

# Clavicle Fractures: Which to Fix???



**Paul Tornetta III**

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## *Disclosures!*

• **Publications:**

- Rockwood and Green, Tornetta and Ricci TIFS, Tornetta and Einhorn; Subspecialty series, Court-Brown, Tornetta; Trauma, AAOS; OKU Trauma, ICL Trauma, Tornetta; Op Techn in Ortho Surg, OTA Slide project
- Journals: JOT; Deputy editor, CORR, JAAOS, JBIS; Reviewer

• **Research:**

- NIH, OTA, FOT, OREF, Aircast foundation, AIOD, Smith Nephew

• **Consultant / Designer**

- ~~Smith and Nephew, Exploramed~~

• **Boards / Officer:**

- AOA

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## **Surgical Indications**

- **Failure of nonop Rx**
- **Pain**
- **Dysfunction**
- **Nonunion**
- **Malunion**



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## Nonunion

- Thought to be very low
- Until recently
  - Poor numbers
  - Retrospective
- Better work has come
- Higher than previously thought



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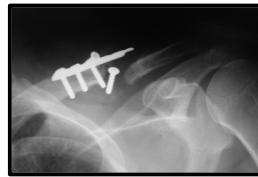
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## Predisposing Factors

- Displacement
- Physiology
- Gender
- Comminution
- Location
- Age



**Surgery?**

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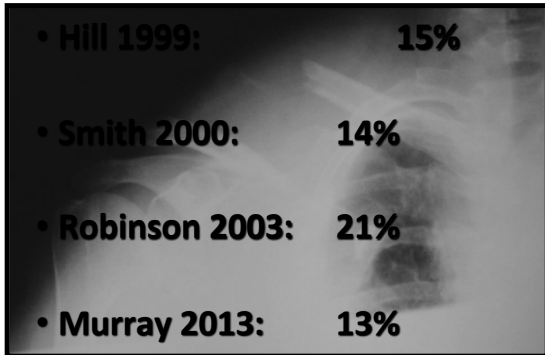
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## Nonunion risk

- Hill 1999: 15%
- Smith 2000: 14%
- Robinson 2003: 21%
- Murray 2013: 13%



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## Non-Union Risk

- Increased displacement

- ◆ Nordqvist

- ◆ Hill

- Female

- ◆ Larsson

- ◆ Women 13%

- ◆ Men 3%



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## Risk Factors

- Robinson '04

- ◆ 581 patients

- ◆ 4.5% prevalence

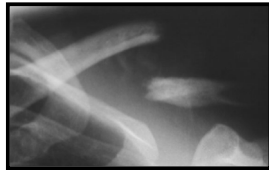
- Risk factors

- ◆ Complete displacement

- ◆ Comminution

- ◆ Advancing age

- ◆ Female gender



**23% Lost**

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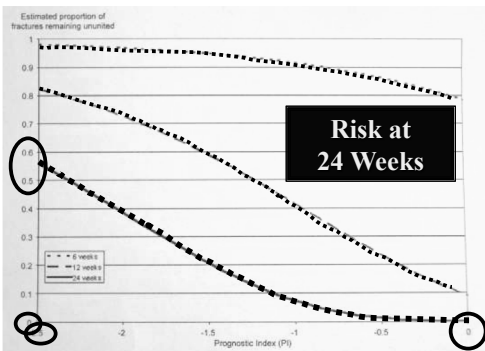
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## Prognostic Index



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## Robinson '04

Age (yr)	Displaced		Comminuted		Displaced and Comminuted	
	Females	Males	Females	Males	Females	Males
25	19%	8%	7%	3%	33%	20%
35	20%	11%	8%	4%	35%	21%
45	25%	14%	10%	5%	37%	25%
55	28%	18%	12%	6%	42%	29%
65	33%	20%	18%	7%	47%	33%

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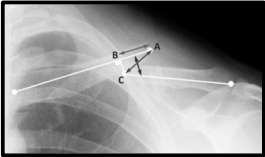
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## Risk Factors

- Murray (displaced) '13
- 941 Patients
  - ◆ Smoking
  - ◆ Comminution
  - ◆ Displacement
  - ◆ Sex
  - ◆ Overlap
  - ◆ Translation




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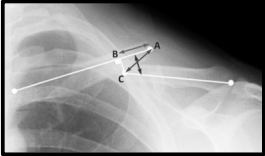
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## Risk Factors

- Murray (displaced) '13
- 941 Patients
  - ◆ Smoking
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# Murray 2013

TABLE II "Ready Reckoner" for Estimating the Risk of Nonunion

Overall Displacement (mm)	Risk (%)			
	Noncomminuted Fracture in Nonsmoker	Comminuted Fracture in Nonsmoker	Noncomminuted Fracture in Smoker	Comminuted Fracture in Smoker
10	2	3	6	10
15	3	6	12	19
20	7	12	23	34
25	14	23	39	52
30	26	39	57	70
40	62	74	86	92

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# Level One Evidence

Plate Fixation Versus Nonoperative Treatment for Displaced Midshaft Clavicular Fracture

Study	No. of Patients Randomized (Op./Nonop)	No. of Patients with Nonunion (Op./Nonop)
COTS, 2007 <sup>7</sup>	142	76 (34/42)
Robinson, 2013 <sup>19</sup>	60 (29/31)	50 (26/24)
Virtanen, 2012 <sup>5</sup>	200 (95/105)	178 (86/92)
Woltz, 2017 <sup>22</sup>	60 (28/32)	51 (26/25)
	160 (86/74)	148 (83/65)

**614 Patients**

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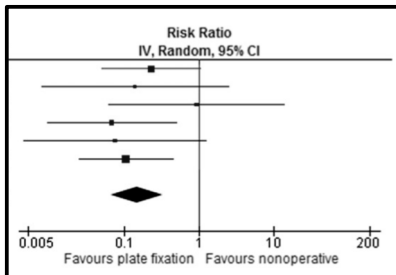
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# Nonunion

- Operative = 2%
- Nonoperative = 16%




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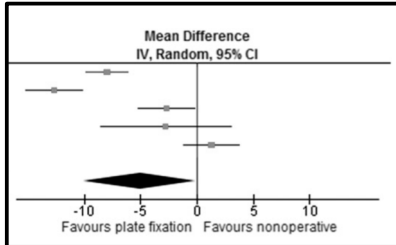
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## DASH

- Operative < Nonoperative
- 5 Points (all); 1 Point (united)




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## Secondary Operation

- All:
- Operative                      18%
- Nonoperative                  17%
- Adverse events
- Operative                      7%
- Nonoperative                  16%

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## Shortening

- Several articles discuss
- > 2 cm quoted
- Indication for surgery
- Predisposes to poor outcome
- Definition???

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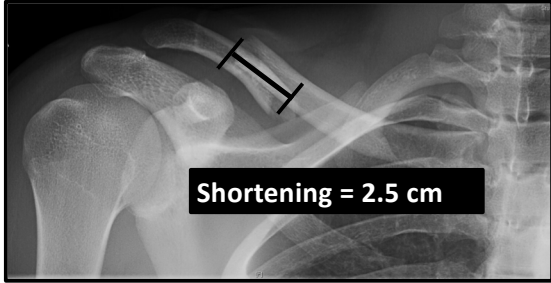
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### Example




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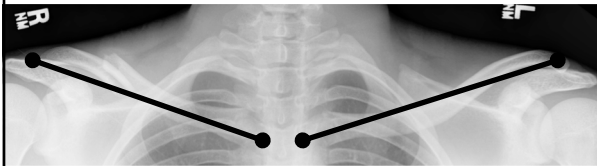
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### Better Way



Shortening = 1.2 cm

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### Length Determination in Midshaft Clavicle Fractures: Validation of Measurement

*Vinzenz Smekal, MD,\* Christian Deml, MD,\* Alexander Irenberger, MD,\*  
Christian Niederwanger, MD,† Martin Lutz, MD,\* Michael Blauth, MD,\*  
and Dietmar Krappinger, MD PhD\**

- **30 Patients**
- **AP, tilted shoulders, PA chest, CT**
- **15 Degree tilted shoulder**
  - ◆ **AP = 7.4%**
  - ◆ **Panoramic shoulder = 2.2%**

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# Shortening?

The Influence of Shortening on Clinical Outcome in Healed Displaced Midshaft Clavicular Fractures After Nonoperative Treatment

E.B. Goudie, MRCSEd, N.D. Clement, FRCSEd(Tr&Orth), PhD, I.R. Murray, MRCSEd, PhD, C.R. Lawrence, FRCSEng(Tr&Orth), M. Wilson, A.J. Brooksbank, FRCSEd(Tr&Orth), and C.M. Robinson, FRCSEd(Tr&Orth)

Investigation performed at The Edinburgh Shoulder Clinic, The Royal Infirmary of Edinburgh, Edinburgh, United Kingdom




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# Shortening

TABLE VI Mean DASH and Constant Scores at Each Follow-up Time Point Using 1 cm and 2 cm of Shortening as Cutoff Points

Outcome Measure	Shortening					
	1-cm Cutoff			2-cm Cutoff		
	≤1 cm* (N = 24)	>1 cm* (N = 24)	P Value	≤2 cm* (N = 43)	>2 cm* (N = 5)	P Value
<b>DASH</b>						
6 wk	30.1 (20.5)	26.8 (18.7)	0.44	27.6 (20.0)	35.6 (14.6)	0.35
3 mo	10.4 (10.7)	15.5 (18.4)	0.27	13.2 (15.8)	12.8 (12.9)	0.98
6 mo	3.8 (5.8)	9.8 (13.7)	0.11	7.0 (11.8)	8.1 (6.8)	0.82
12 mo	2.7 (3.6)	6.7 (14.2)	0.22	5.0 (10.8)	1.9 (1.3)	0.51
<b>Constant</b>						
6 wk	64.0 (18.9)	68.7 (18.1)	0.39	66.4 (19.1)	66.3 (14.1)	0.99
3 mo	82.2 (12.3)	78.1 (17.3)	0.36	79.5 (15.7)	84.7 (8.0)	0.47
6 mo	90.2 (8.4)	85.5 (15.2)	0.26	87.2 (12.9)	89.4 (8.1)	0.68
12 mo	89.6 (8.9)	87.6 (17.6)	0.67	88.1 (14.2)	92.7 (5.8)	0.48

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# Nonunion

- How bad is it?
- How important to avoid it?
- Treatment?
- Results?




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## Surgical Indications

- Pain!!!




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## Treatment

- Basic fracture principles

- Diaphyseal

- Open
- Re-canalize

- Stable fixation

- Possible bone graft




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## Results..Union

• Olsen '95	(16)	94%
• Davids '96	(14)	100%
• Bradbury '96	(32)	97%
• Ebraheim '97	(16)	94%
• Boyer '97	(7)	100%
• Larson '99	(12)	92%
• Sadiq '02	(13)	100%
• Rosenberg '07	(13)	100%
• Rolf '08	(24)	100%
• McKee '08	(38)	95%

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## Outcome Clinical

- **McKee '08**
  - ♦ 32/36 (89%) satisfied with the procedure
  - ♦ Mean DASH score 12.5 (0 to 58)
  - ♦ Mean SF-36 score 75.9 ± 17.1
- **Khan '08**
  - ♦ Locking plates..osteopenia
  - ♦ DASH 24 (from 42)



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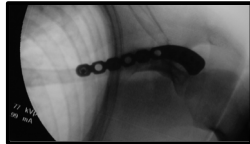
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## Clinical Outcome

- **Rosenberg '07**
- **13 Patients**
- **All united**
- **46% Returned to priors**
- **3 / 10 Pain free**



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## Functional Outcome?

- **Potter, et al '07**
  - ♦ 15 Acute, 15 Nonunions (9 yrs older)
  - ♦ Satisfaction: Acute 9.8, Delayed 9.6
  - ♦ Union 100%
  - ♦ DASH
  - ♦ BTE testing



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## Potter, et al

	Delayed fixation	Early fixation
DASH	7.2	3.0
CSS	89	95

Variable	Delayed fixation (%)	Early fixation (%)
Strength		
Flexion	93	94
Abduction	97	97
External rotation	90	97
Internal rotation	96	97
Endurance		
Flexion	80	109
Abduction	81	107

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## When to Pull the Trigger?

- Das, et al '14

- No difference



- < 3 Weeks

- 3 - 12

- Watch and wait OK!

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## Technique

- If you do it

- Be careful!!!

- Real risks

- Bone is crooked!

- Minimize stripping

- Go loooooooooooooooooong




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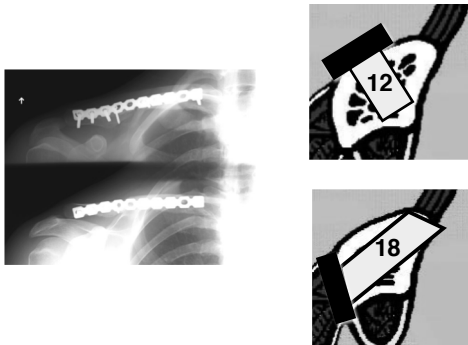
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### Plate Location



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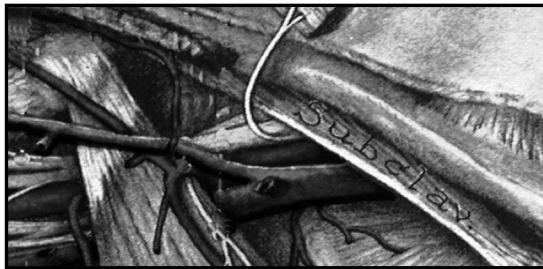
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### Plate Location



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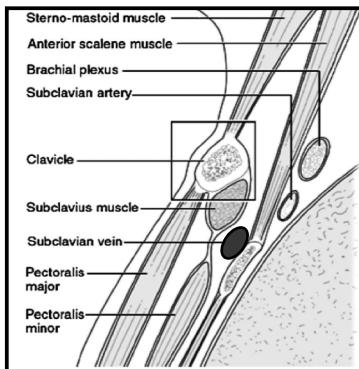
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### Plate Location



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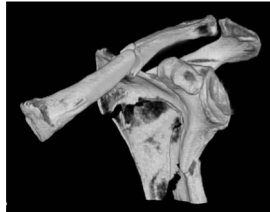
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## Anterior Inferior Plating



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## Superior or Anterior?

Midshaft Fractures of the Clavicle: A Meta-analysis  
Comparing Surgical Fixation Using Anteroinferior Plating  
Versus Superior Plating

*Alex Nourian, BS,\* Satvinder Dhaliwal, MPH,† Sitaram Vangala, MS,† and Peter S. Vezzeridis, MD‡*

- **No difference in:**

- ◆ Union
- ◆ Implant failure
- ◆ DASH or Constant

- **More symptoms and removal**

**Superior!**

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**Clavicle Fractures:  
Which to Fix???**

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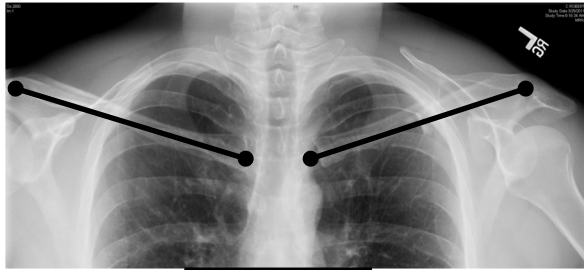
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**This One**



2.2 cm

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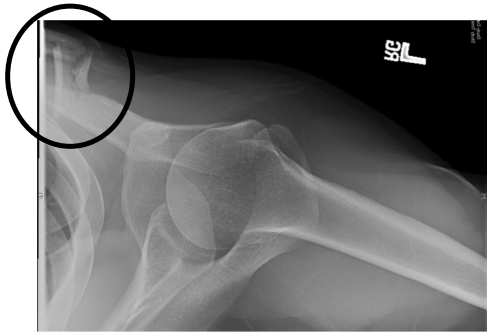
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**This One**



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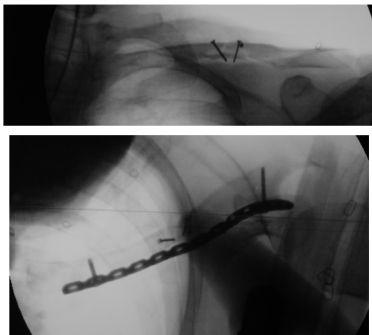
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**This One**



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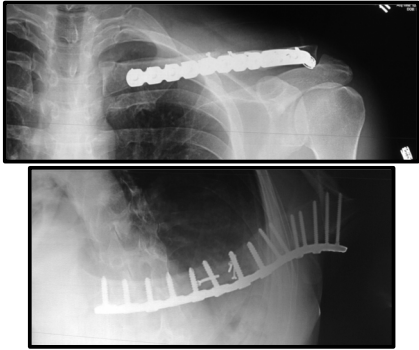
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**This One**



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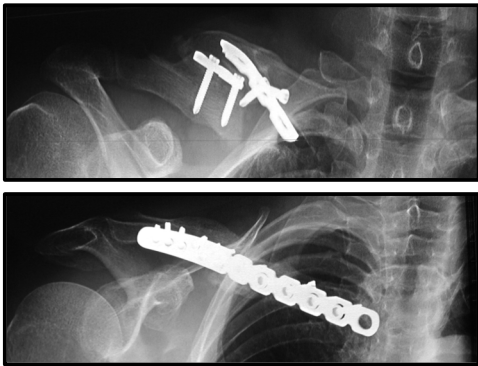
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**Not This One**



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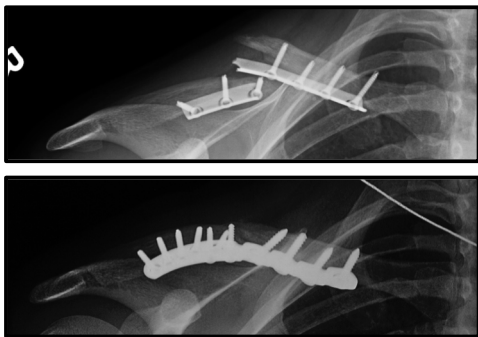
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**Not This One**



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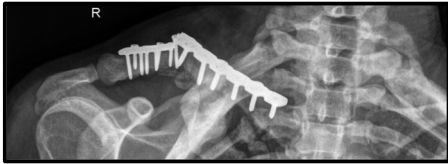
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**Not This One**



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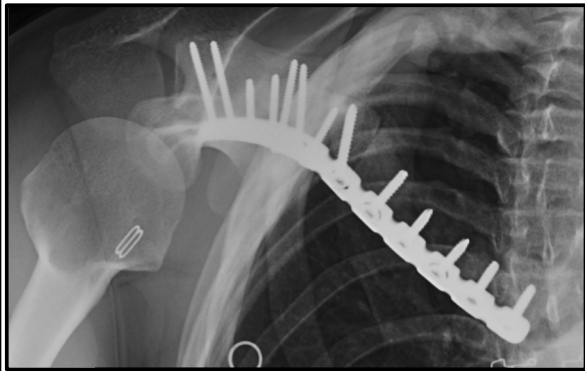
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**Not This One**



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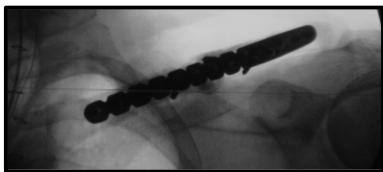
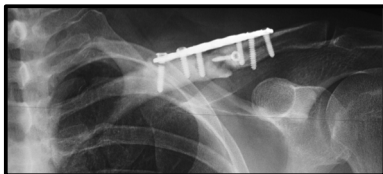
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**Not This One**



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## This One?



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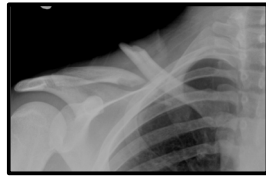
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## Decisions

- Nondisplaced.....NO!
- Displaced?
- Comminuted?
- Smokers?
- All risks?
- Estimate nonunion and the patient decides!!



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## Displaced

- 100 Patients c displaced fx
- 80 Operations on patients that would have healed
- 20 That could have similar outcome if did later....
- 10% - 20% Secondary procedures!

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## My Opinion...

- **Very short (> 2cm)**
- **Very inferior**
  - Droop!!
- **Floating shoulder?**
- **Neurologic compromise**
- **Skin at risk**
- ***Painful nonunions***



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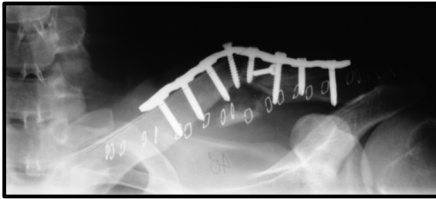
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# Thank You



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