Clavicle fractures: Nonoperative vs Operative Management

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Disclaimer

No conflict(s) of interest in relation to this presentation

17 yo football player

Mid October of senior year

Also wrestles and plays baseball

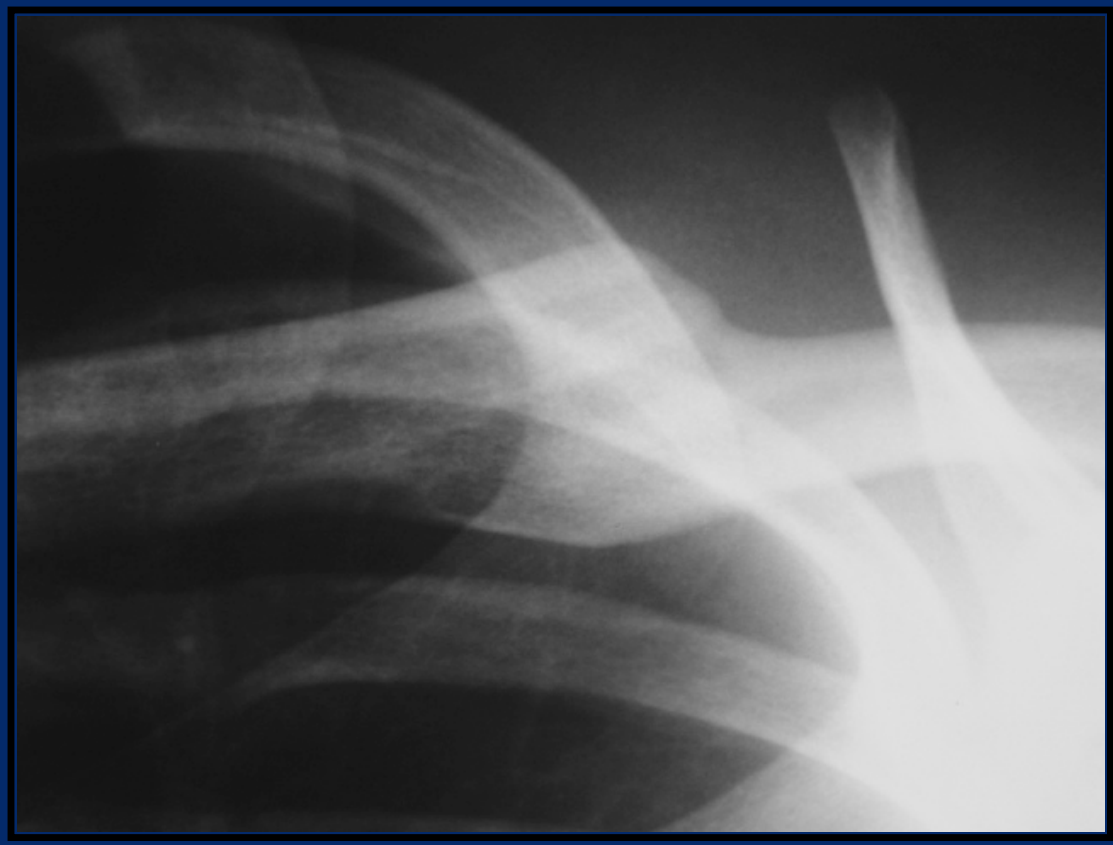
Dominate arm

Acute, mid-shaft clavicle fractures

So what's the big deal?

- *"They all do fine"*
- *"They all heal"*

"Don't worry about it"



Acute, mid-shaft clavicle fractures

Nonoperative treatment

The existing literature is relatively clear: they don't *all* do well with nonoperative treatment !!

Acute, mid-shaft clavicle fractures

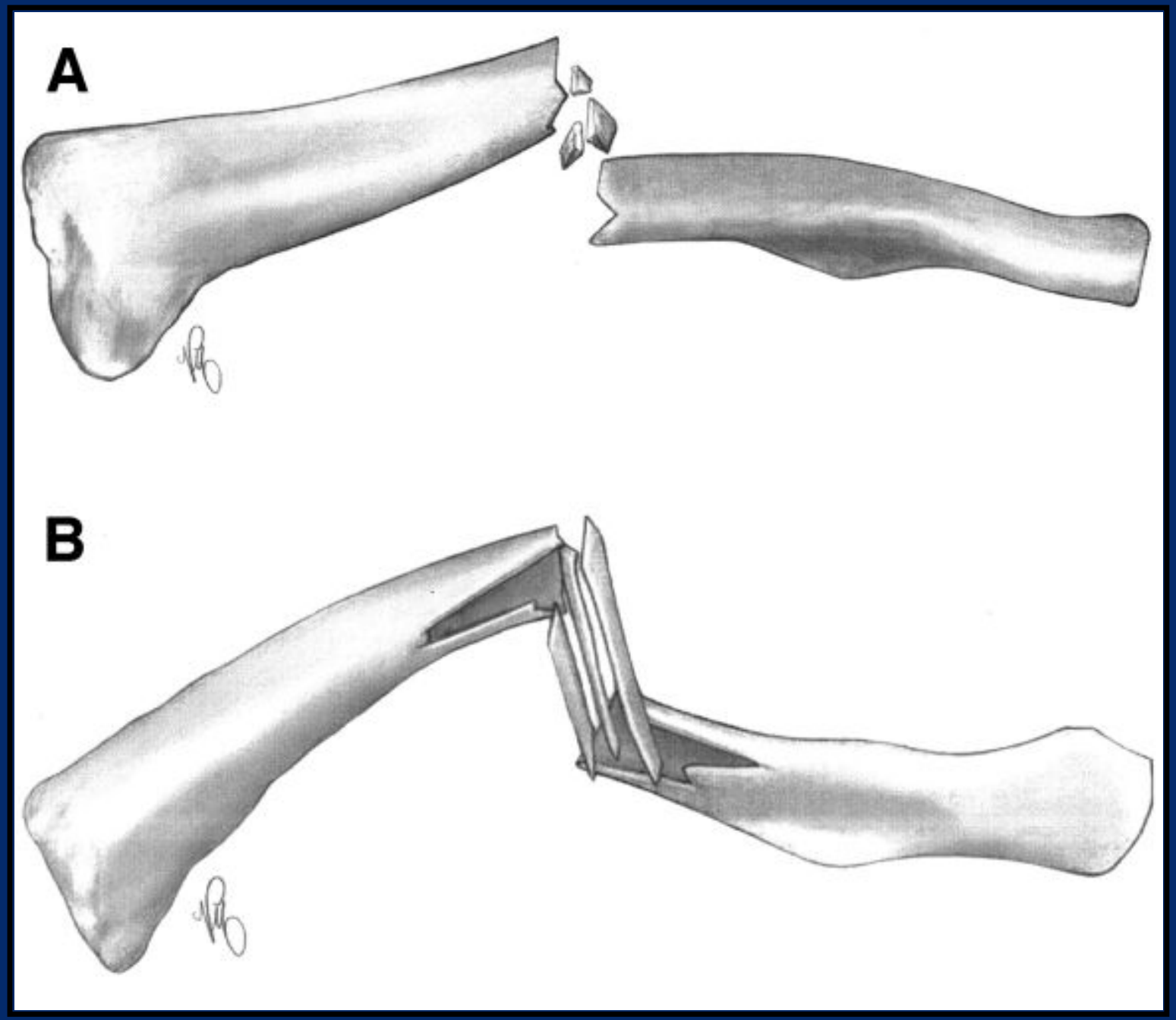
Nonoperative treatment

- **Closed treatment of dislaced middle-third fractures of the clavicle gives poor results.** *Hill et al JBJS-Br., 1998.*
  - **242 consecutive clavicle fractures**
  - **Patient-based outcome assessment (questionniare)**
  - **52 / 242 completely displaced, middle-third**
    - **15% nonunion**
    - **31% unsatisfactory clinical results (pain, brachial plexus sxs)**
  - **Factor associated with nonunion / poor results: *initial shortening > or = 2 cm***

Acute, mid-shaft clavicle fractures

Nonoperative treatment

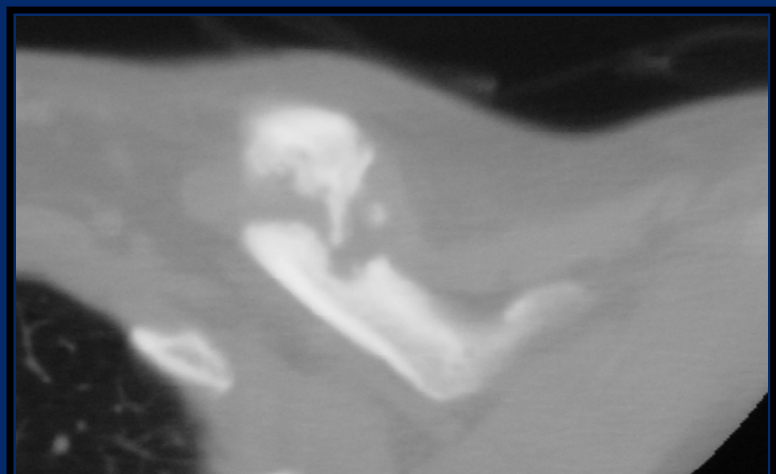
- **Can we predict long-term sequelae after fractures of the clavicle based on initial findings? A prospective study with 9 – 10 years follow-up** *(Nowak, et al 2000)*
  - 245 consecutive clavicle fractures
  - 46% still with "sequelae" 9 years later (7% nonunion)
    - "No bony contact" was strongest predictor for sequelae
    - Communited fractures with "transverse" fragments


A
B

Acute, mid-shaft clavicle fractures

Nonoperative treatment

- **Estimating the risk of nonunion following nonoperative treatment of a clavicular fracture.** Robinson et al. JBJS 2004.
  - 581 diaphyseal fractures
  - Overall 4.5% risk of nonunion
  - Significant increased incidence with . . .
    - Advancing age
    - Female gender
    - Displacement of fracture (“no contact”)
    - Presence of comminution



Acute, mid-shaft clavicle fractures

Nonoperative treatment

- **Estimating the risk of nonunion following nonoperative treatment of a clavicular fracture.** Robinson et al. JBJS 2004.

	Displaced		Comminuted		Displaced & Comminuted		Not Displaced, Not Comminuted	
Age (yrs)	Females	Males	Females	Males	Females	Males	Females	Males
25	19%	8%	7%	3%	33%	20%	3%	<1%
35	20%	11%	8%	4%	35%	21%	4%	<1%
45	25%	14%	10%	5%	37%	25%	5%	1%
55	28%	18%	12%	6%	42%	29%	6%	2%
65	33%	20%	18%	7%	47%	33%	7%	3%

Acute, mid-shaft clavicle fractures

Nonoperative treatment

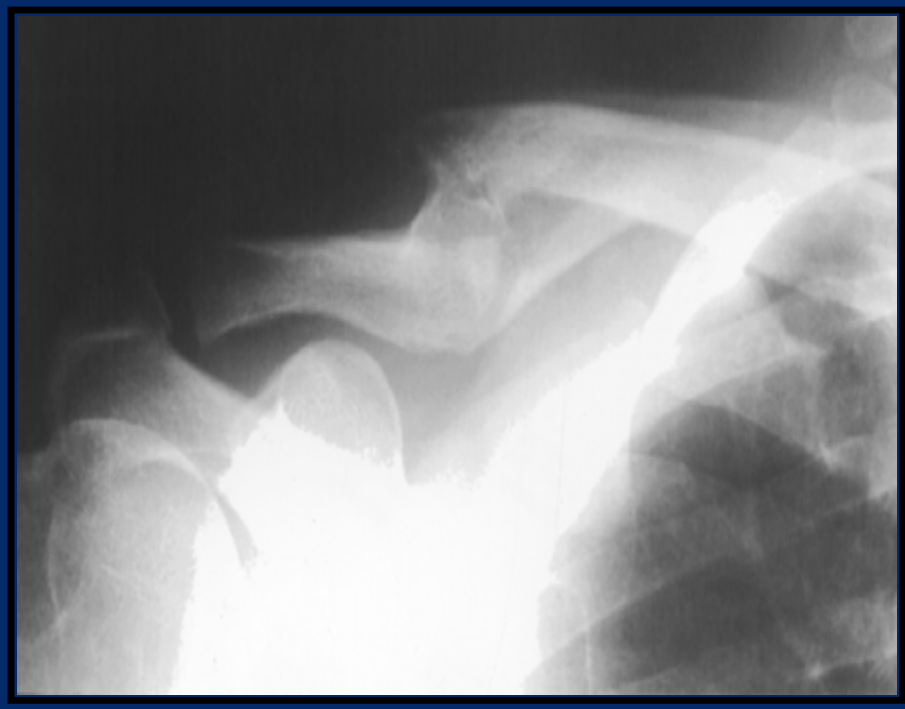
- **Estimating the risk of nonunion following nonoperative treatment of a clavicular fracture.** Robinson et al. JBJS 2004.

	Displaced & Comminuted	
Age (yrs)	**Females**	**Males**
25	**33%**	**20%**
35	**35%**	**21%**
45	**37%**	**25%**
55	**42%**	**29%**
65	**47%**	**33%**

Displaced mid-shaft clavicle fractures

Deficits following nonoperative treatment

- McKee, et al. JBJS 2006
  - 30 patients
    - All healed
  - "Patient-based" outcome measurements
    - Residual Disabilty
  - Strength Testing
    - Decrease Max 18-19%
    - Decrease Endurance 18-33%



Acute, mid-shaft clavicle fractures

Not so fast, surgeons . . .

- Nordqvist et al
  - 69 displaced fractures with no bony contact and 85 displaced / comminuted fractures
  - Only 1 of 7 nonunions had a poor result
  - Permanent clavicular shortening is common with no clinical sequelae
- Oroko et al
  - 41 patients with clavicle shortening of 15mm or more
  - Could not demonstrate relationship between shortening and shoulder function
- Pedersen et al
  - 90% of 99 patients had no pain at follow-up
  - Shortening and displacement were not risk factors for pain
- Blomer et al
  - 151 patients
  - Neither axial angulation nor shortening caused shoulder dysfunction

Acute, mid-shaft clavicle fractures

Why the contradictions in the literature?

"It is clear that patient-based outcome measures reveal residual impairment that surgeon-based or radiographic measures do not."

McKee et al

McKee, et al JBJS 2007
Nonoperative vs plate fixation of displaced fractures

Multicenter, randomized clinical trial – 132 patients

- Operative treatment statistically better . . .
  - Constant / DASH score
  - Return to activities
  - Time to union
  - Nonunions
  - Symptomatic malunions
  - Patient satisfaction

Robinson, et al JBJS 2013
Nonoperative vs plate fixation of displaced fractures

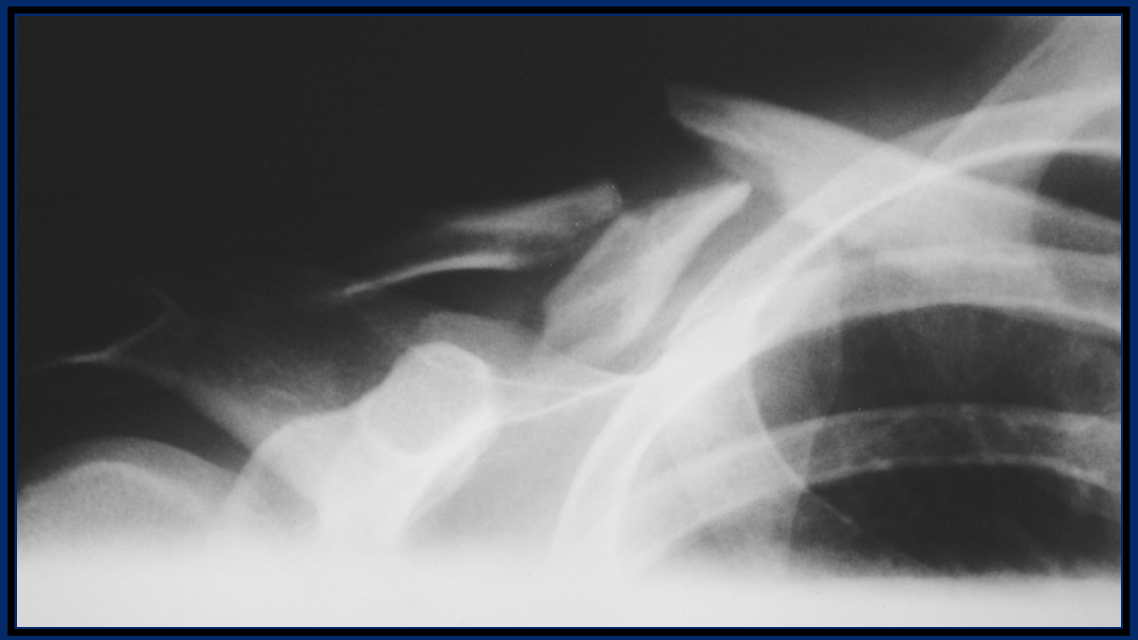
Multicenter, randomized clinical trial – 200 patients (16-60yo)

- At 1 year ORIF pts better than non-op
  - Lower Nonunion rate (1 vs 16)
  - Constant / DASH scores
    - Exclude nonunions than scores the same
  - Pt satisfaction
    - Shoulder droop
    - Bump
    - Shoulder asymmetry
  - Higher cost

Acute, mid-shaft clavicle fractures

"Evolving" indications for surgery – general patient population

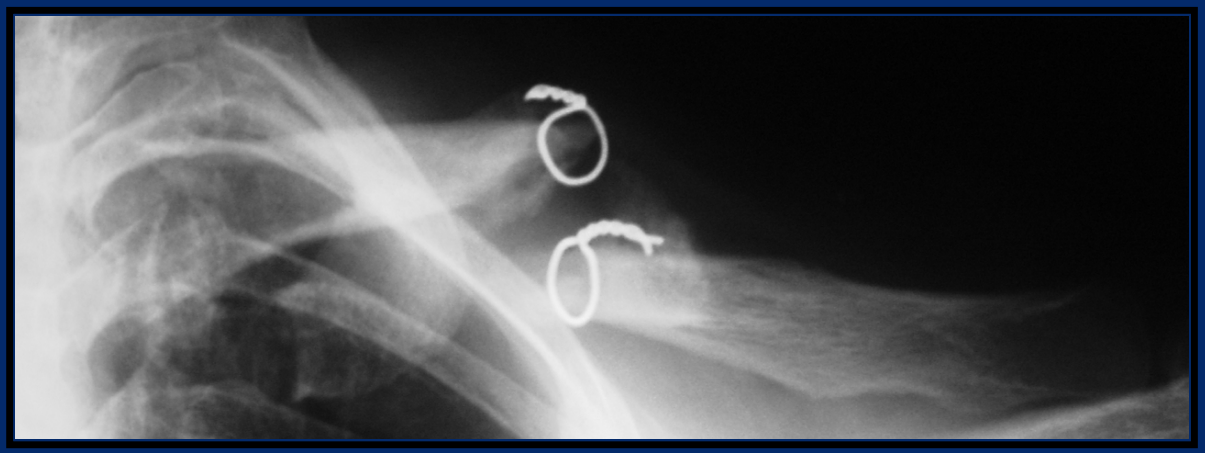
- Degree of displacement / shortening
  - "No contact"
  - > 2 cm
- Communution
- Amount of "energy"
- Fracture pattern ("zed")
- Patient-specific factors
  - Contact athletes
  - Year round athletes



Acute, mid-shaft clavicle fractures

Surgical technique options

- Compression plating
- IM fixation
- Other creative techniques (?)



Acute, mid-shaft clavicle fractures

Technique options: plating

- The most commonly utilized technique
- Complications associated with ORIF / plating primarily related to plate selection and technical issues
  - Pre-contoured, anatomic plates

McKee, et al JBJS 2007
Nonoperative vs plate fixation of displaced fractures

Multicenter, randomized clinical trial

- Complications of ORIF – 9%
  - 3 / 67 (4.4%) infections
    - All managed initially with antibiotics and local wound care
    - Hardware removal after healing
    - No sequelae
  - 2 / 67 (3%) symptomatic hardware requiring removal
  - 1 / 67 (1.5%) broken plate (ATV accident 6 weeks post-op)

  - No catastrophic complications

Acute, mid-shaft clavicle fractures

Technique options: plating

The plate doesn't do it by itself !!

Mid-shaft clavicle fractures

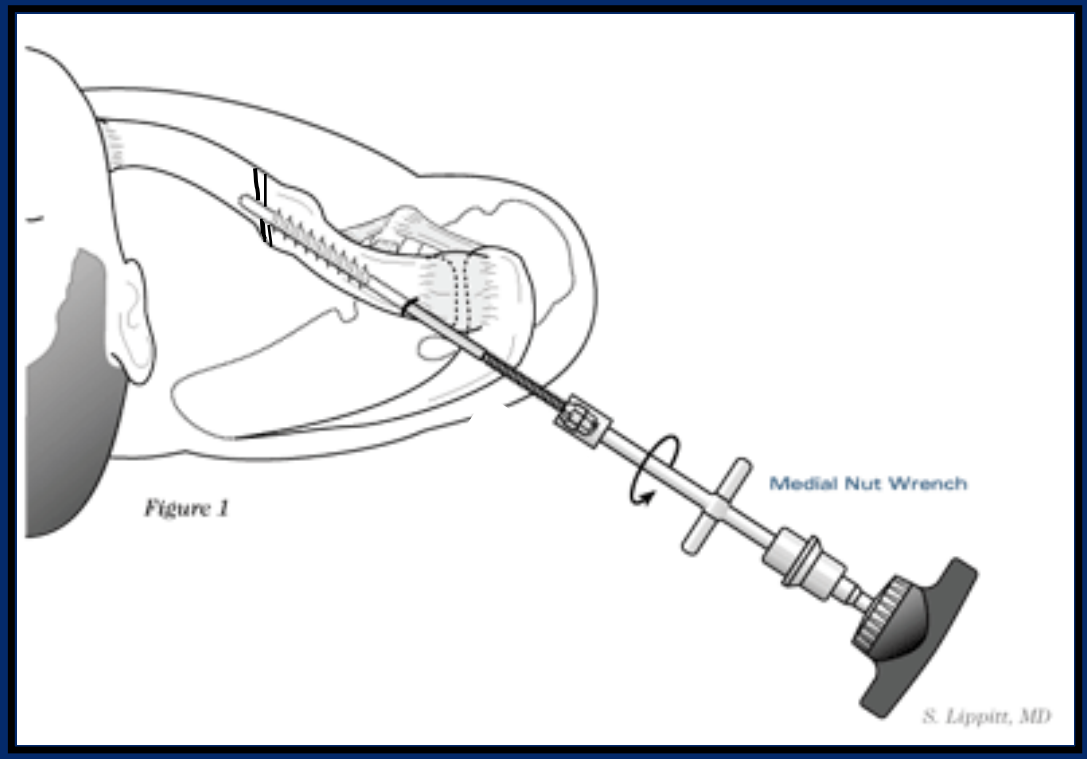
Surgical pearls - plating

- Identify / protect supraclavicular nerves
- Precise approach through delto-trapezial fascia
- Anatomic / compressive fixation
  - Pre-contoured anatomic plates
  - Avoid medial prominence
- Respect periosteum / soft-tissue attachments
- Bone graft substitute if comminuted
- Thick, “water-tight” delto-trapezial fascia repair

Acute, mid-shaft clavicle fractures

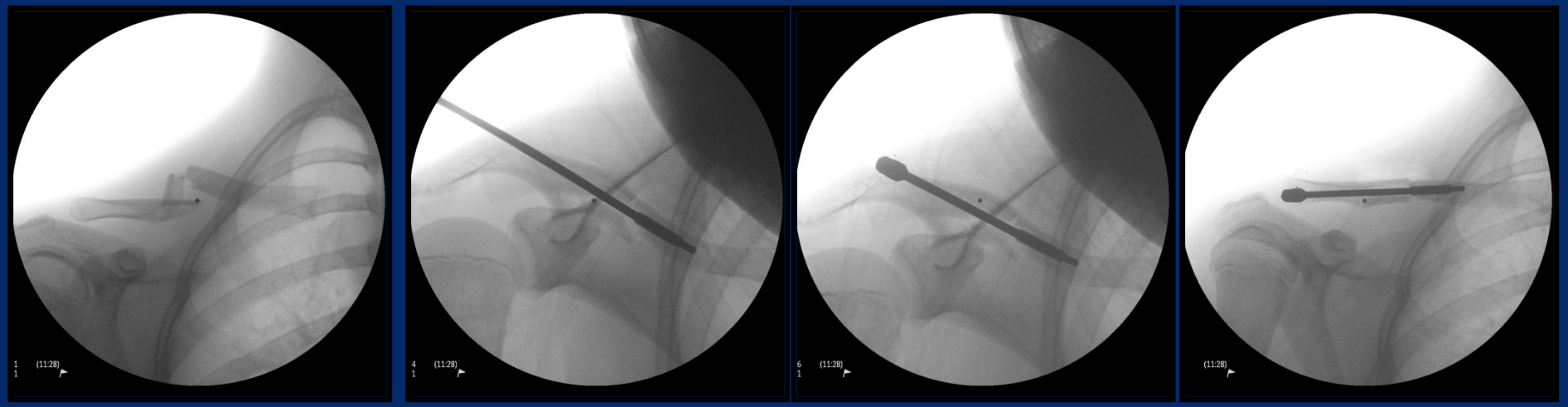
Technique options: IM fixation

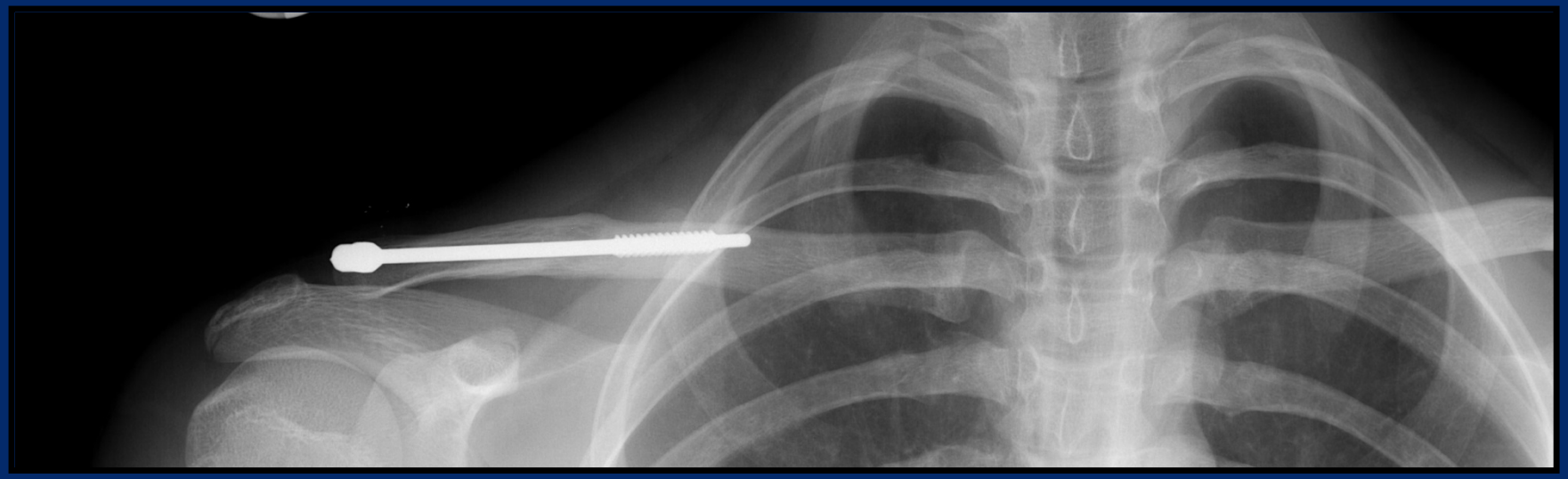
- Stable fixation with thread on one end and “bolt” on the other
- Technique:
  - Open fracture site
  - Retro / anterograde placement of pin from behind AC joint
  - Engage medial, anterior cortex
  - Bolt behind AC joint to prevent migration



Acute, mid-shaft clavicle fractures

Technique options: IM fixation

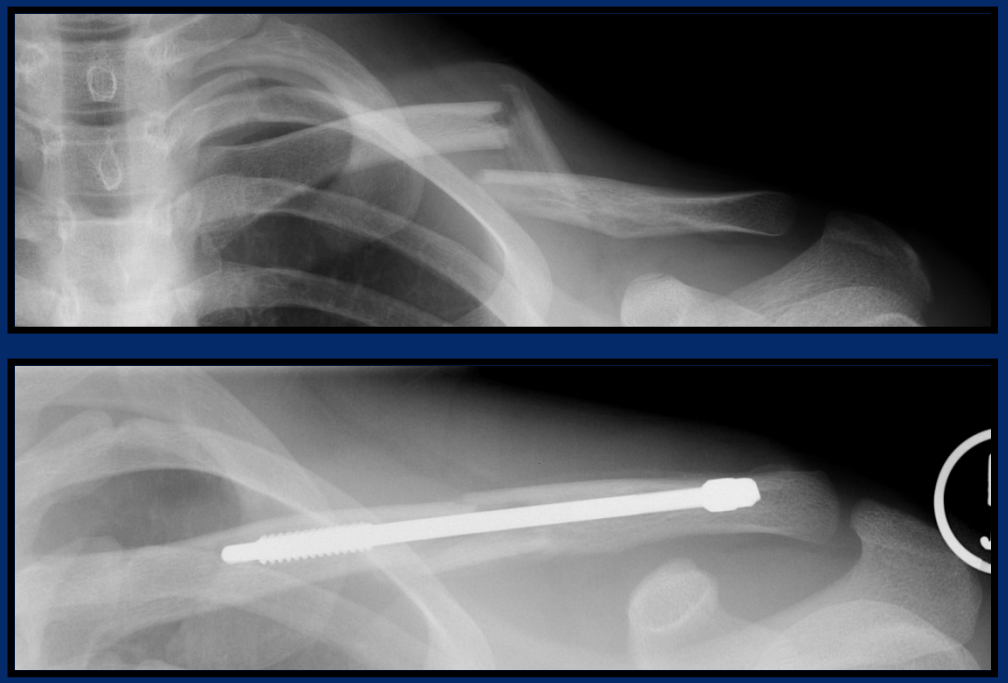




Acute, mid-shaft clavicle fractures

Technique options: IM fixation

- Advantages
  - Less dissection
  - More cosmetic
  - No long-term retained hardware issues
  - Ideal in younger patients with severe, acute fractures
- Disadvantages
  - All require hardware removal (2nd surgery)
  - Bolt symptomatic



Acute, mid-shaft clavicle fractures

Technique options: intramedullary fixation

Neither does the pin !!

Acute, mid-shaft clavicle fractures

Complications of IM fixation

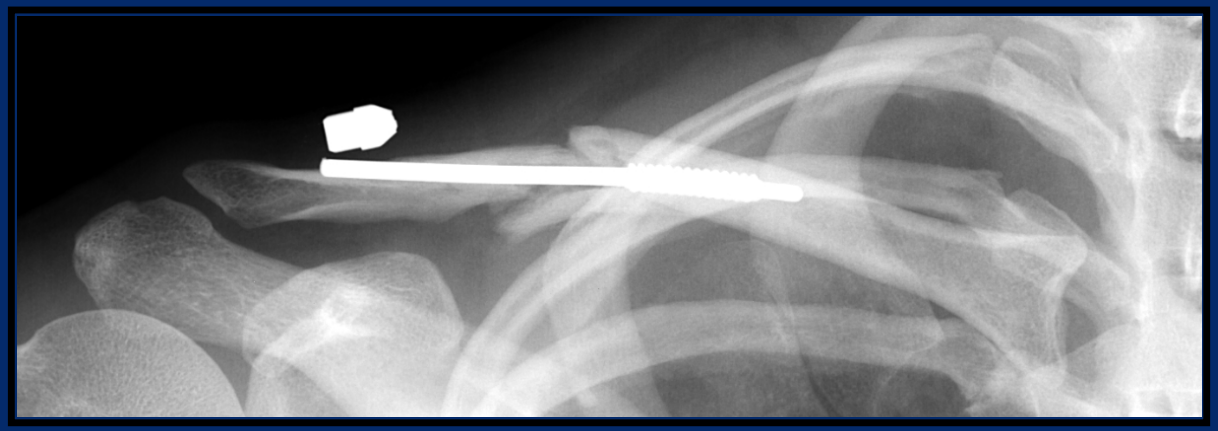
- Device dependent
  - Rockwood pin
  - Knowles pin
  - Hagie pin
  - Threaded Steinman pin
  - K-wires
  - Complication rate very variable in the literature
  - Range: 5% - 50%

Grass, Strauss, Chu, Ngarmukos, Boehme

Acute, mid-shaft clavicle fractures

Surgical pearls – intramedullary fixation

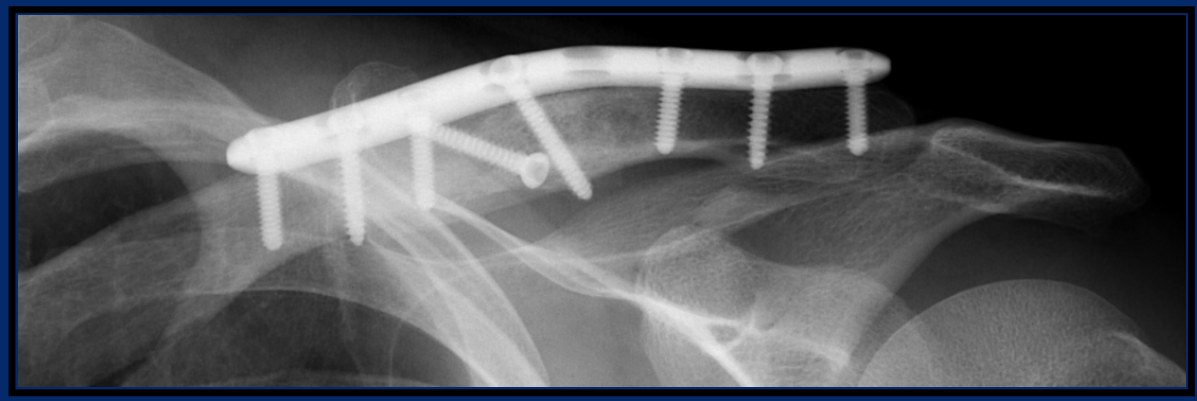
- Small incision over fracture; extend prn
- Largest diameter pin that will traverse canal
- Look via C-arm in different planes; stay centered
- Threads cross fracture site; reduce fragments anatomically
- Don’t exit too high laterally
- “Cold weld” medial and lateral bolts together
- Cut pin as short as possible to minimize symptoms
- Suture comminution and delto-trapezial fascia closure



Timing?

Does delay matter?

- Potter, McKee, et al JSES 2007
  - 15 immediate vs 15 delayed fixation
  - No differences . . .
    - Healing
    - Strength of shoulder flexion
    - Shoulder abduction
    - ER
    - IR
    - DASH scores
  - Marginally better outcomes in Constant scores and in endurance strength with acute fracture repair



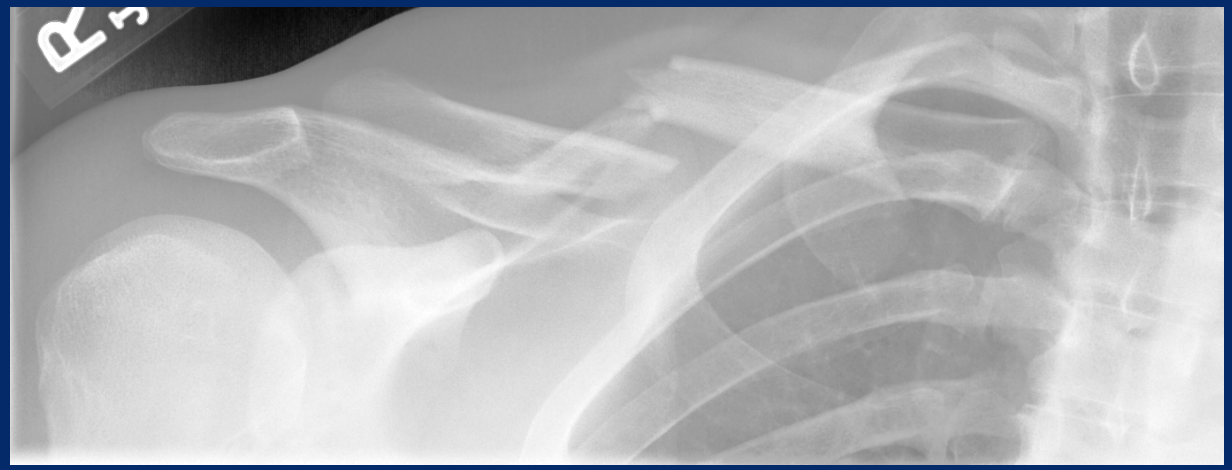
Case examples . . .

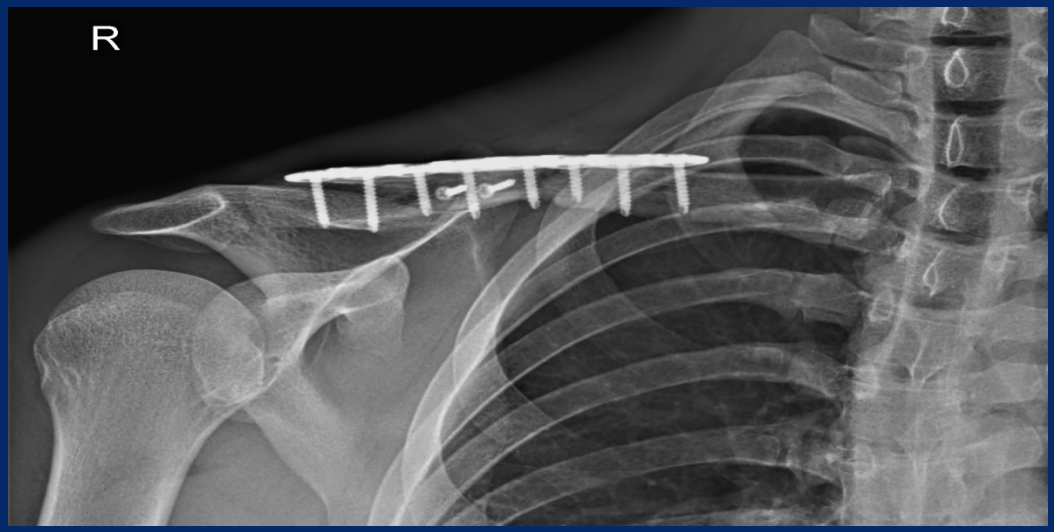
Acute, mid-shaft clavicle fractures

Patient-specific factors: HS FB Player

Acute, mid-shaft clavicle fractures

Patient-specific factors: 25 yo manual laborer

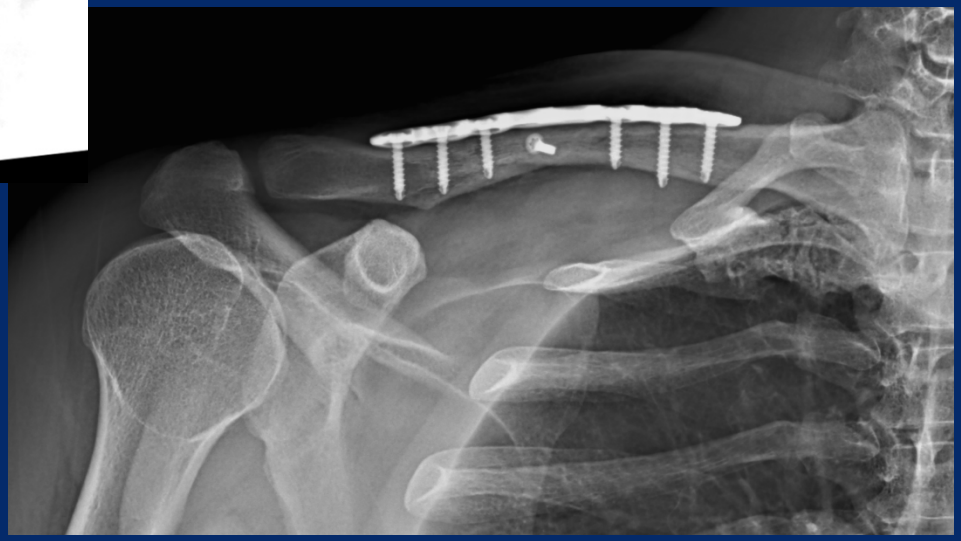




Acute, mid-shaft clavicle fractures

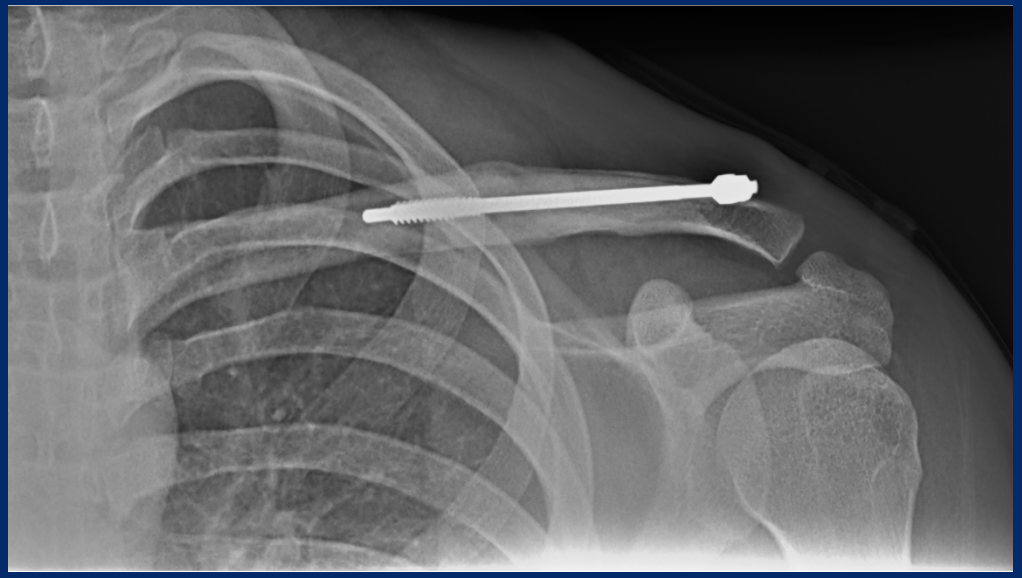
Patient-specific factors: 36 yo construction worker

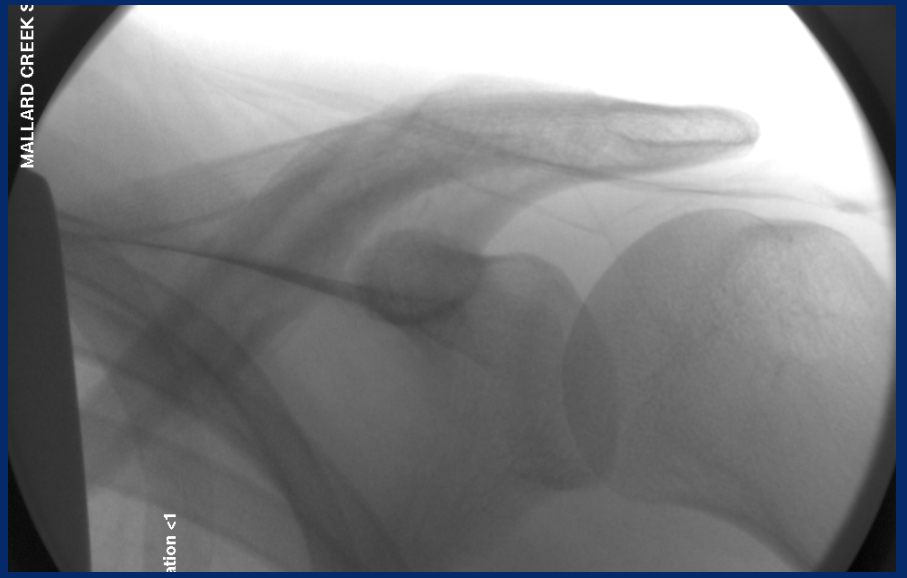
Dirt bike injury



Acute, mid-shaft clavicle fractures

Patient-specific factors: Missionary





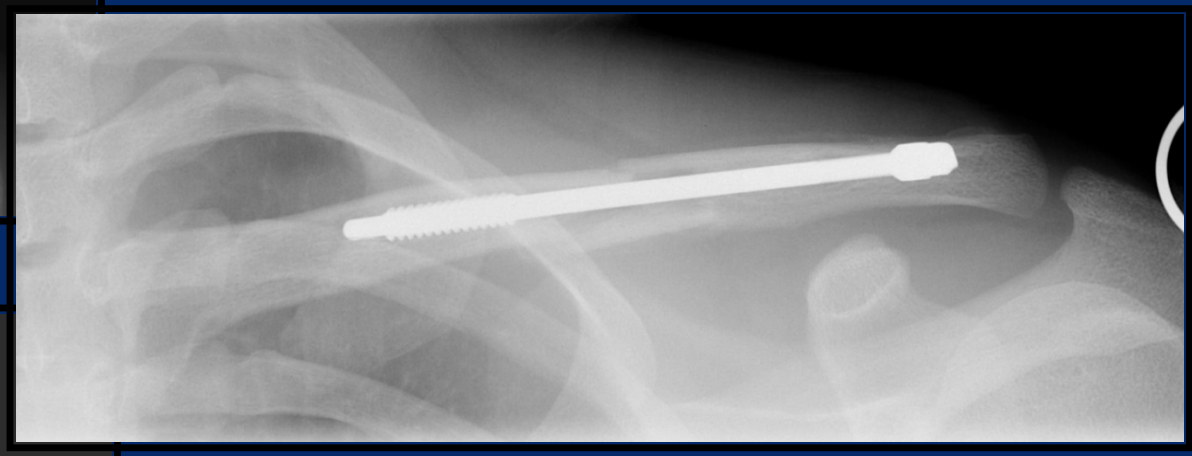
Acute, mid-shaft clavicle fractures

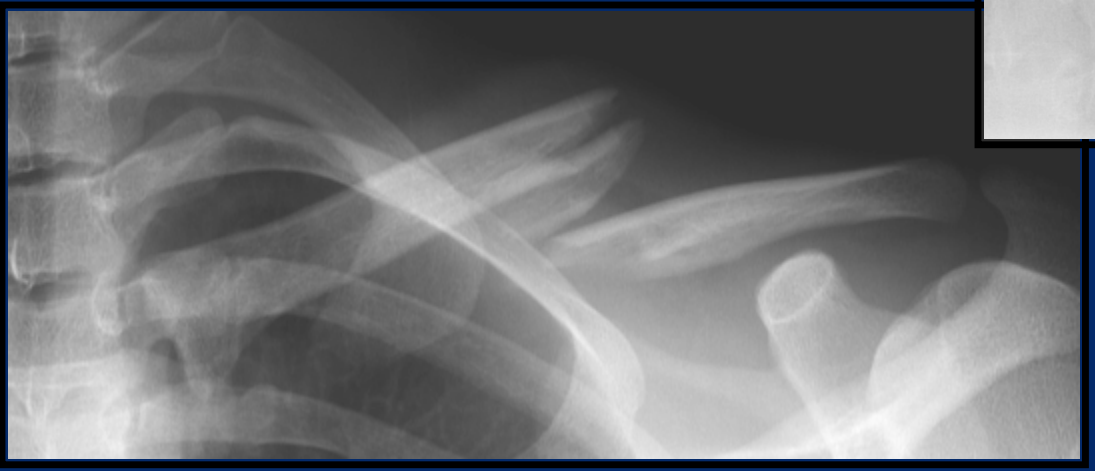
Patient-specific factors: Missionary

6 months later

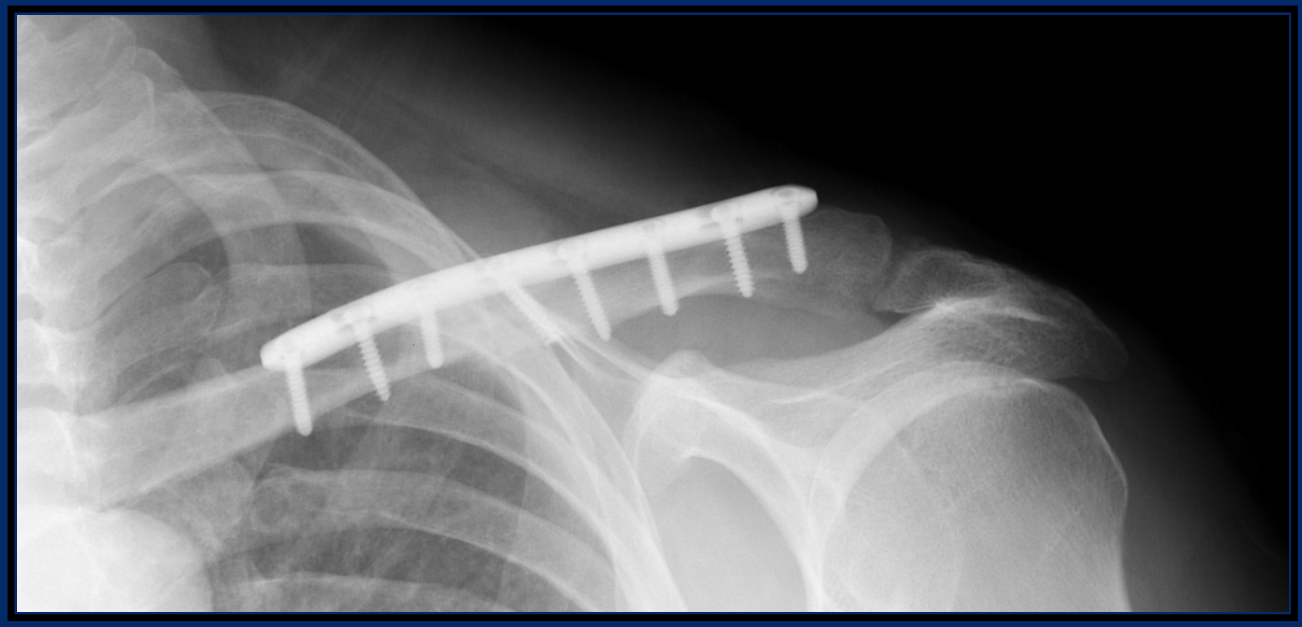
Acute fracture

15 year old boy





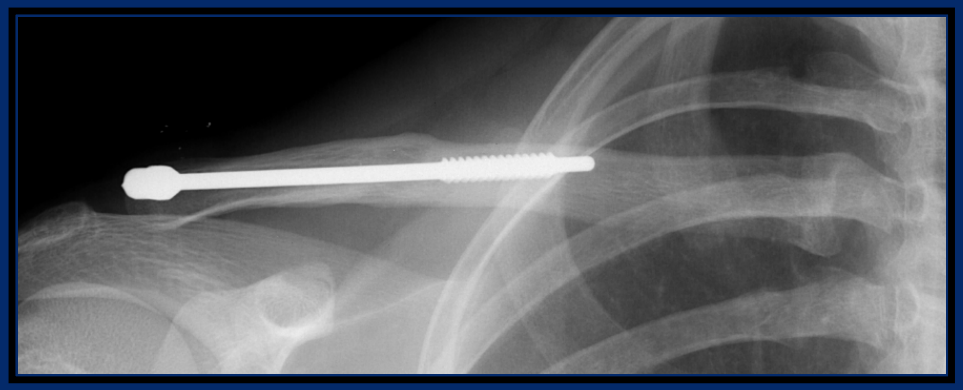
Malunion + thoracic outlet symptoms

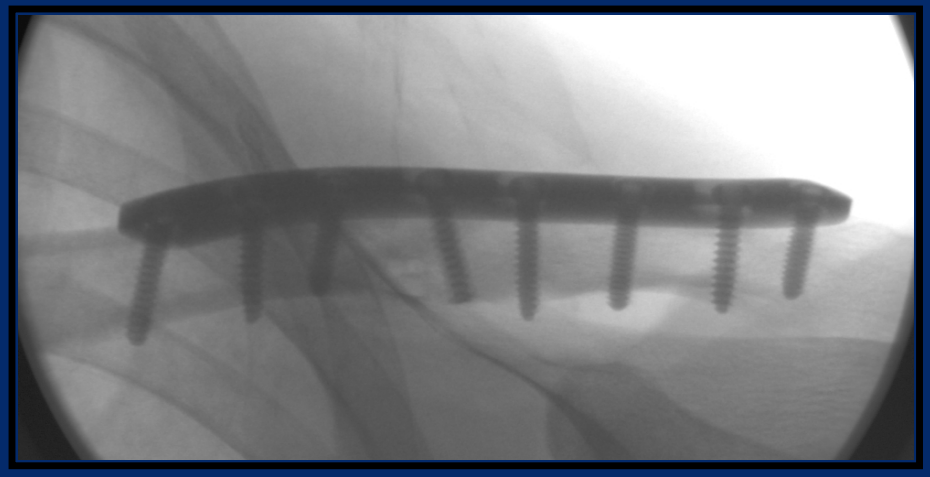


Mid-shaft clavicle fractures

Implant selection: my personal preference

- Acute fractures
  - IM pin
    - Younger patients
  - Plate
    - Most patients
    - 2nd operation less desirable
- Nonunions
  - Plate





Acute, mid-shaft clavicle fractures

Summary

Although displaced mid-third clavicle fractures can be managed successfully without surgery,

patient-based outcome studies suggest that a larger percentage of *displaced* mid-clavicle fracture results are “less than ideal”

Acute, mid-shaft clavicle fractures

Summary

- Factors potentially associated with poorer results include . . .
  - Degree of displacement / shortening > 2 cm (“no contact”)
  - High-energy / comminuted fractures
  - Fracture pattern (“zed”)
  - Displaced Type II distal clavicle fractures
  - Patient-specific factors (contact athletes)
- Operative management should be considered in these higher-risk clinical scenarios

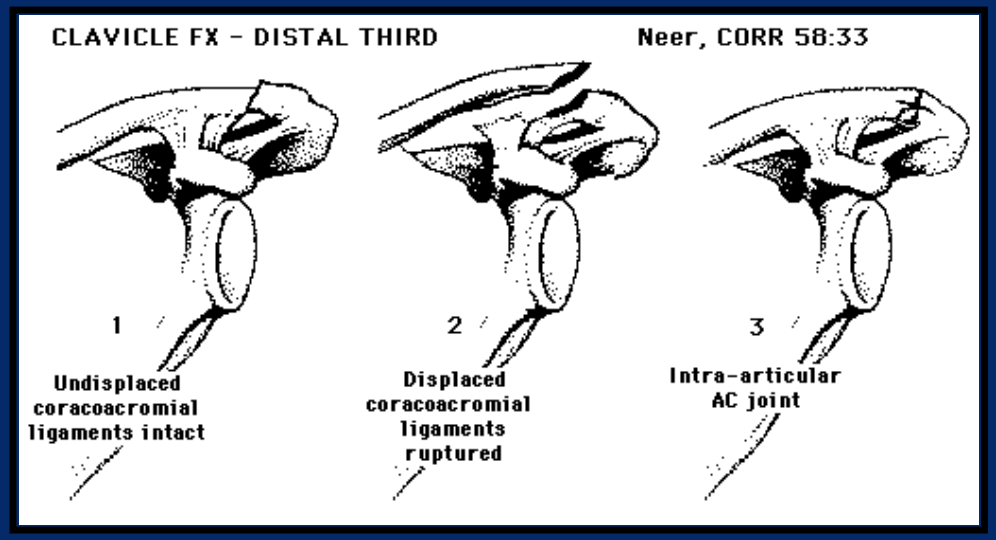
Mid-shaft clavicle fractures

Implant selection: talking points

- Time to heal – return to activities
- Nonunion risks
- Expected outcomes
- Non-op complaints
- Operative complaints
- Cost
  - Surgery
  - Time out of work

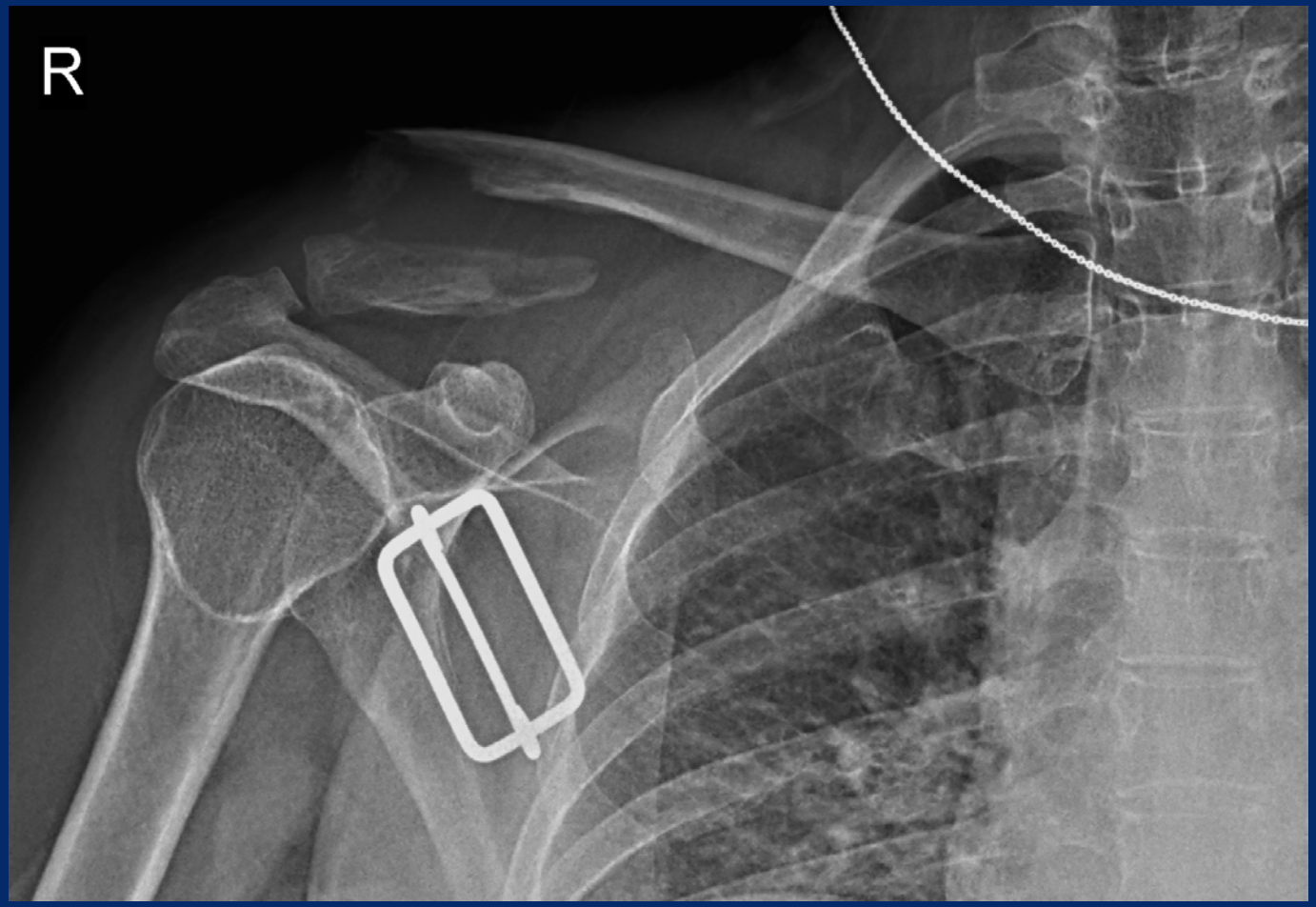
Lateral clavicle fractures

10-15% of all clavicle fractures



Lateral clavicle fractures

40 yo teacher – bike accident at the beach



Lateral clavicle fractures

10-15% of all clavicle fractures

- Natural history . . .
  - Charles S. Neer II, MD — ~ 1/3 problematic
  - Nordquist Acta Orthop Scand ’93 — 25% pain / nonunion
  - Robinson JBJS ’04 — 21% required surgery

Displaced lateral clavicle fractures

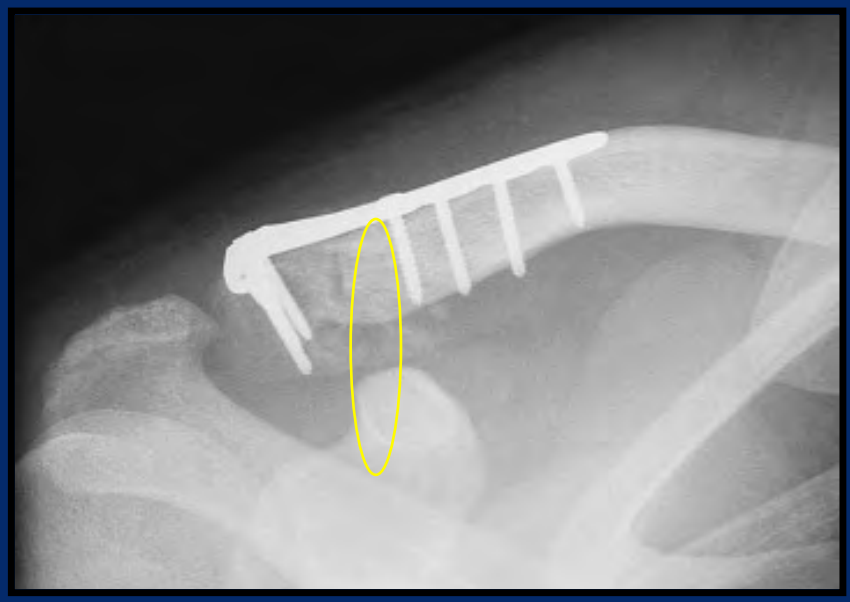
- Treatment options . . .
  - Plating
    - Multiple “standard” options
    - Anatomic, precontoured plate
  - Coracoid fixation
    - Primary
    - Supplemental with other technique(s)
  - Hook plate
  - K-wires / TBW across AC joint
  - Other creative techniques . . .
  - Excise distal bone fragment(s) + modified Weaver-Dunn

Lateral clavicle fractures

Plating

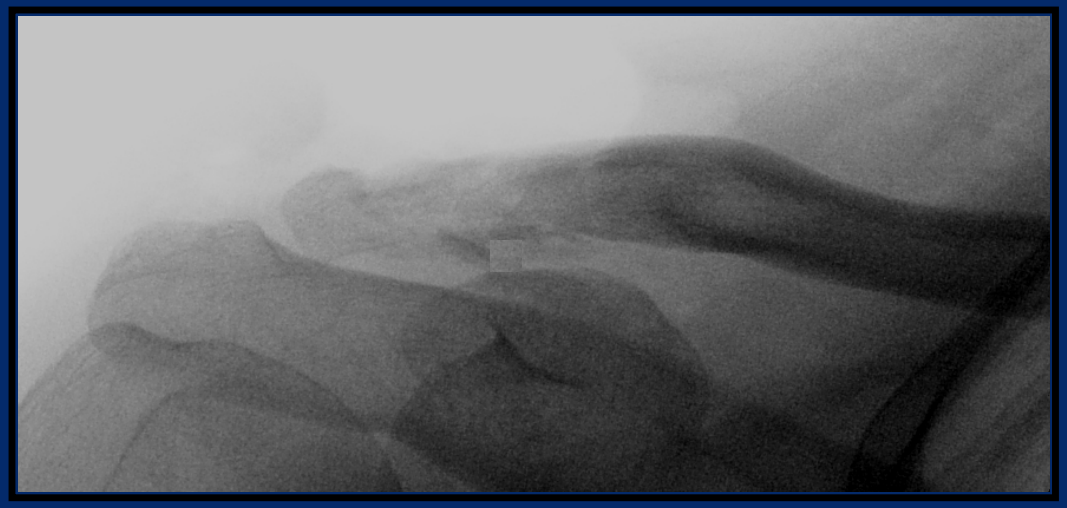
- Often inadequate lateral bone for standard plates
- Options . . .
  - Anatomic, precontoured plates

  - Strongly consider supplemental coracoid sling fixation
    - Sutures
    - +/- graft



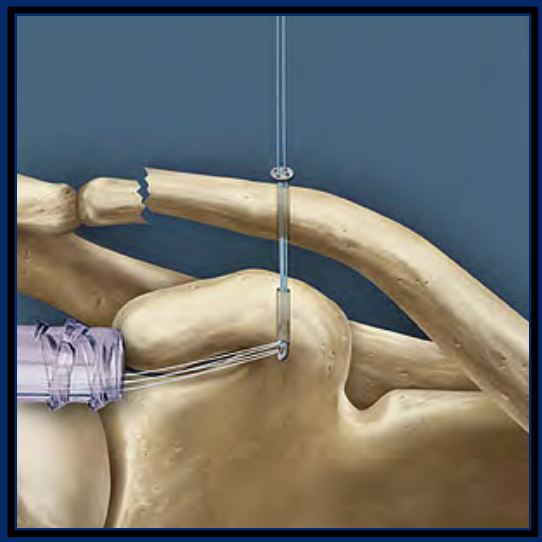
Lateral clavicle fractures

Coracoid fixation in isolation



Lateral clavicle fractures

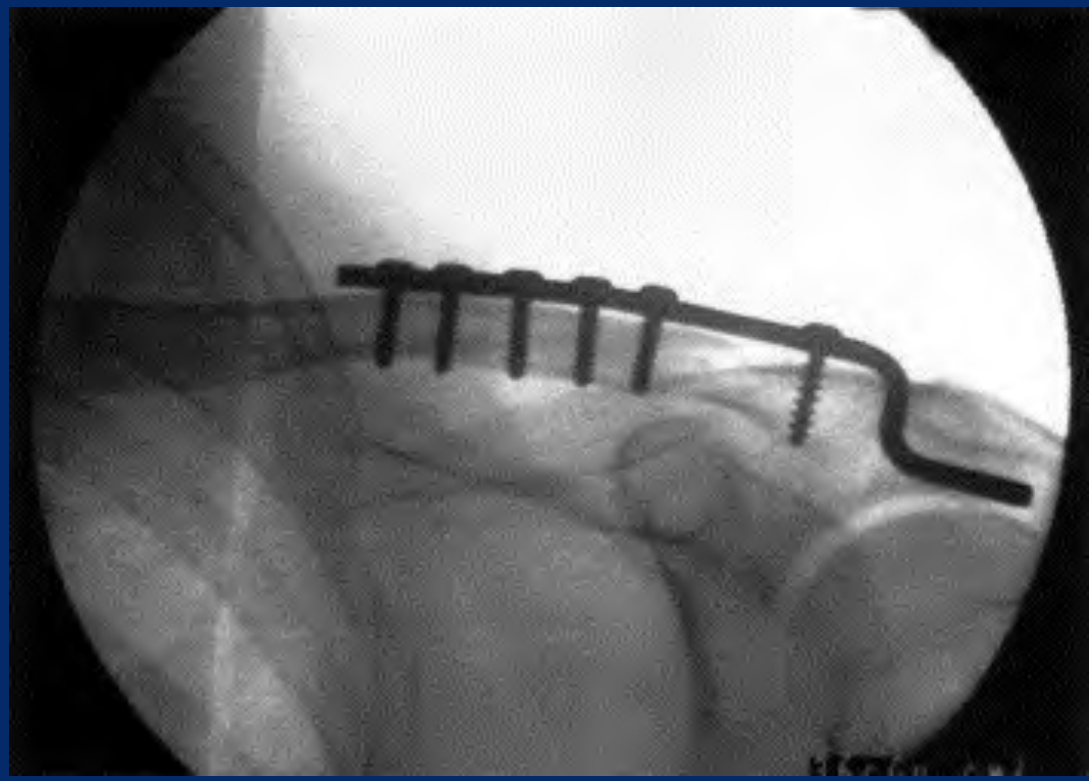
other techniques . . .



Lateral clavicle fractures

"Hook plate"

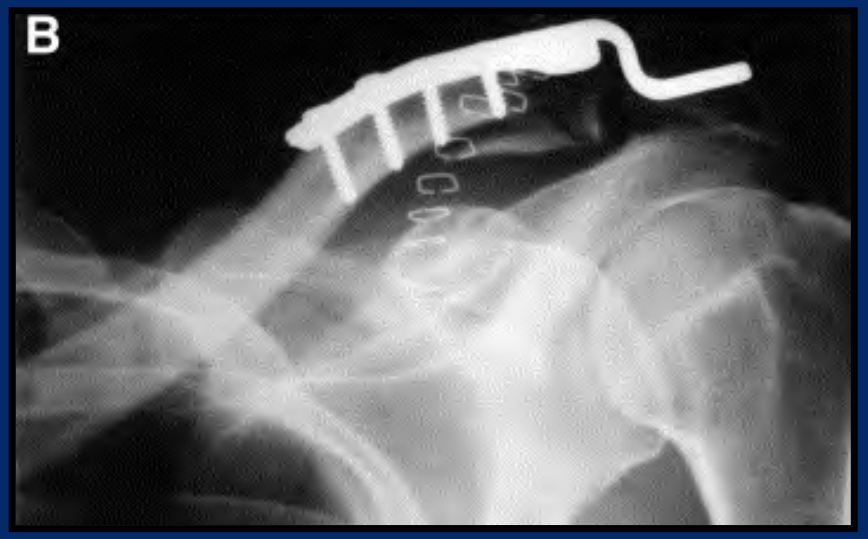
- Haidar, et al JSES 2006
  - 22 patients
  - 12 month minimum follow-up
  - Until plate removal, only 90° FE allowed
  - ROH 3-4 months
  - 21/22 ultimately healed
  - 86% satisfaction



Lateral clavicle fractures

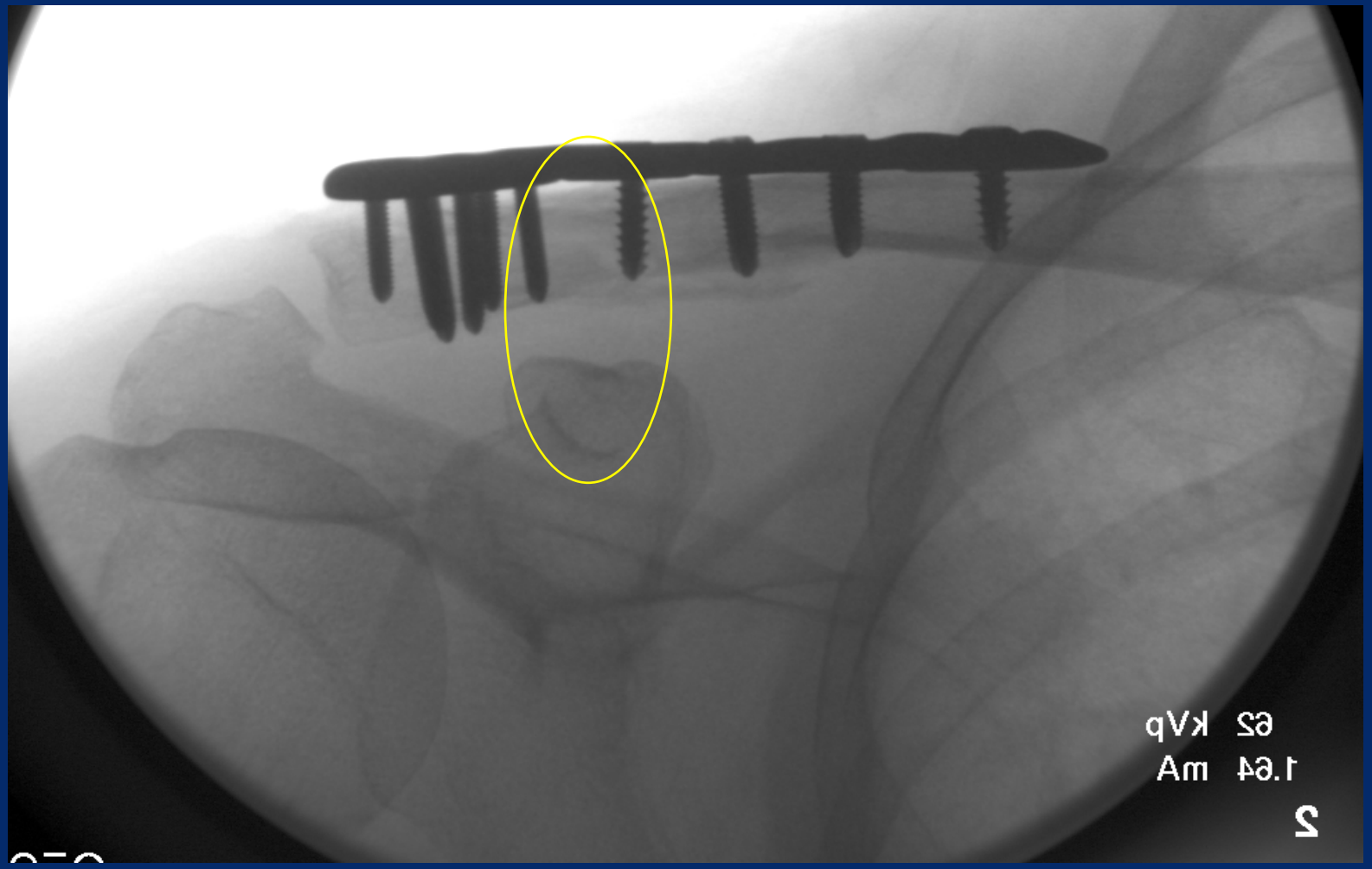
"Hook plate"

- Haidar, et al JSES 2006
  - "4 (18%) complications"
    - 1 malunion
    - 1 nonunion ("marked, subcutaneous bony prominence")
    - 1 wound breakdown / exposed plate
    - 2 failure of fixation
    - 1 stress fracture medial to plate
    - (3 patients with asymptomatic "acromial erosion")
    - 6/22 (27%) complications



Lateral clavicle fractures

Teacher



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