WHEN TO ADD BONE STIMULATION

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Bone Healing
- Fracture Hematoma (Immediate)
- Inflammatory Phase (Days)
- Reparative Phase (Weeks)
- Remodeling Phase (Months)

Bone Healing
Multiple factors
- Location in the body
- Patient factors
- Surgical vs. Nonsurgical
Bone Healing

- Location
  - Not modifiable

Bone Healing

- Patient factors
  - Modifiable
  - Diabetes
  - Smoking
  - Malnutrition
  - Age
  - Irradiation
  - EtOH Abuse
  - Venous stasis

Bone Healing

- Surgical vs. Nonsurgical
  - Modifiable
### Nonunion/Delayed Union

- **Nonunion**
  - No radiographic healing 6-9mo
  - No change on 3 consecutive monthly x-rays

- **Delayed union**
  - Has not advanced at “average” rate for similar fractures

### Treatment of Nonunions

- **Have to figure out why it didn’t heal and what you can change**

### Treatment of Nonunions - Surgical

- **Stabilization**
- **Bone grafting**
  - Autograft, Allograft
  - Adjuvants:
    - BMP-2, PRP, DMB
Nonunions

- What about noninvasive options?

**BONE GROWTH STIMULATORS**

Background

- 1950’s - Ultrasound useful for fractures
- 1970’s - Clinical use of electrical currents and electromagnetic fields
- 1980’s - Ultrasound

- Led to increasing physician and industry interest

Bone Stimulators

- 3 main types
  - Electrical
    - Capacitive coupling
  - Electromagnetic
  - Pulsed
  - Continuous - combination of direct and alternating current
  - Ultrasound
Bone Stimulators

Principle is that it uses external stimulation to create a cellular response to initiate a bone healing response.

How It Works (electrical)

How It Works (ultrasound)

Activation of cell surface mechanoreceptors (integrins)

Intracellular Upregulation

COX-2  VEGF  BMP's
Length of Use

- Wear time
- Electrical 2-4 h/day
- EMF/Ultrasound 20-30min/day

Applications

- Fresh Fractures
- Nonunions
- Spinal Fusions

- Other uses
  - Complicated fusions
  - Osteotomies
  - AVN

Nonunions/Delayed Union

- Revision surgical nonunions
- Nonoperatively treated fractures
  - Atrophic, oligotrophic
- Likely the best indication for the use of bone stimulators
  - “Is there anything else other than surgery”
Nonunion

- 16 yo football player twisted his foot in last game of the season.

Nonunion

- 4 mo referred due to concern of healing
- Pain in boot
- Refused surgery

Nonunion

- 6 mo using inserts, no boot, no pain
- Was running without pain
Nonunion

- 50 y.o. woman s/p fall from horse
- Conservative treatment with cast and limited weight bearing
- No healing at 3 months
- Pain over nonunion

Medial Malleolus Nonunion

- 5 weeks after BG stimulator started still with pain
- Used walking boot “at times”

Medial Malleolus Nonunion

- 10 weeks after BG stim started
- No significant healing
- Minimal pain thus no surgery
- BG stimulator continued
Medial Malleolus Nonunion
- 4 months after BG stim
- Healing occurring
- Less pain

Medial Malleolus Nonunion
- 7 months after BG stim
- Healed
- No pain
- Full function

Fresh Fractures
- Mostly studied in tibial fractures (distal radius)
- Accelerated bone healing/Decreased delayed healing
  - Bussie et al. CMAJ 2002
  - Cook et al. CORR 1997
- Randomized trial for tibia fractures (IM rod)
  - No difference compared to placebo
  - Enami JOT 1999
Fresh Fractures

Not all fractures need a bone stimulator to heal

Not all fractures or patients are created equal

Fresh Fractures

- 48 yo female with open R pilon fracture
  - Smoker (1-2ppd)
  - Diabetes (HbA1C ~8)
  - Neuropathic
  - Ulcerative Colitis (on steroids)

Fresh Fracture

- 4wks
  - Non healing anteromedial wound
Fresh Fracture

Primary Fusions

PEMF and Hindfoot Arthrodesis
- Prospective randomized
- 64 pts., Triple or subtalar arthrodeses
- Control vs. PEMF (12 hrs./day)
- Increase the rate and speed of radiographic union
- 0 nonunions PEMF group vs. 5 in control group

Dhamu SK et al. J Foot and Ankle Surg 2004
Difficult Fusions

Ankle and Hindfoot
- Risk of Nonunion 5-40% for ankle fusions and 16% for subtalar fusions
- 3-4 times higher for smokers
- Other risk factors:
  - Infection
  - A.V.N.
  - Previous nonunion
  - Previous adjacent fusion
  - Major medical problems

Difficult Fusions
- 64 y/o diabetic
- Charcot ankle and midfoot

Difficult Fusions
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Difficult Fusions

- Internal fixation
- 6 Months in Ex-fix
- Bone graft
- BG stim utilized

Difficult Fusions

Doing well >8yrs
Difficult Fusions
- High Risk Ankle and Subtalar Fusion
  - ORIF+BG – 12/13 healed
    - Donley and Ward Foot Ankle Int 2002
- Revision Ankle Fusions
  - 10/10 healed with exfix + stimulator
    - Mole and Conti Foot Ankle Int 2002

Avascular Necrosis
- 23 yo nurse with spontaneous R ankle pain
- 6 wks – no response
- MRI
Avascular Necrosis

- 6 mo with continued pain and new radiographic changes
- Patient offered surgical drilling +/- Bone stim

My Bone Stimulator Use

- Minimal use in my practice
- Patient preference
  - Nonop fractures with poor blood supply
- Difficult fractures with limited ability to mechanically stabilize
- Patient factors/Comorbidity

Summary

- Bone stimulators have evidence to suggest that they increase time of healing
- They have relatively little risk
- Increasing conditions which they are covered by insurances
- They **DO NOT** replace the need for good technical practices and decision making for treating difficult problems