fusion to TAA

7 years successful fusion - then hindfoot/midfoot pain

What TAA TO DO??

- IN BONE
- SALTO
- STAR
- Zimmer
- Infinity

Right now = whatever you are comfortable with – a learning curve

Some better with bone loss and instability? Time
Some Unresolved Issues with TAA

- Mobile Bearing
- Deformity
- Poly type or thickness
- Revisions
- Indications

Why is TAA not as good as THA?

- Design?
- Stiff
  - Gutters (medial malleolus)
  - Post-traumatic
- Hindfoot deformity/motion/DJD
- Soft tissue balancing
- Initial stability (Cast)
- Early lucency

Why is TAA not as good as THA?

- Difficult salvage when all goes bad
  - Poor incorporation of interpositional bone graft fusions
    - Metal not FDA approved
  - Lack of revision systems
  - Amputation???

What Now?

- A Paradigm Shift as a change from one way of thinking to another
- If we are to shift we need at least
  - Longitudinal data
  - Biomechanical testing
  - Kinematic testing
  - Modularity
  - Answers from other than design surgeons
Final Thoughts

- Early experience in TAA has morphed into solid confidence
  - Not immune from disasters
- Most issues I had with the Agility have been addressed to some degree with current designs
  - Evolution continues

Tightened indications
- Preexisting hindfoot disease and/or fusion
- Age?
- Deformity??

Who Knows what the Future will Bring

- Preop computer modeling
  - Prophecy (WMT) = Custom cutting guides
- Virtual surgery
- 1-2 degrees variance from plan

Case Example

- 55 y/o man, W/C
- Talar OCD – failed 3 surgeries
Case Example

- 55 y/o man, W/C
- Infinity - Prophecy

The Future?

- Gold Standard in question
  - Patients with ankle arthritis are disabled
  - We must do better than fusion
  - We are on the right track with TAA
- Stay tuned

Am I Over thinking this?

- Perhaps not a paradigm shift but where one is in his/her career...
  - Young cowboy
    - Single/socially mobile
    - Looking to make a name
    - Egocentric
  - Push the TAA
    - Fun, challenging
- Able to move to another city when things go bad

Am I Over thinking this?

- Perhaps not a paradigm shift but where one is in his/her career...
  - Middle age
    - Happily married with kids
    - Church, country club
    - Looking for low stress, predictable surgeries
  - TAA's are going to fail!
    - Go with the fusion – safe bet, pay decent and you can stay in town
Am I Over-thinking this?

- Perhaps not a paradigm shift but where one is in his/her career...
  - Older – twilight of your career
    - Financially secure
    - Kids gone
    - Bored with fusions (and at home)
  
TAA – fun, challenging

Retire when they start to go!

Thank You!