Biplanar Plating with an Anatomic Tension-Side Plate for Lapidus Fusion: Improved Biomechanical Properties

Robert Santrock, MD
Assistant Professor & Chief of Foot & Ankle Surgery
Dept. of Orthopaedics, West Virginia University School of Medicine, Morgantown, WV

Bret Smith, DO, MSc
Director, Foot & Ankle Division, Palmetto Health-USC Orthopedic Center
Assistant Professor, Orthopedics, University of South Carolina, Columbia, SC

Daniel Hatch, DPM
Surgical Director Northern Colorado PM&S Residency, Greeley, CO

Paul Dayton, DPM, MS
Assistant Professor, College of Podiatric Medicine and Surgery, Des Moines University, Des Moines Iowa
UnityPoint Clinic, Fort Dodge, IA
Disclosures

• Bret Smith: Treace Medical Concepts (consultant, royalty, stock ownership)
• Robert Santrock: Treace Medical Concepts (consultant, royalty)
• Daniel Hatch: Treace Medical Concepts (consultant, royalty, stock ownership)
• Paul Dayton: Treace Medical Concepts (consultant, royalty)

See final AOFAS Program for complete disclosures.
Introduction

• Limitation of Lapidus fusion: Extended period of immobilization required with rigid, compression fixation

• Recent AO internal fixation evolution
  • Advocating relative stability fixation, allowing controlled micromotion to stimulate secondary “biological” bone healing¹

• Novel relative stability Lapidus construct: Biplanar plating with two small locking plates oriented 90° (without interfrag screw)
  • Biomechanically tested to be superior to traditional anatomic Lapidus plate with interfrag screw in both static & cyclic loading²
Introduction

• Tension-Side Plating ➔ Improved Stability³
  • Plantar Lapidus plate acts as tension-band to counteract bending moment of WB
    • Demonstrated promising initial clinical results under immediate-to-early WB⁴,⁵
  • However, plantar Lapidus plating not widely adopted due to challenges associated with surgical exposure

• Novel biplanar fixation construct recently developed
  • Low-profile dorsal plate + anatomic medial-to-plantar plate
    • Application through standard dorsal incision
    • Biomechanical advantages of tension-side fixation
    • Biological healing benefits of biplanar locked plating
Purpose

Determine if novel biplanar locking plate construct with tension-side fixation provides improved biomechanical stability versus previously-tested 90-90 straight biplanar construct under static and cyclic loading.
Methods

Two unique 2-plate fixation constructs *(Treace Medical Concepts, Inc., Ponte Vedra Beach, FL)*:

- Both constructs fixated with 2.5mm unicortical locking screws, 12mm distally & 14mm proximally (no interfrag screw)
- Bone models: 4th generation Sawbones cuneiform & metatarsal composite

1) **Straight 90-90 Biplanar Plate Construct**

   Two straight low-profile titanium four-hole locking plates; one on dorsal surface & other medial surface, 90° to each other.

2) **Biplanar Construct with Tension-Side Fixation**

   Straight low-profile locking plate on dorsal surface & anatomic tension-side locking plate wrapping from medial cuneiform to plantar surface of 1st metatarsal.
Methods

Mechanical Testing Protocol

• Cantilever bending (30mm moment arm) on servo hydraulic materials testing machine (MTS Systems).

• Two types of testing:
  1. Static ultimate failure (3 pairs ea)
  2. Cyclic fatigue loading (10 pairs ea)
     • 120N load for 1\textsuperscript{st} 50,000 cycles
     • Increase 25N each successive 50,000 cycles until failure or 250,000 cycles was reached

Statistical analysis: Paired t-tests
Results

Static Ultimate Failure Results

![Graph showing failure load comparison between Straight Biplanar Construct and Biplanar with Tension-Side Fixation](image)

- **Straight Biplanar Construct**
- **Biplanar with Tension-Side Fixation**

Failure Load (N)

- $p = 0.04$

![Image of constructs](image)
Results

Cyclic Fatigue Loading Results

- Straight Biplanar Construct
- Biplanar with Tension-Side Fixation

* p < 0.001
Discussion

• Biplanar plating with tension-side fixation significantly improves biomechanical properties over straight 90-90 biplanar plating under both static & cyclic loading
  • Consistent with previous biomechanical studies of tension-side Lapidus constructs\textsuperscript{6,7}
  • Builds on previous biomechanical study of biplanar plating vs anatomic plate + interfrag screw construct\textsuperscript{2}
• Locked plating without a compression screw can act as an “internal external-fixator” \(\rightarrow\) independent, multiplanar stability provided by interlocking components
  • Mechanical stimulation & micromotion of early WB can promote robust “biological” secondary bone healing process via callus formation\textsuperscript{1}
Conclusion

Novel construct shows promise as a practical approach to tension-side fixation for 1st TMT arthrodesis

- Allows application through a standard dorsal incision
- Biomechanical benefits of tension-side fixation for accelerated WB
References


