Retrospective Case Series of Tibiotalocalcaneal Fusion Treated with Carbon Fiber Nail

Ryan W Hadden², Caleb Jones², Kenneth Smith, M.D.¹, Ashish Shah, M.D.¹

¹University of Alabama at Birmingham Department of Surgery, Division of Orthopedic Surgery;
²University of Alabama School of Medicine
Disclosure

• No financial conflicts to disclose
Tibiotalocalcaneal (TTC) arthrodesis is a salvage option reserved for:
- Severe ankle and hindfoot deformities
- Arthritis of the ankle and subtalar joints
- Avascular necrosis of the talus
- Failed total ankle arthroplasty
- Charcot arthropathy

Implants have long been made from various metals, most commonly, stainless steel or titanium alloys. However, disadvantages of metal implants include:
- Limited fatigue life
- Mismatch of modulus of elasticity
- Potential for wear debris
- Corrosion
- Radiodensity that can preclude accurate radiographic visualization
Carbon fiber implants have been available for years. The advantageous properties of carbon fiber for use as orthopaedic implants include:

- A similar modulus of elasticity to bone to decrease stress shielding
- Biocompatibility
  - Minimal histologic cellular response when studied in vitro and in vivo
- Dramatically increased fatigue strength as compared to steel implants
- Radiolucency on radiography

The purpose of the study is to report short-term outcomes of IMN using a carbon fiber implant in TTC arthrodesis.
Methods

• Retrospective analysis of patients who underwent first time TTC/ TC arthrodesis with an intramedullary carbon fiber nail (CarboFix)

• 2 orthopaedic surgeons specializing in foot and ankle surgery; one academic center; 2014-2015

• Average follow-up was 7.4 (± 3.9) months status post TTC/ TC

• Outcomes assessed:
  • Fusion rate
  • Complication rate

• Union defined as:
  - Plain radiograph evidence of bridging bone on 3 of 4 cortices
Materials and Imaging

CarboFix nailing system; radiolucency demonstrated on plain radiograph


Knowledge that will change your world
• 28 patients identified; 15 patients excluded due to:
  - Revision of prior, failed arthrodesis (10)
  - Inadequate follow-up time (3)
  - Lost to follow-up (2)

• Patient Demographics
  - 9 females and 4 males
  - Mean age = 53 yrs
  - Mean BMI = 30.6 kg/m²
  - Tobacco history in 53.8 %
  - Diabetic neuropathy in 7.7 %

<table>
<thead>
<tr>
<th>Indication for TTC</th>
<th>Number of patients (13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-op diagnosis</td>
<td></td>
</tr>
<tr>
<td>Prior non-union</td>
<td>1</td>
</tr>
<tr>
<td>Arthritis</td>
<td>3</td>
</tr>
<tr>
<td>AVN of talus</td>
<td>4</td>
</tr>
<tr>
<td>Failed primary*</td>
<td>2</td>
</tr>
<tr>
<td>Pilon fracture</td>
<td>2</td>
</tr>
<tr>
<td>Congenital varus deformity</td>
<td>1</td>
</tr>
</tbody>
</table>

* Non-TTC procedure
Results

Overall Fusion Rate

- Unions (8)
  - Mean time = 15.3 wks
  - Range = 6-24 wks
  - 4 uncomplicated (50%)

- Non-unions (5)
  - 3 infected

Union 62%

Non-union 38%
Results

Complications from TTC Arthrodesis in our Patients

<table>
<thead>
<tr>
<th>Complication</th>
<th>Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-union</td>
<td>38.5%</td>
</tr>
<tr>
<td>Nerve Irritation</td>
<td>30.8%</td>
</tr>
<tr>
<td>Soft Tissue Infection</td>
<td>23.1%</td>
</tr>
<tr>
<td>Osteomyelitis</td>
<td>15.4%</td>
</tr>
<tr>
<td>Wound Dehiscence</td>
<td>15.4%</td>
</tr>
<tr>
<td>DVT</td>
<td>7.7%</td>
</tr>
</tbody>
</table>

*Percentage of patients with any complication
**Percentage of patients with at least 1 major complication: infection requiring I&D or hardware removal
***Percentage of patients with at least 1 minor: soft tissue infection, DVT, nerve irritation, or wound dehiscence
Discussion

• Fusion rate was inferior to mean rate seen in TTC arthrodeses with metal nails (62% v. ~85%).¹⁻³
  ➢ Likely due to small sample size error
  ➢ 3 non-unions were in the setting of patients with multiple risk factors:
    • Prior non-TTC ankle reconstruction (3), obesity (3), current tobacco use (2)
  ➢ Mean time to fusion for 8 patients was 15.3 weeks; compared to mean of 18 weeks demonstrated by previous studies using metal nails.¹,²
• Complication rate similar to other studies with rate near 60%⁴
  ➢ Non-union being most common ³,⁴
Carbon fiber nails can be used successfully for TTC arthrodesis

The theoretical advantages of carbon fiber nailing make it an attractive option in the future for TTC fusions

- Radiolucency enables early, clear assessment of union
- However, full appreciation of the superior biomechanical advantage may not be realized for years status post procedure

Further studies are needed for long term follow up and larger patient cohorts
References


