Nitinol: The Minimax Application in Trauma Surgery

Dr. Patrick Wiater
Orthopaedic Trauma Surgeon
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Dr. Patrick Wiater

Dr. Wiater is a board certified Orthopaedic Trauma Surgeon at William Beaumont Hospital in Beverly Hills Michigan. He attended Wayne State University School of Medicine in Detroit Michigan and trained in Orthopaedic surgery at the University of Michigan. He pursued fellowship training at the University of Washington School of Medicine, Harborview Medical Center in Seattle. He’s been in practice for more than 20 years and received the “Best Doctors in America” Award in 2009 and 2010.
“Nitinol” Primer

• The word is derived from its composition and its place of discovery

• Nickel Titanium-Naval Ordnance Laboratory

• 1959-William Buehler and Frederick Wang
  – Trying to make a better missile nose cone
Nitinol

• Metal alloy of nickel & titanium
  – Roughly equal atomic percentages

• Unique properties
  – Shape memory
  – Super-elasticity
CONUNDRUM: Interfragmentary compression across transverse or short oblique diaphyseal fracture

HOW CAN THIS BE ACHIEVED?
Some Basics First

- Interfragmentary compression by:
  - Loading plate in compression
  - Articulated tensioning device
Compression Plate Compromises

- The art of plate bending
- Limited compression
  - Proportional to bone quality
    - Poor in metaphyseal bone
- Requires perfect plate contour
  - Otherwise mal-reduction

Articulated Tensioning Device (ATD) Compromises

- Unfamiliar to most surgeons
- Large fragment only
- Need larger incision
- Requires perfect plate contour
- Stress riser from ATD screw
How does nitinol fit in with traditional fracture fixation?

• **“Minimax”** fracture fixation concept by Bernhard G Weber, MD
  – **“Mini-”**: smaller, problem focused implants
  – **“-Max”**: supported by a robust fixation (plate, nail, or frame)

The *Minimax* Fracture Fixation Construct

Begins with the anti-glide plate

Purpose

• Resist shear forces across a fracture during reduction & compression

Anti-glide Concept

- ¼ tubular plate
- 2.7 mm cortical screw
Anti-glide Plate

- Every fracture is exposed to shearing forces
- Resist shear forces on fracture during interfragmentary compression
- Bone reduction clamps placed orthogonal (right angle) to the plate
Add nitinol to the \textit{Minimax} equation = \textit{Maximum compression}
The “Mini-” component of *Minimax* construct

Provisional fracture fixation construct

¼ tubular anti-glide plate & nitinol staple
- Anatomic reduction
- Transverse fracture under interfragmentary compression
“Minimax” fracture fixation concept
Bernhard g. Weber, md

- Problem focused implants
- ¼ tubular anti-glide plate and Nitinol staple
- Protected by the strong neutralization plate
Minimax cases
Minimax
Pilon: Case I

- 58 year old male
- 12’ fall from height
- Comminuted closed AO 43 C3.
- Complete articular, multifragmentary
Minimax Pilon I: Initial management

- Closed reduction
- Spanning external fixation
Minimax Pilon I:
Initial Management High Energy Pilon
- The Waiting
Minimax Pilon I:
Pre-operative Planning CT Scan
Minimax Pilon I:
Preoperative Planning: Axial ct
Minimax Pilon I: AO Approach

Minimax Pilon I: Problem Focused Fixation
Minimax Pilon I: final construct
Minimax Ulnar Nonunion

- 69 year old female referred
- Fall on outstretched arm
- Short oblique diaphyseal ulna fracture
- Plated with 1/3 tubular plate
- Interfragmentary compression screw
- Failed at 6 weeks
Minimax Ulnar Nonunion
Step 1: “Mini-” Problem Focused Implants

- Bone reduction clamp
- ¼ tubular anti-glide plate
- Elite 4 prong Nitinol staple
- Anatomic reduction with maximum interfragmentary compression
**Minimax** Ulnar Nonunion
Step 2: “\-max\-” Neutralization Bridge
**Minimax** ulnar nonunion

"mini-" problem focused implants

"-max" robust protection plate
Minimax ulnar nonunion
Minimax
Bicondylar Tibial Plateau Fracture

- 46 year old female, fall from height
- Impending compartment syndrome
- Emergent decompressive 4 compartment fasciotomy
Minimax Bicondylar tibial Plateau Fracture

- Closed reduction, spanning external fixation
Preoperative planning

- Segmental joint depression 4 cm
- Medial condylar segment
- Posterolateral comminution
• Segmental joint depression 4 cm
• Medial condylar segment
• Posterolateral comminution
ORIF

- Progressively reduce from medial to lateral
- Medial tibial condyle fracture amenable to anti-glide plate reduction and Nitinol staple fixation
Provisional reduction

- AO distractor
- Kirschner wires
- Bone reduction clamps
Problem Focused Fixation: Coronal Split Medial Tibial Condyle

- Simple
- Effective
- Low profile
- Doesn’t crowd bony corridors
- Plenty of room for robust neutralization plates
Minimax Bicondylar Tibial Plateau Fracture
MORE EXAMPLES OF NITINOL MINIMAX FRACTURE FIXATION CONDENSED CASE SERIES
Minimax Pilon
Partial articular fibula intact tibial Pilon
Minimax Pilon

Reduction

- Die-punch articular segment reduced
- Metaphyseal cortical fragment reduced
  - ¼ tubular anti-glide plate
  - Nitinol staple
**Minimax Pilon**

**Mini-**

- 2 screws
- 2 plates
- 2 staples

= anatomic reduction
Minimax Pilon
Humeral Shaft Fracture

- 22 year old male
- High speed MVC
Minimax Humeral Shaft
Minimax
Minimax Clavicle Fracture
Minimax Acetabulum
Clavicle Fracture
Posterior Column Fracture

- 55 YO male
- High speed MVC
- Fracture dislocation of right acetabulum
Initial management
Posterior column fracture
Problem-Focused Implants
INTERFRAGMENTARY COMPRESSION
Neutralization
**Minimax Acetabulum:**
Transverse/Posterior wall

- 38 YO male
- High speed MVC
- Fracture dislocation right acetabulum
Initial Management
Non-displaced transverse with associated posterior wall
Percutaneous stabilization of anterior column component of transverse
**Minimax** problem focused implants

interfragmentary compression of posterior column component of transverse
MINIMAX-PROBLEM FOCUSED IMPLANTS
REDUCTION, INTERFRAGMENTARY
COMPRESSION OF POSTERIOR WALL
Neutralization
Minimax pelvis
open book pelvic injury

- 40 YO male
- Motorcycle crash
Pubic symphysis diastasis with disruption of right sacroiliac joint
ORIF Pubic Symphysis
Percutaneous sacroiliac screw