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The Treatment of Clavicle Fractures in 2023

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I (and/or my co-authors) have something to disclose.

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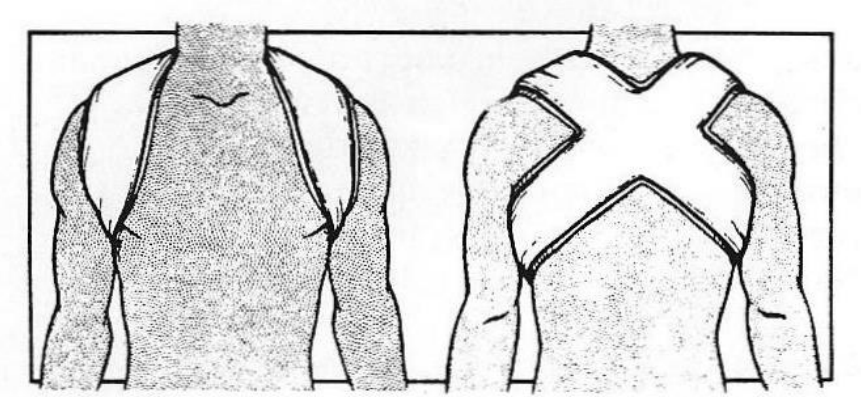
This talk focuses on completely displaced fractures in healthy patients aged 16 -60 years

Literature

- Neer CS, “Nonunion of the clavicle” JAMA 1960, reported 3 nonunions in 2235 fractures treated closed (nonunion rate 0.1%)

- Rowe CR, “An atlas of anatomy and treatment of midclavicular fractures” CORR 1968, reported 4 nonunions in 566 fractures treated closed (nonunion rate 0.9%)



Conventional Dogma

- Outcome " ….generally good…."
- Displaced fractures of the clavicle "…generally do well with non-operative treatment…"
- Nonunion rate <1% (Neer – 3 / 2239 cases)
- "Malunions of the clavicle require no treatment…"
- Operating on a clavicle fracture: A bad idea !

Clavicle nonunion

Is There a Problem?

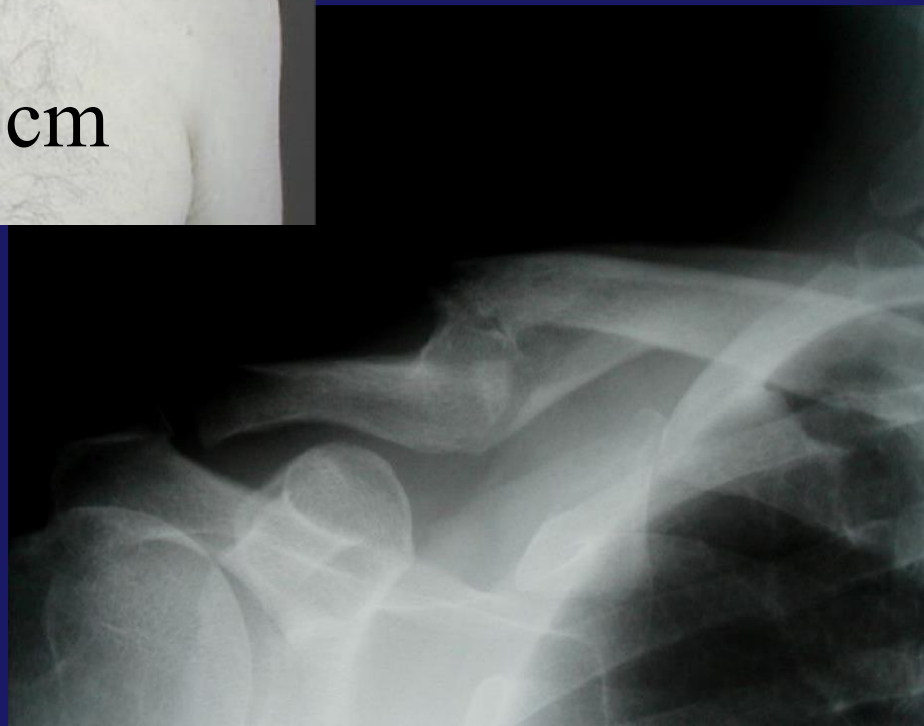
- **Hill et al JBJS 1999**
- **"Closed treatment of displaced middle-third fractures of the clavicle gives poor results"**

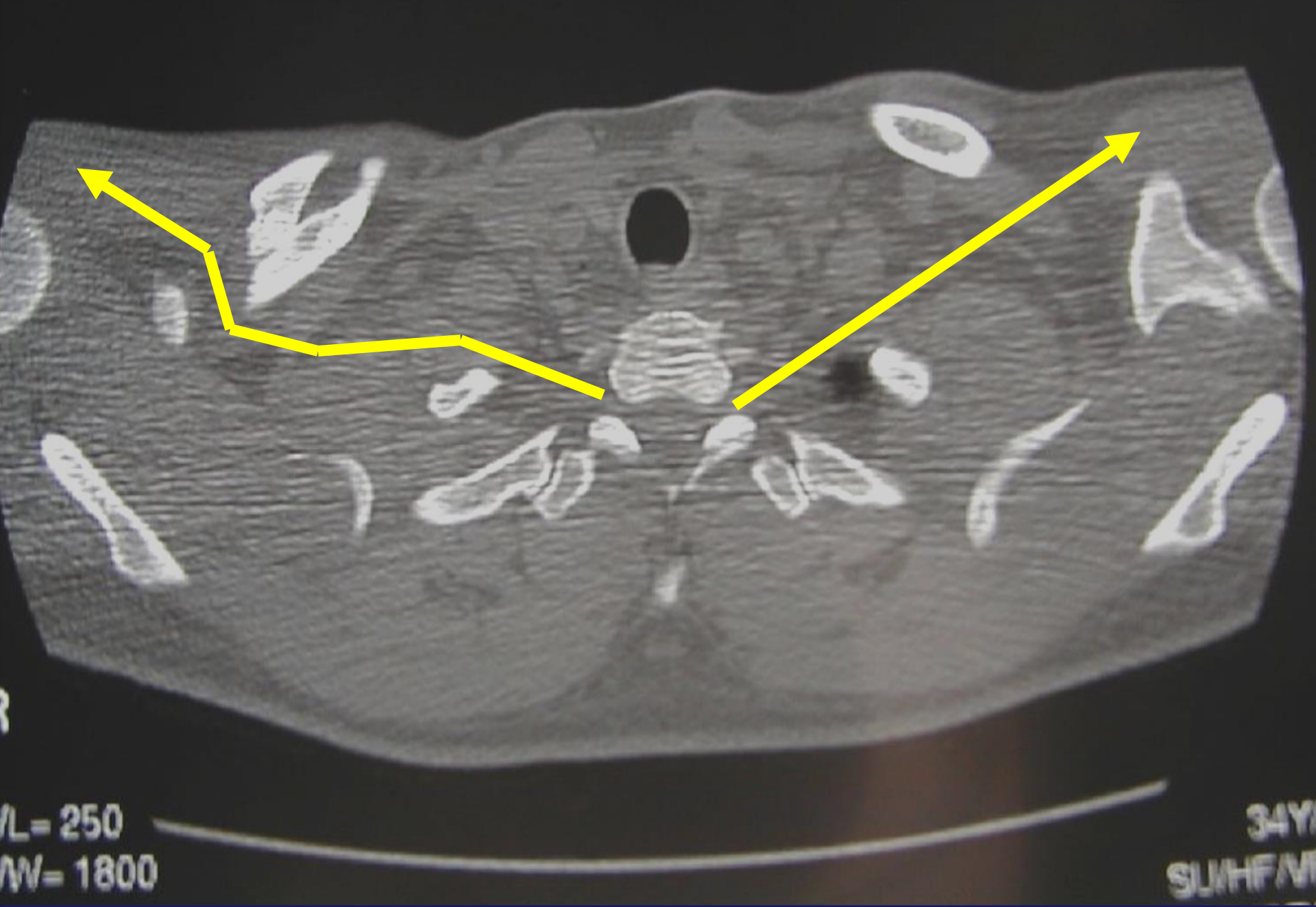
- **Patient-oriented outcome - 31% poor**
- **15% nonunion**
- **Associated with shortening > 2 cm**

J. A. - California

- "I am a 22 year old male living in the United States. I broke my collarbone when I was 15 and surgery was not performed even though the bone were quite overlapped. And I was told by my orthopaedist that after 6-9 months I would be fine. Well, I'm far from that. I know things are out of place. I have tried for quite some time now and have not been able to find the help that I need."


Mean shortening 2.9 cm

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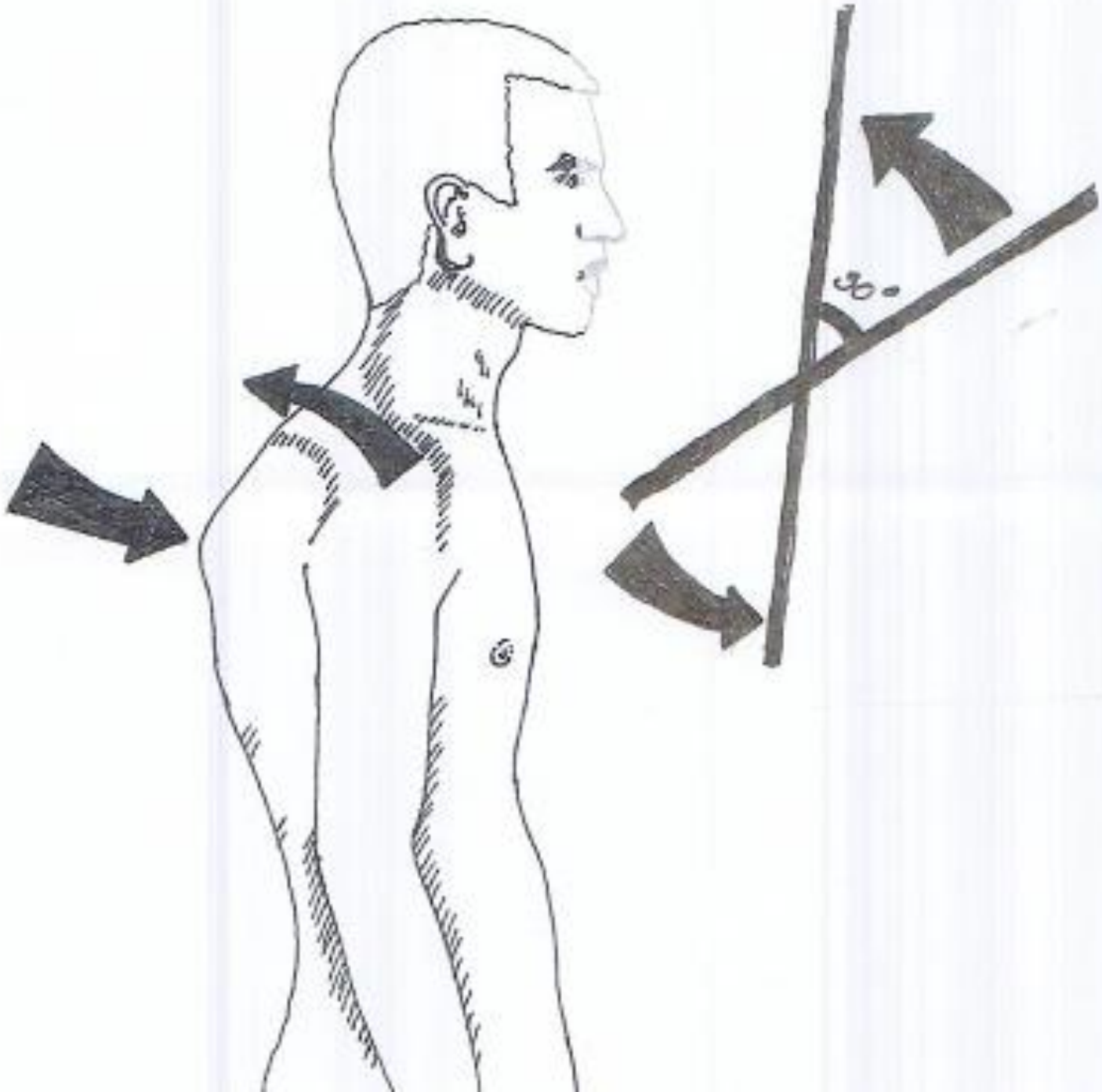
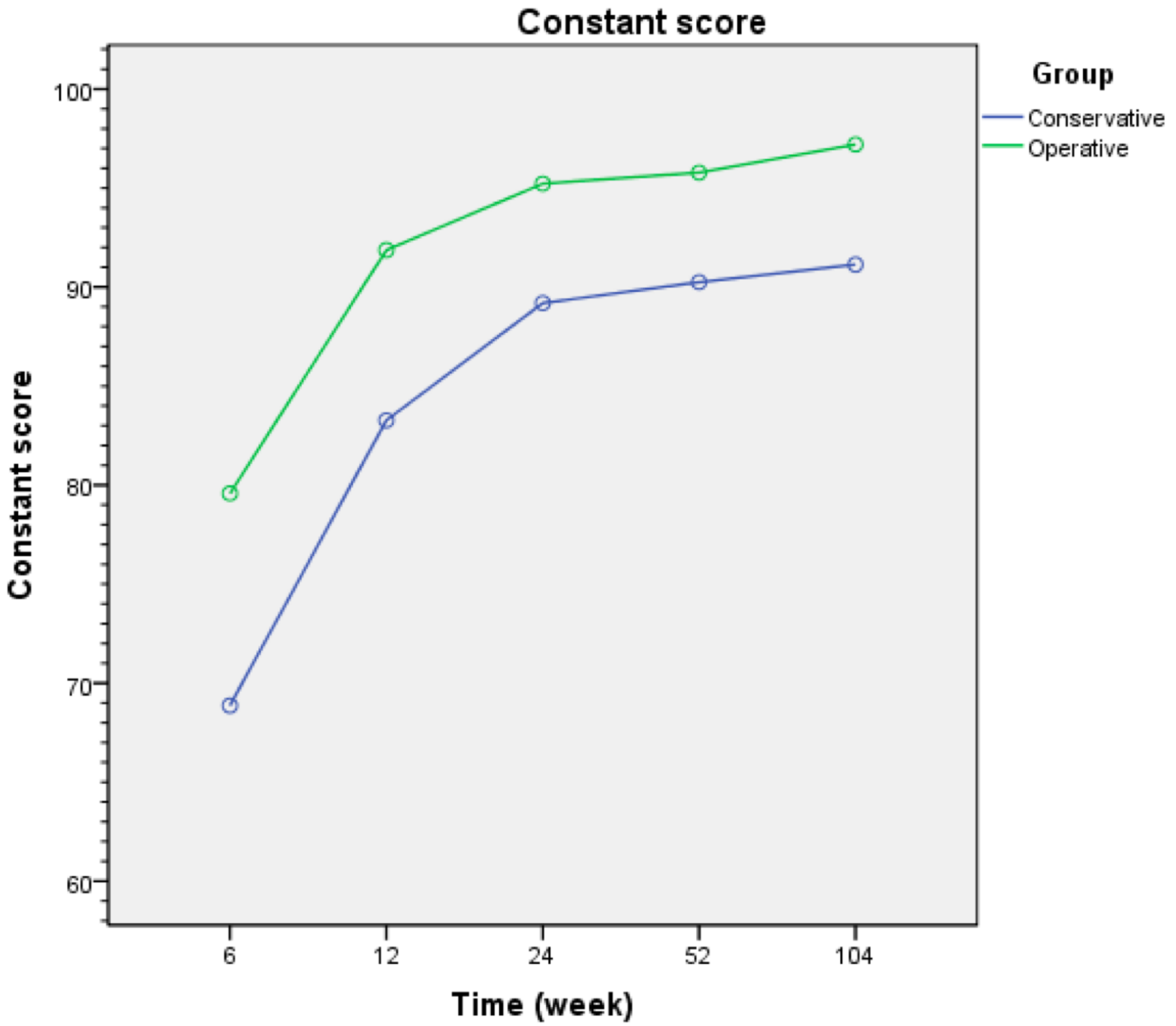

30°

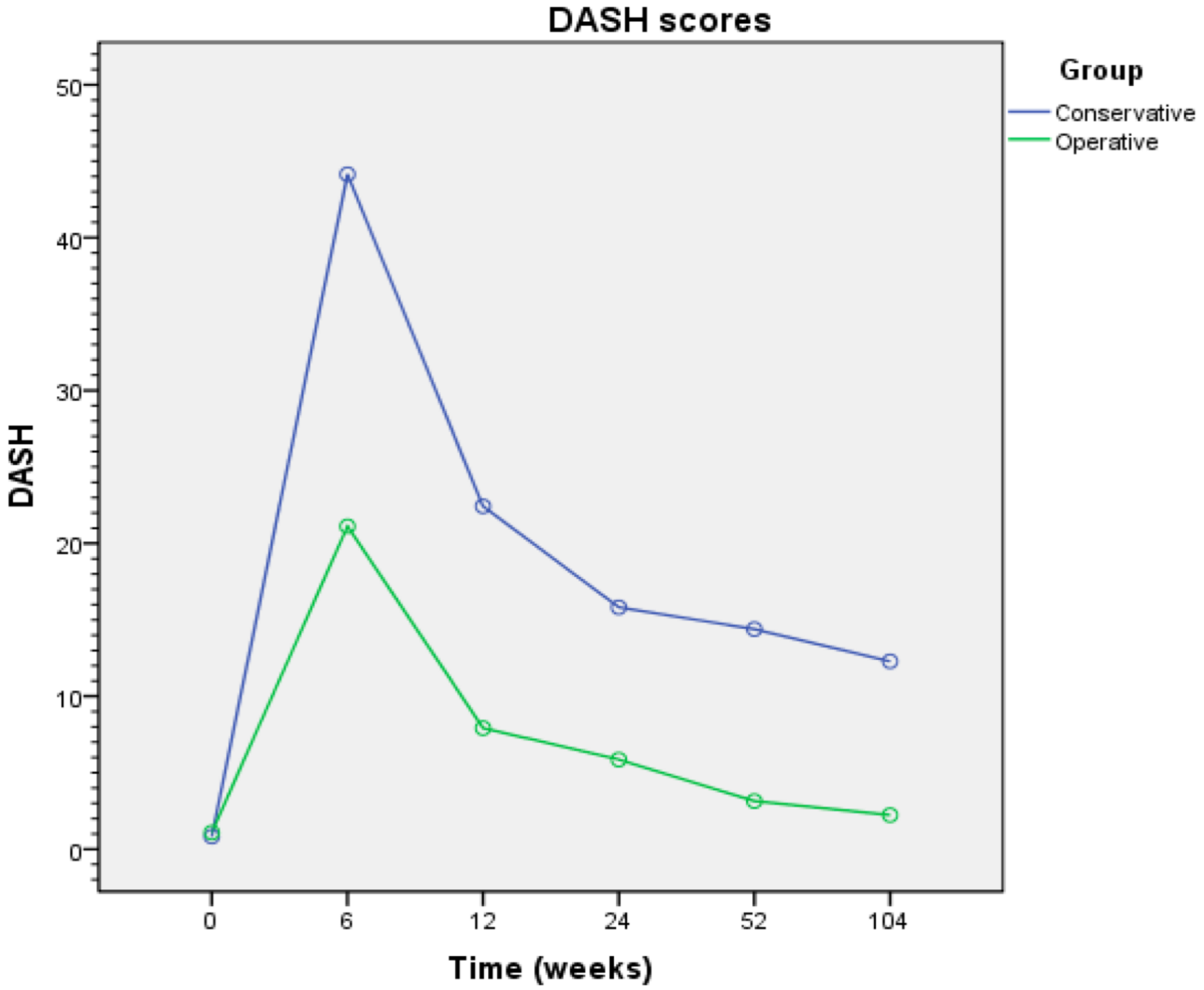
Scapular winging following malunion and nonunion of the clavicle

Nonoperative Treatment Compared with Plate Fixation of Displaced Midshaft Clavicular Fractures

A Multicenter, Randomized Clinical Trial

By the Canadian Orthopaedic Trauma Society


Constant score
Group
Conservative
Operative
100
90
80
70
60
Constant score
6
12
24
52
104
Time (week)


DASH scores
Group
Conservative
Operative
DASH
50
40
30
20
10
0
0
6
12
24
52
104
Time (weeks)

Operative Versus Nonoperative Care of Displaced Midshaft Clavicular Fractures: A Meta-Analysis of Randomized Clinical Trials

Robbin C. McKee, Daniel B. Whelan, MD, FRCS(C), Emil H. Schemitsch, MD, FRCS(C), and Michael D. McKee, MD, FRCS(C)

Investigation performed at St. Michael's Hospital and the University of Toronto, Toronto, Ontario, Canada

Background: Recent studies have suggested benefits following primary operative fixation of substantially displaced midshaft fractures of the clavicle. We reviewed randomized clinical trials of operative versus nonoperative treatment of these fractures, and pooled the functional outcome and complication rates to arrive at summary estimates of these outcomes.

Methods: A systematic review of the literature was performed to identify studies of randomized clinical trials comparing operative versus nonoperative care for displaced midshaft clavicular fractures.

Results: Six studies (n = 412 patients, mean Detsky score = 15.3) were included. The nonunion rate was higher in the nonoperatively treated patients (twenty-nine of 200) than it was in patients treated operatively (three of 212) ($p = 0.001$). The rate of symptomatic malunion was higher in the nonoperative group (seventeen of 200) than it was in the operative group (0 of 212) ($p < 0.001$).

Conclusions: Operative treatment provided a significantly lower rate of nonunion and symptomatic malunion and an earlier functional return compared with nonoperative treatment. However, there is little evidence at present to show that the long-term functional outcome of operative intervention is significantly superior to nonoperative care.

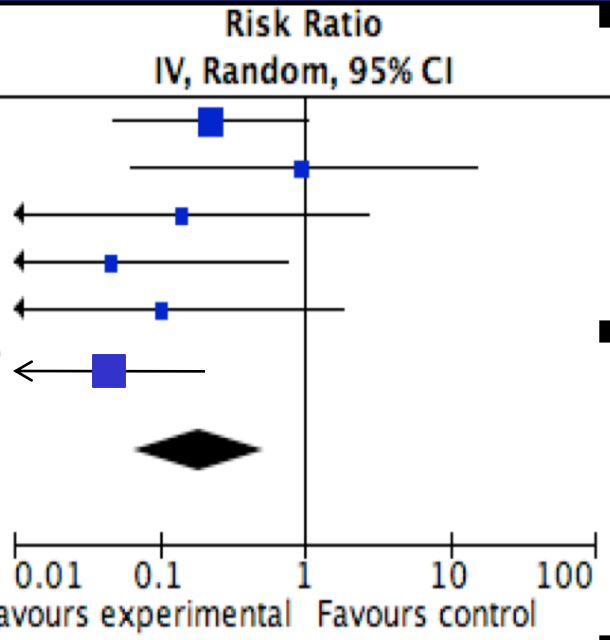
Level of Evidence: Therapeutic Level I. See Instructions for Authors for a complete description of levels of evidence.

Nonunion

Study or Subgroup	Operative Events	Operative Total	Nonoperative Events	Nonoperative Total	Weight	Risk Ratio IV, Random, 95% CI
COTS 2007	2	62	7	49	46.0%	0.23 [0.05, 1.04]
Judd 2009	1	29	1	28	14.5%	0.97 [0.06, 14.70]
Smekal 2009	0	30	3	30	12.6%	0.14 [0.01, 2.65]
Smith 2000	0	30	12	35	13.8%	0.05 [0.00, 0.75]
Virtanen 2010	0	28	5	32	13.2%	0.10 [0.01, 1.79]
Robinson 2014	1	94	36	98	54.5%	0.21 (0.01, 0.75)
Total (95% CI)		**214**		**207**	**100.0%**	**0.19 [0.07, 0.54]**
Total events	3		28			

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 2.61$, df = 4 (P = 0.62); $I^2 = 0\%$

Test for overall effect: Z = 3.14 (P = 0.002)

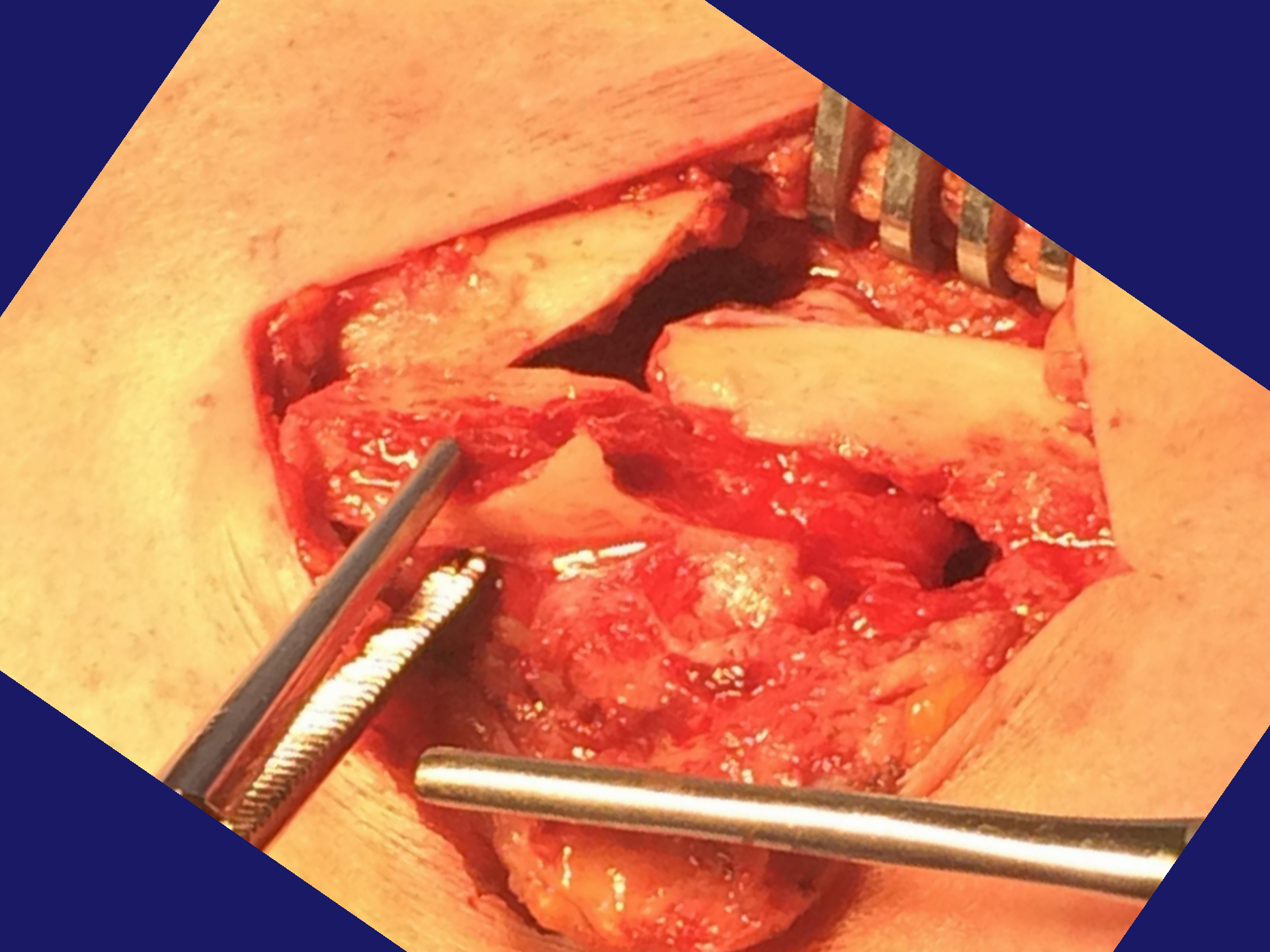


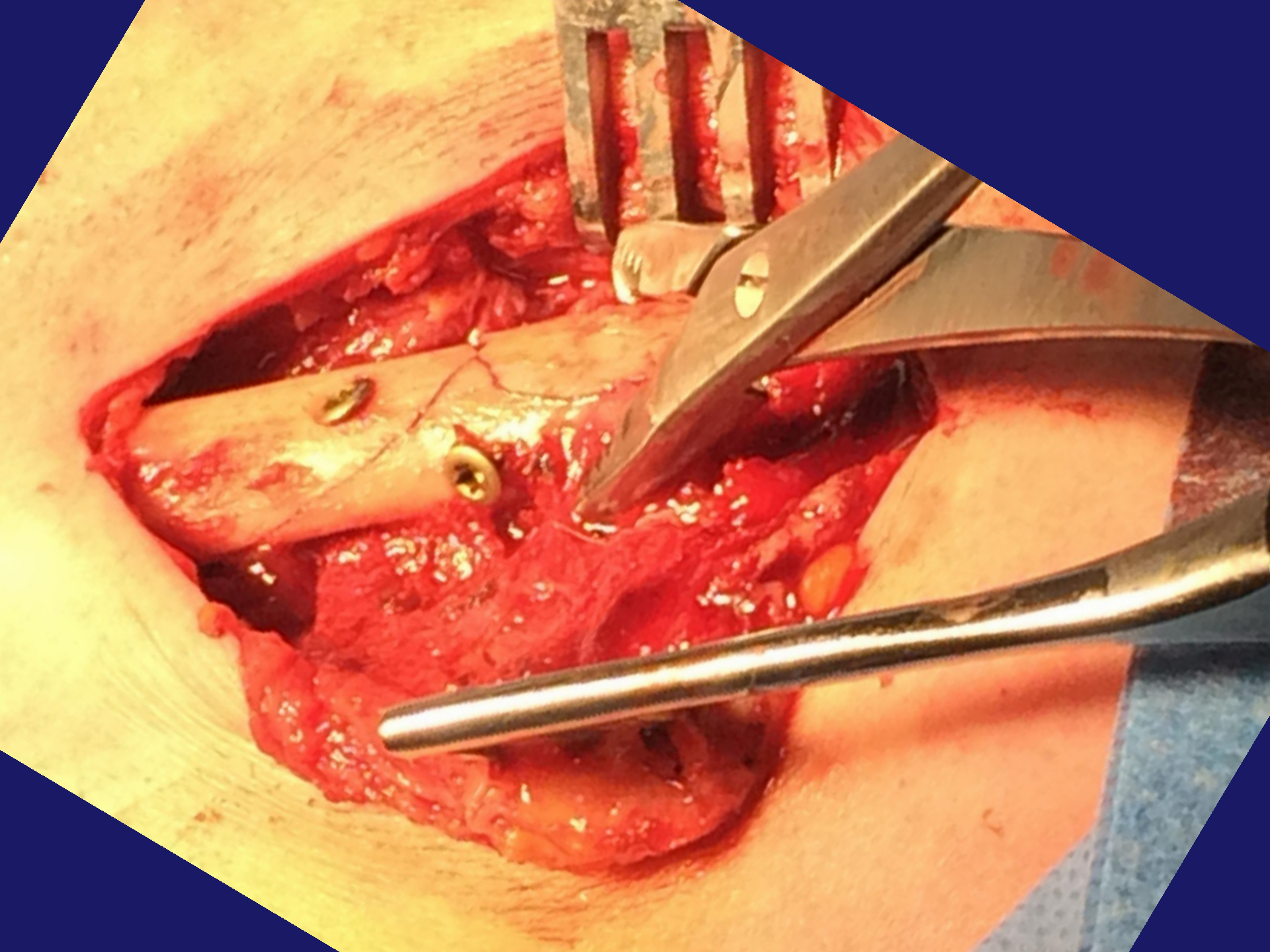
Nonunion / Malunion

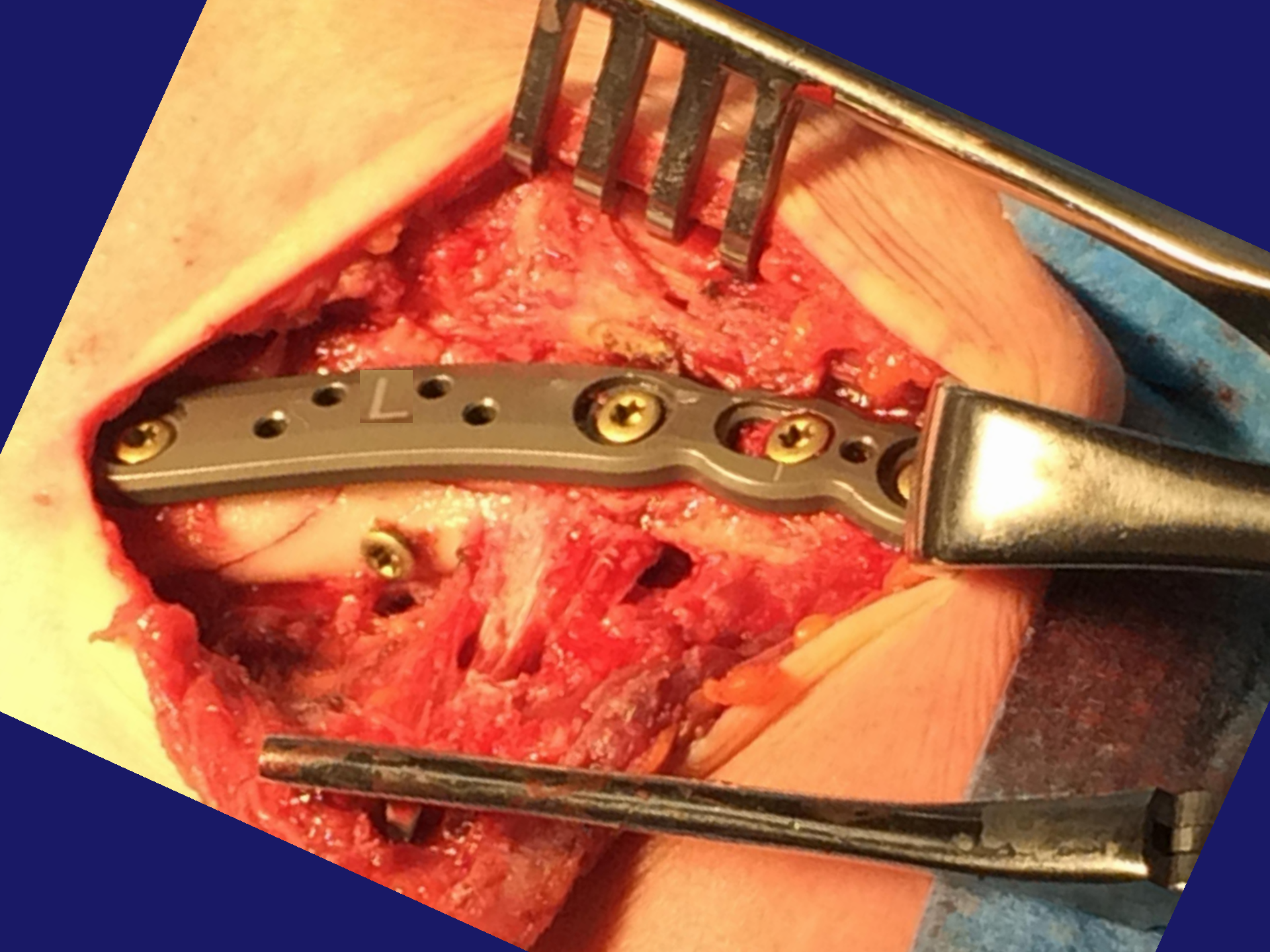
- Primary fixation dramatically reduces the rate of nonunion and symptomatic malunion
- Nounion 15-25% decreased to 1-2%
- Malunion 10-15% decreased to 1-2%

Surgical Technique

- My preferred technique is superior plating with a pre-contoured plate, after lag screw fixation (if possible) of smaller fragments



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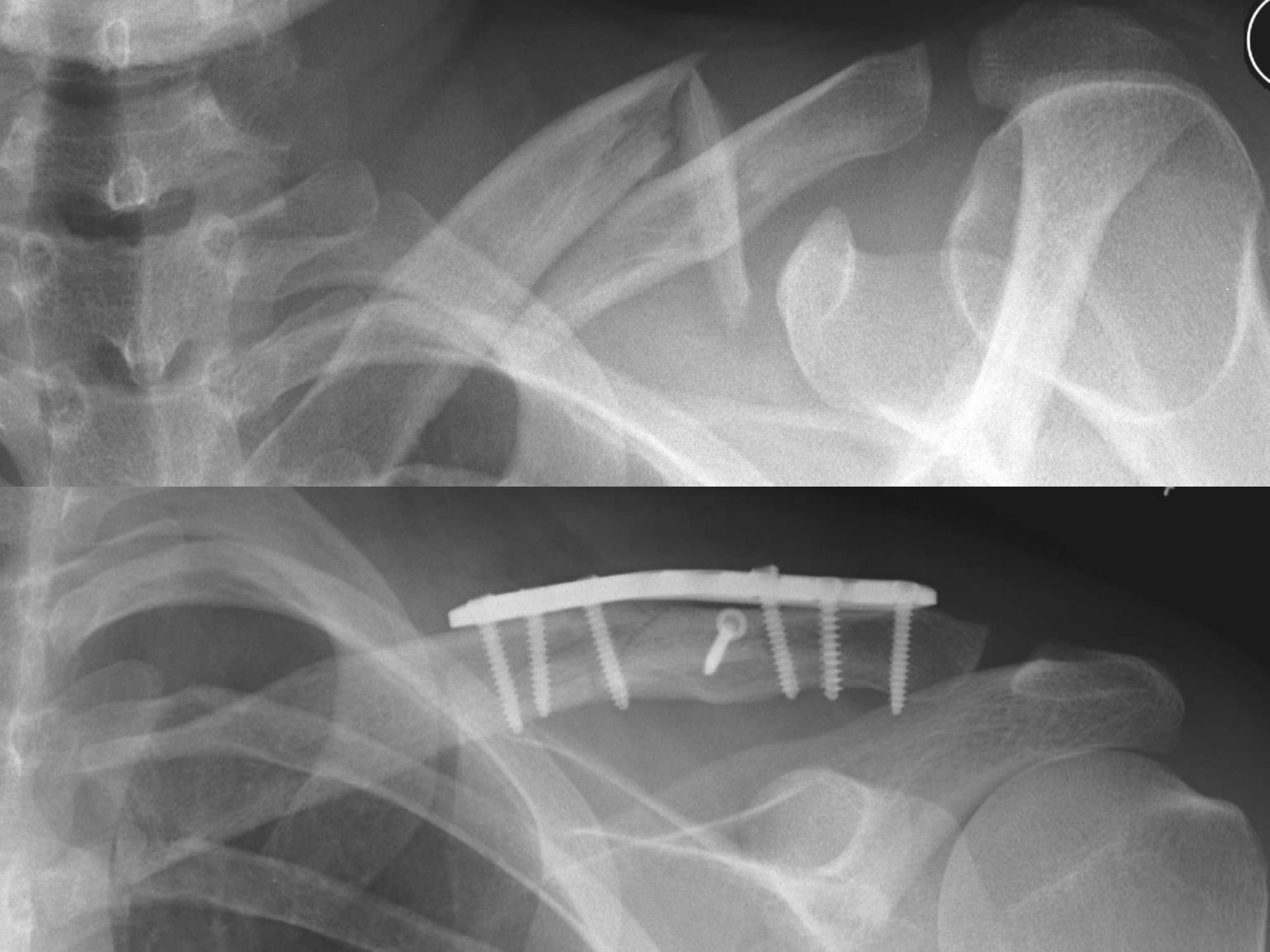


What factors influence me in 2023?

I recommend surgery for:

- Healthy patients
- Increasing displacement (> 2 cm)
- Visible clinical deformity
- Younger, higher demand, esp. sports
- Earlier healing a major benefit to patient
- Scapular winging
- Ipsilateral rib #s
- Floating shoulder

Clavicle Fractures in Trauma Patients

- Tend to displace more with time
- Are / do worse when there are adjacent rib fractures
- When fixed, can allow early UE ambulation
- Benefit from fixation in many cases of multiple injury

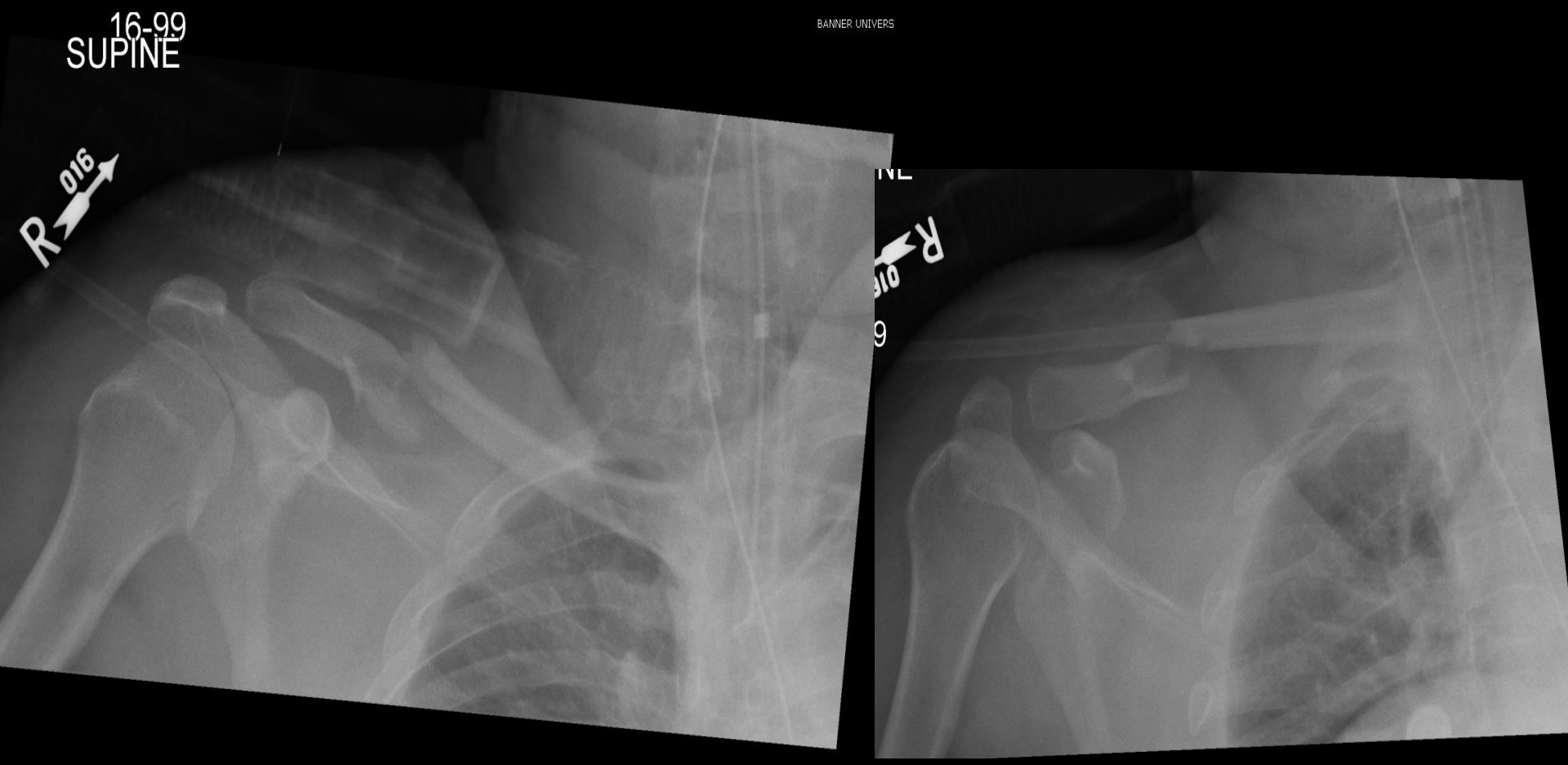
“Natural History”

- Malik A. et al. Positional Change in Displacement of Midshaft Clavicle Fractures: An Aid to Initial Evaluation. J Orthop Trauma. 2017 Jan;31(1)

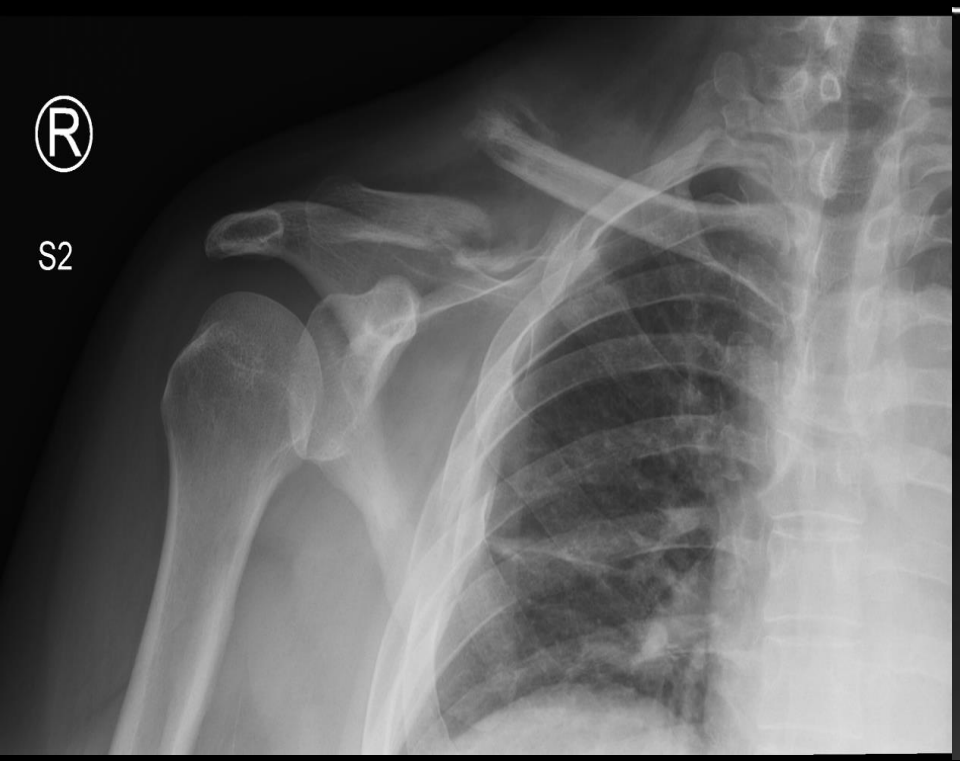
- 80 patient review at a Level I trauma center

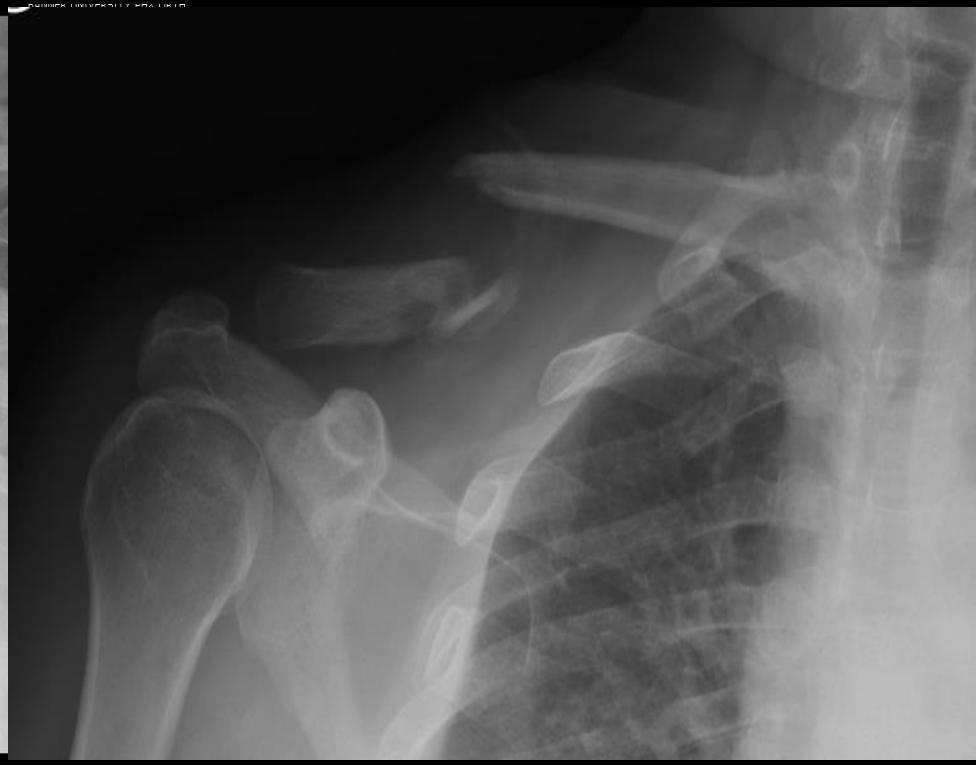
- Patient position is associated with significant changes in fracture displacement. Over 3 times more patients meet operative indications when placed in the upright versus supine position.

Initial Supine Trauma Films



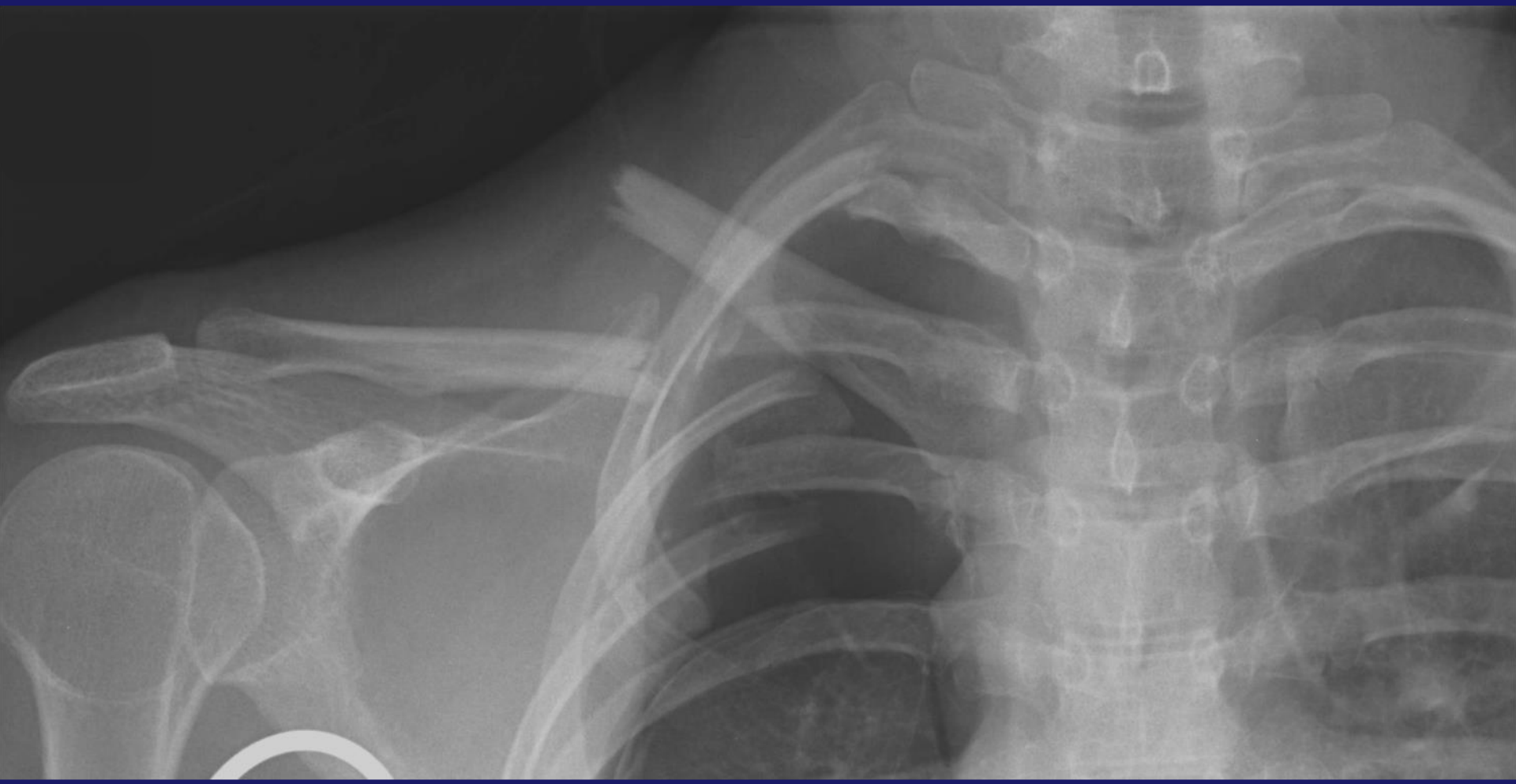
Upright radiographs two weeks later





Intra-operative radiograph

Patients with a displaced clavicle fracture and multiple ipsilateral rib fractures do poorly without surgery



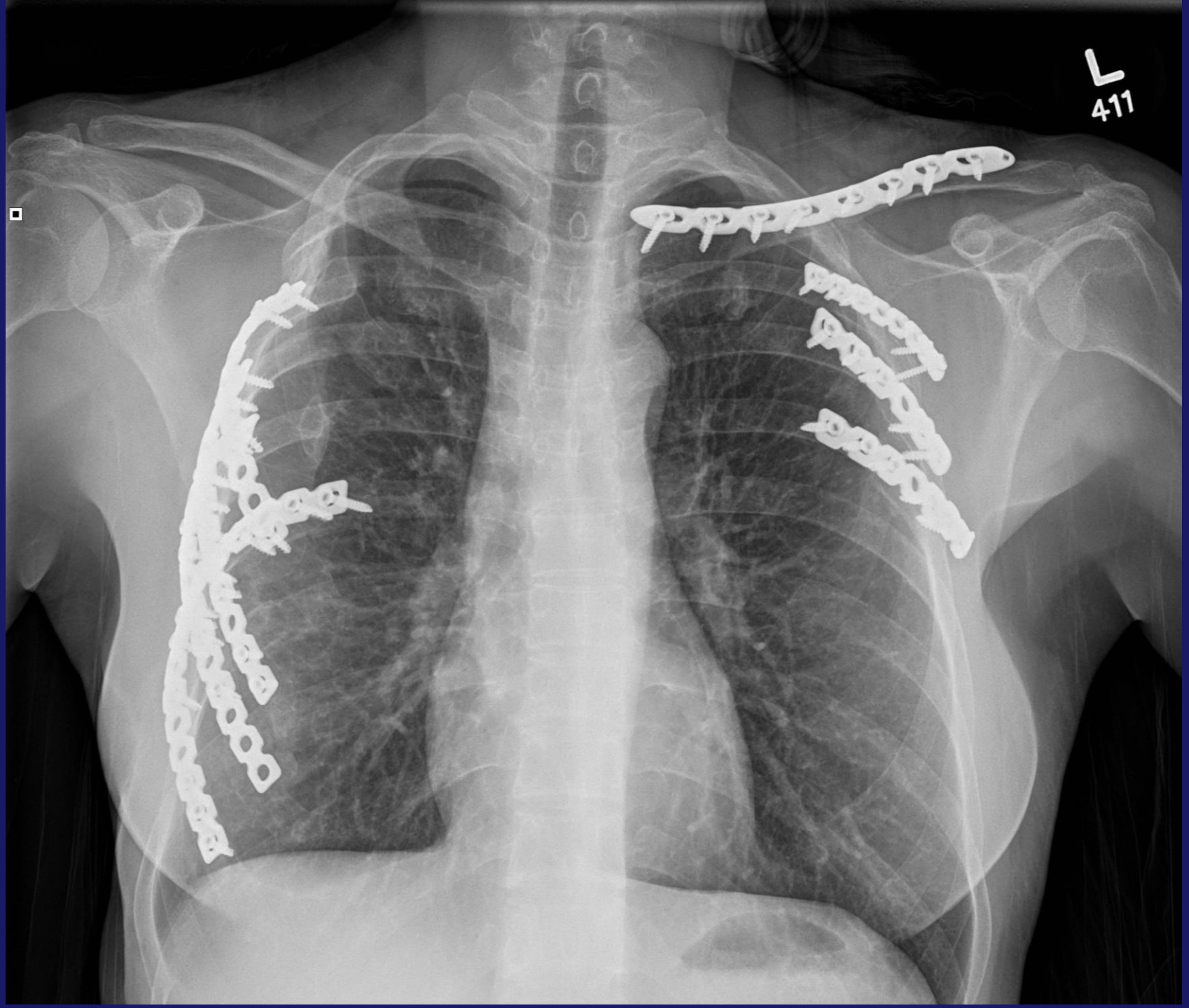
Adjacent rib fractures

- **Stahl D, Ellington M, Brennan K, Brennan M. Association of Ipsilateral Rib Fractures With Displacement of Midshaft Clavicle Fractures. JOT April 2017**

- **149 with rib fractures, 94 without rib fractures**

- **The presence of concomitant ipsilateral rib fractures significantly increased the rate of midshaft clavicle fractures being >100% displaced. In addition, a fracture involving the upper one-third of the ribs significantly increased the rate of the clavicle fracture being >100% displaced on early follow-up.**


L
206
Trauma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411

- **Feb 24, 2015: Patrick Kane out for season with a broken clavicle**

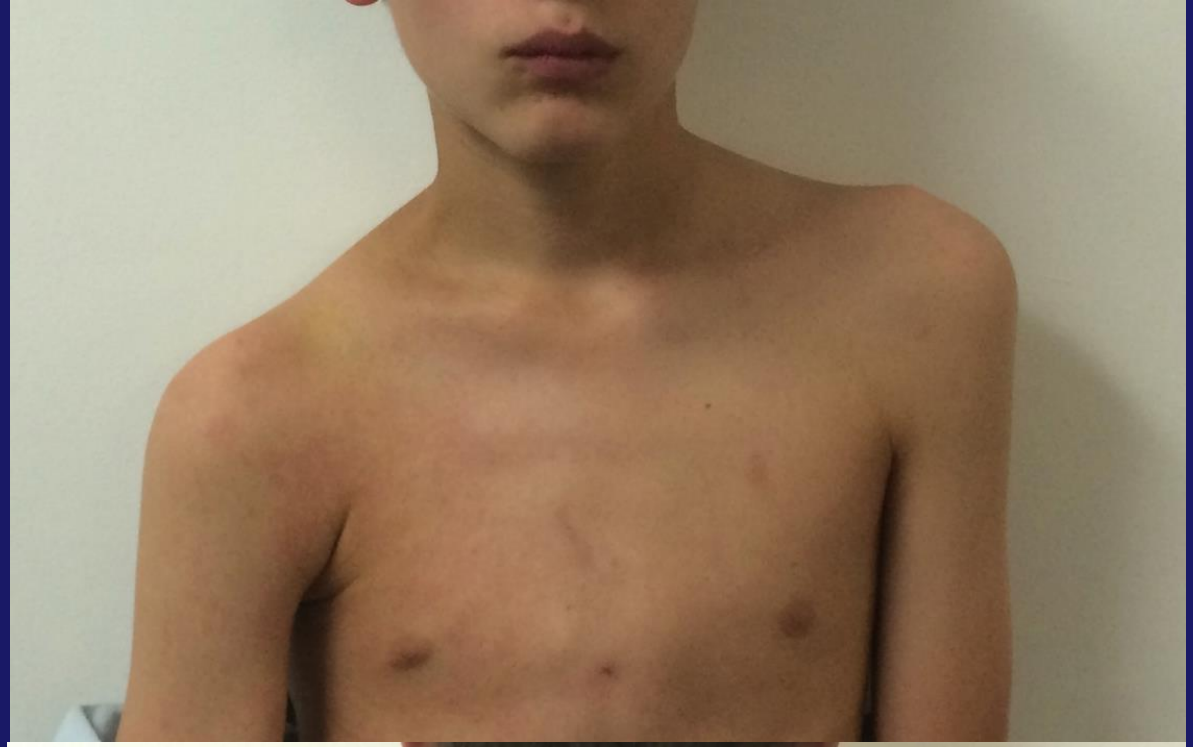
- **Feb 26, 2014: Patrick Kane has surgery on fractured clavicle**

- **April 12, 2015: Patrick Kane Injury Update: Blackhawks Star Cleared to Return for Playoffs**

Current Controversies

- Adolescent clavicle fractures
- Plate type / size / location

- 14 year old boy
- Dominant arm
- High level golfer



Current Concepts Review

Clavicular Fractures in the Adolescent

Midhat Patel, MD, Benton E. Heyworth, MD, Niloofar Dehghan, MD, FRCS, Charles T. Mehlman, DO, MPH, ATC, and Michael D. McKee, MD, FRCS

- Current evidence suggests that the majority of clavicular fractures in adolescents can and should be treated nonoperatively.
- Although rare, in certain patients or fracture patterns, nonoperative management may be associated with delayed healing, prolonged disability, and/or poor functional outcome requiring secondary reconstruction.
- When warranted, primary open reduction and internal fixation with plate and screw application has consistently good outcomes with a low complication rate, with the most common complication being implant-related symptoms requiring a secondary surgical procedure for implant removal.
- Prospective, comparative studies examining operative and nonoperative treatment, including measures of early return to function, injury burden, return to athletic activity, complication and reoperation rates, and shoulder-girdle-specific, long-term outcome measures are warranted to further elucidate which fractures may benefit from primary fixation.

The treatment of clavicular fractures in adolescents (from 10 to 18 years of age) has traditionally been nonoperative, but it is clear that an increasing number of orthopaedic surgeons are recommending operative treatment for these injuries. This is based, at least in part, on multiple, high-quality, comparative trials in adults[1]. These studies demonstrated that primary operative repair of displaced midshaft clavicular fractures

informed, joint decision with their patients and patients' families with regard to the optimal treatment for clavicular injury.

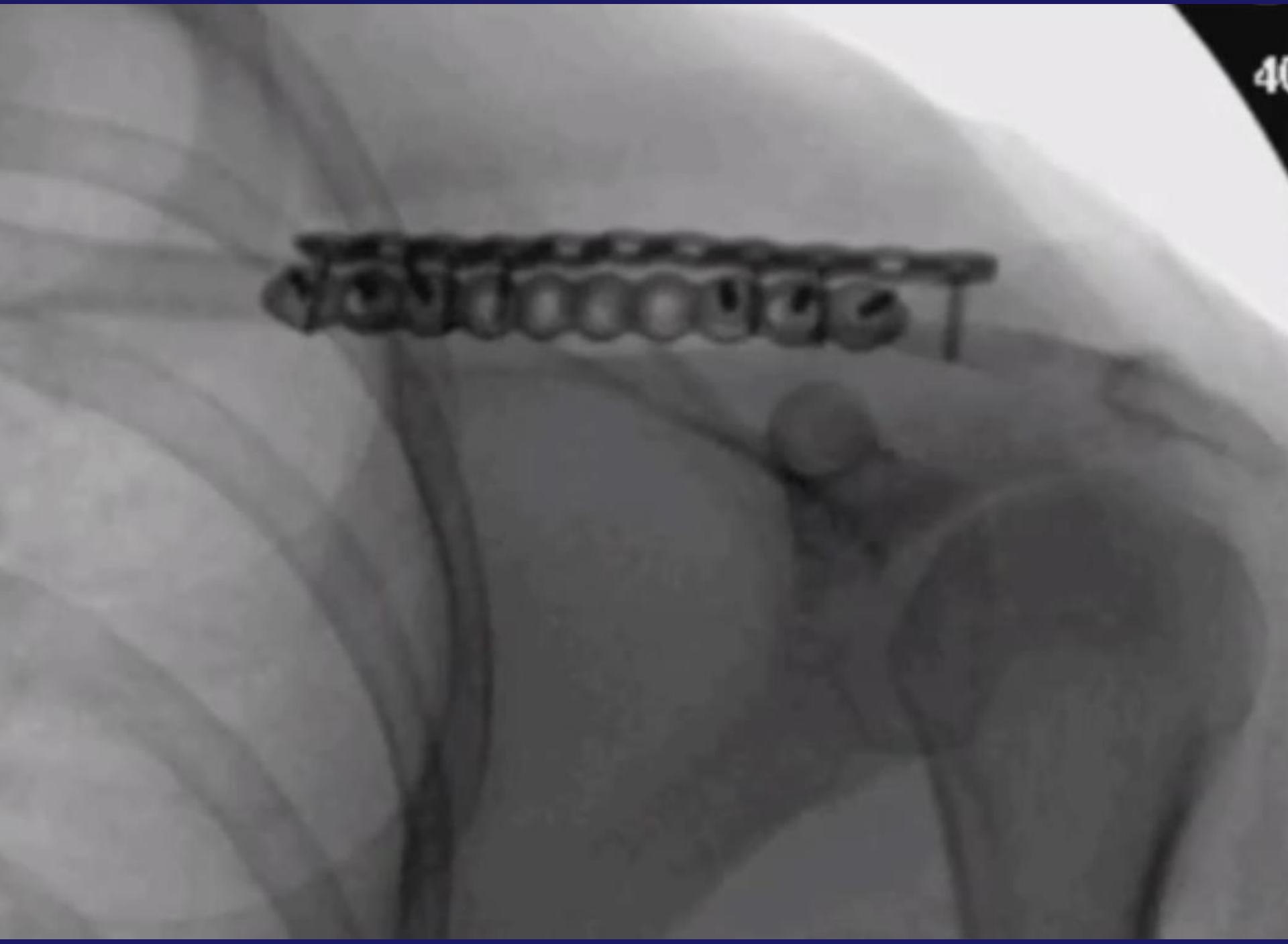
Epidemiology

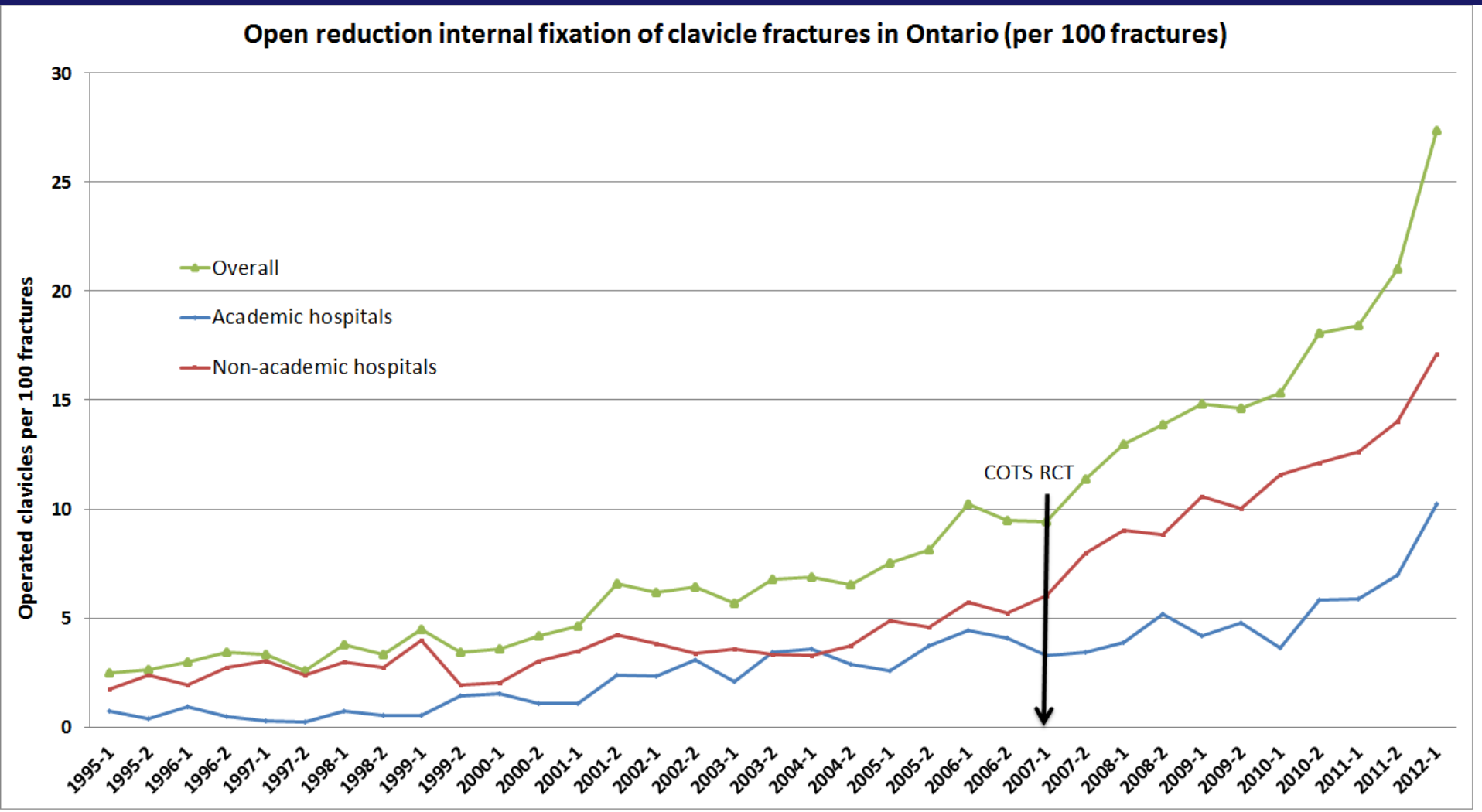
Clavicular fractures account for 10% to 15% of all fractures in children[7,8]. In an epidemiological review of all upper-

Plate choice

- Pelvic reconstruction plates, in isolation, are too small and weak and have a higher mechanical failure rate in multiple series

23 yr old male, 225 lbs




Open reduction internal fixation of clavicle fractures in Ontario (per 100 fractures)
Operated clavicles per 100 fractures
30
25
20
15
10
5
0
Overall
Academic hospitals
Non-academic hospitals
COTS RCT
1995-1
1995-2
1996-1
1996-2
1997-1
1997-2
1998-1
1998-2
1999-1
1999-2
2000-1
2000-2
2001-1
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2006-1
2006-2
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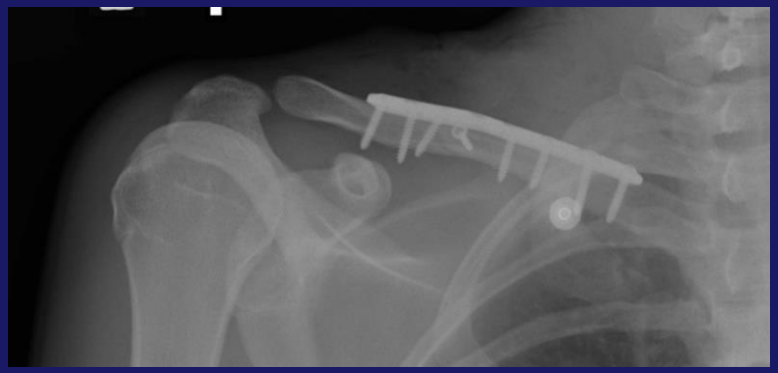
2007-2
2008-1
2008-2
2009-1
2009-2
2010-1
2010-2
2011-1
2011-2
2012-1

Fixing a Clavicle Fracture is a Finesse Operation With a Narrow Risk-Benefit Ratio

Surgical Risk-Benefit Ratio

- Life saving
- Non-op Rx bad
- Indestructible
- Reconstruction difficult
- Ratio: ++++



- Improves U/E function
- Non-op Rx good
- Can fall apart
- Reconstruction reasonable
- Ratio: +

Conclusions - displaced midshaft fracture of the clavicle

- With non-op care, nonunion risk is approximately 15%-20%
- With non-op care, the risk of symptomatic malunion is 15 - 20%
- Deformity (especially shortening) leads to loss of strength and poorer outcome, especially scapular winging
- ORIF is superior to non-operative care in select cases
- ORIF provides more rapid return to function / activity