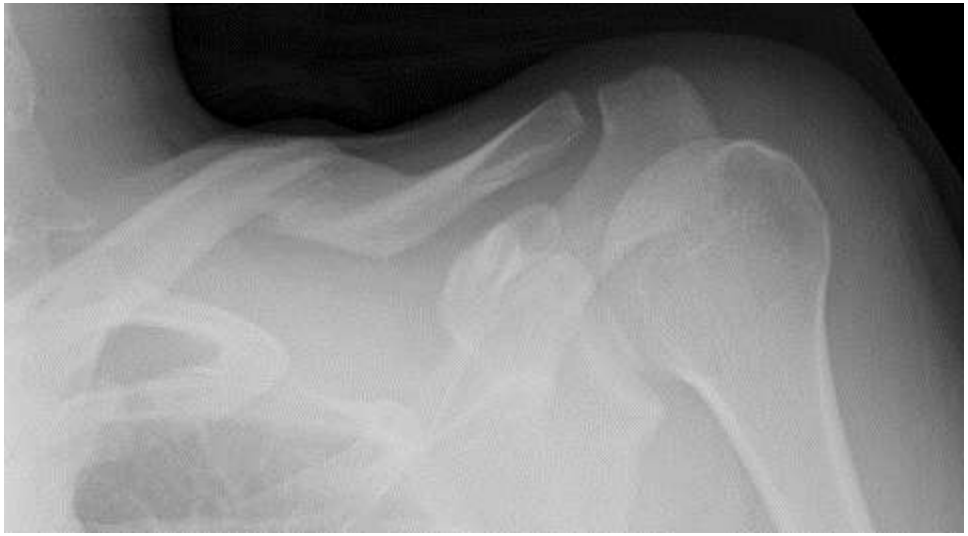
Fractures of midshaft and distal third of the clavicle



Andreas Panagopoulos, MD, Ph.D
Assistant Professor in Orthopaedics
University Hospital of Patras, GR

Evidence based medicine

Early opinion (before and around 1980-1990)

Favor conservative treatment

Rowe stated: “Fortunately for man, nature has endowed the clavicle with excellent reparative powers”.

Current opinion

Favor surgical intervention

CURRENT CONCEPTS REVIEW

Fractures of the Clavicle

By L.A. Kashif Khan, BSc(Hons), MRCSEd, Timothy J. Bradnock, BSc(Hons), MRCSEd, Caroline Scott, MBChB, and C. Michael Robinson, BMedSci, FRCSEd(Orth)

…The traditional view that the vast majority of clavicular fractures heal with good functional outcomes following nonoperative treatment **is no longer valid**.

Recent studies have identified a higher rate of nonunion and specific deficits of shoulder function in subgroups of patients with these injuries.

REVIEW ARTICLE

Midclavicular Fracture: Not Just a Trivial Injury

Deutsches Ärzteblatt International | Dtsch Arztebl Int 2010; 107(41): 711–7

Current Treatment Options

Gereon Schiffer, Christoph Faymonville, Emmanouil Skouras, Jonas Andermahr, Axel Jubel

KEY MESSAGES

- Precise X-ray positioning of the clavicle in two projections is essential for correct analysis of the fracture type.
- No adequate long-term reduction of a displaced midclavicular fracture can be achieved with a rucksack bandage or other such aid.
- Patients with a displaced midclavicular fracture benefit from surgical treatment.
- Simple midclavicular fractures can be managed very elegantly and with high stability by means of an intramedullary titanium nail.
- Complex midclavicular fractures can be treated surgically by insertion of a bridging angle-stable plate.

Historical debate

1930

A METHOD OF FIXATION FOR FRACTURE OF THE CLAVICLE*

BY GORDON MURRAY, M.B., F.R.C.S.(ENG.), TORONTO, ONTARIO, CANADA
From the Toronto General Hospital

* Received for publication on February 29, 1940.

THE JOURNAL OF BONE AND JOINT SURGERY

THE MECHANICS OF AMBULATORY TREATMENT OF FRACTURES OF THE CLAVICLE

BY CHARLES S. YOUNG, M.D., LOS ANGELES,

FIG. 4

Apparatus consisting of a rigid metal strip, bent to allow the occiput to project posteriorly, suspended between wooden blocks.

FIG. 5

Sheet wadding covering stockinet. Felt pads under back, over iliac crests, anterolateral surface of thorax, and inferior to olecranon.

FIG. 6

Inserting extra felt pad between stockinet and original felt over crest of ilium on affected side.

locking serrations, and

FIG. 7

Completed cast. Attention is called to molding-in over iliac crests.

Questions?

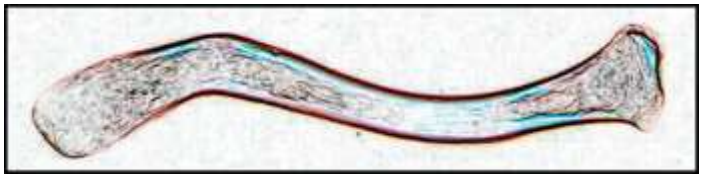
Surgery or Non-surgery?

Which conservative treatment is better?

Which surgical treatment is better?

What is the expected outcome?

Anatomy

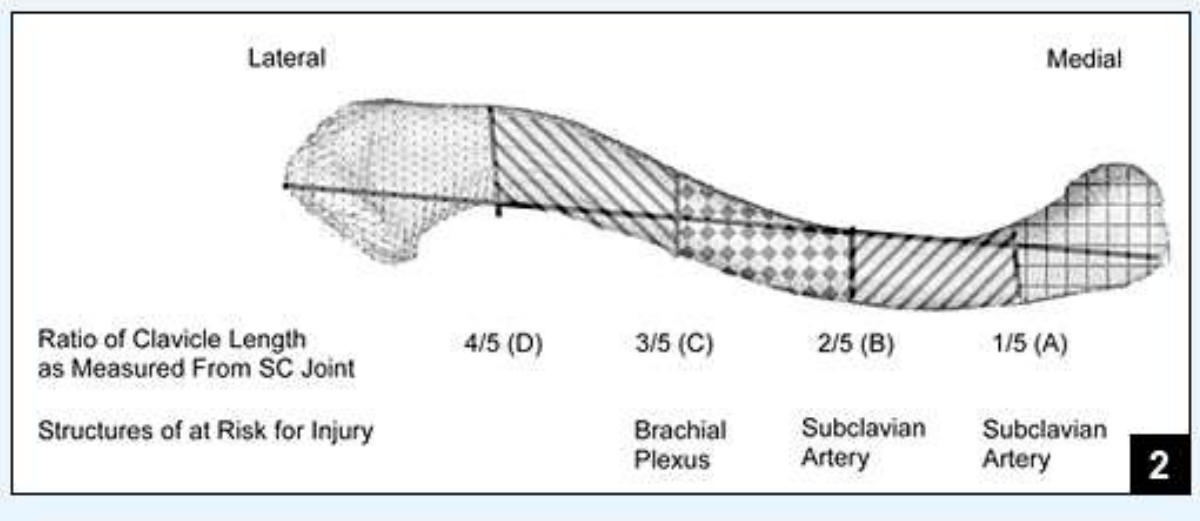


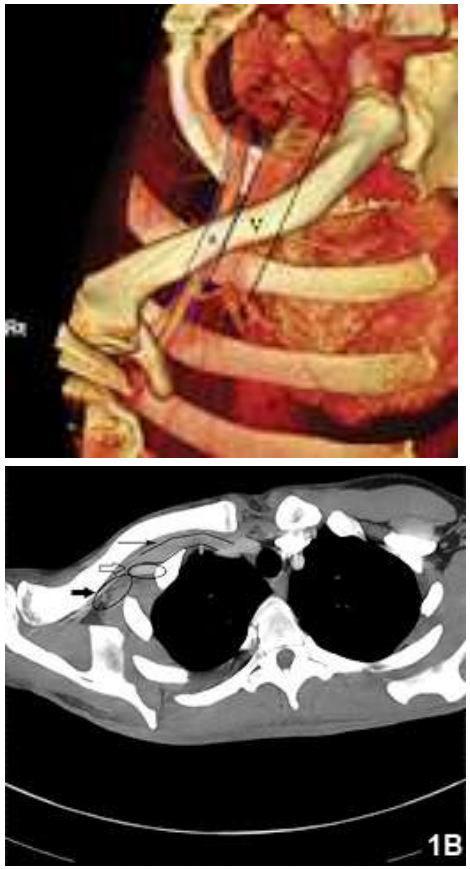
Coracoclavicular ligaments

- "Suspensory ligaments of the upper extremity"
- Two components:
  - Trapezoid
  - Conoid
- Stronger than AC ligaments
- Provide vertical stability to AC joint

Surgical anatomy

care should be observed with placement of screws in the medial half of the clavicle





Epidemiology

2.6% of all fractures and 44% of shoulder girdle

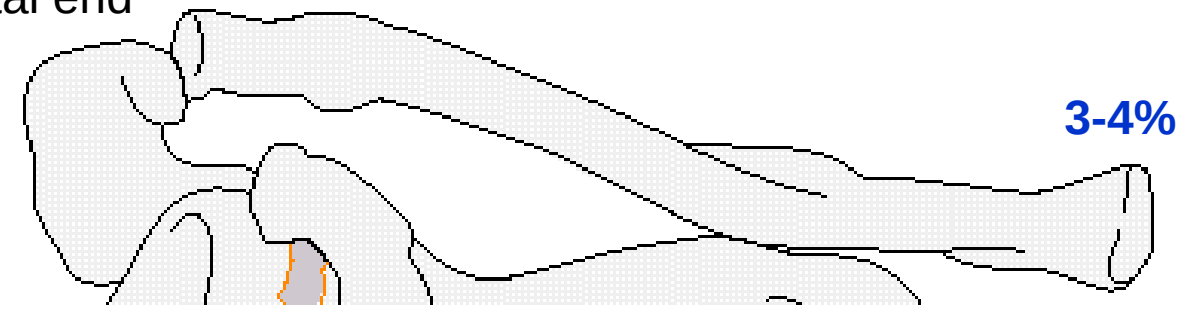
Men (68%) > women (32%).

Left side (61%) > right side (39%).

Middle 1/2 fractures are the most common (81%), are displaced in 48% of cases and comminuted in 19%.

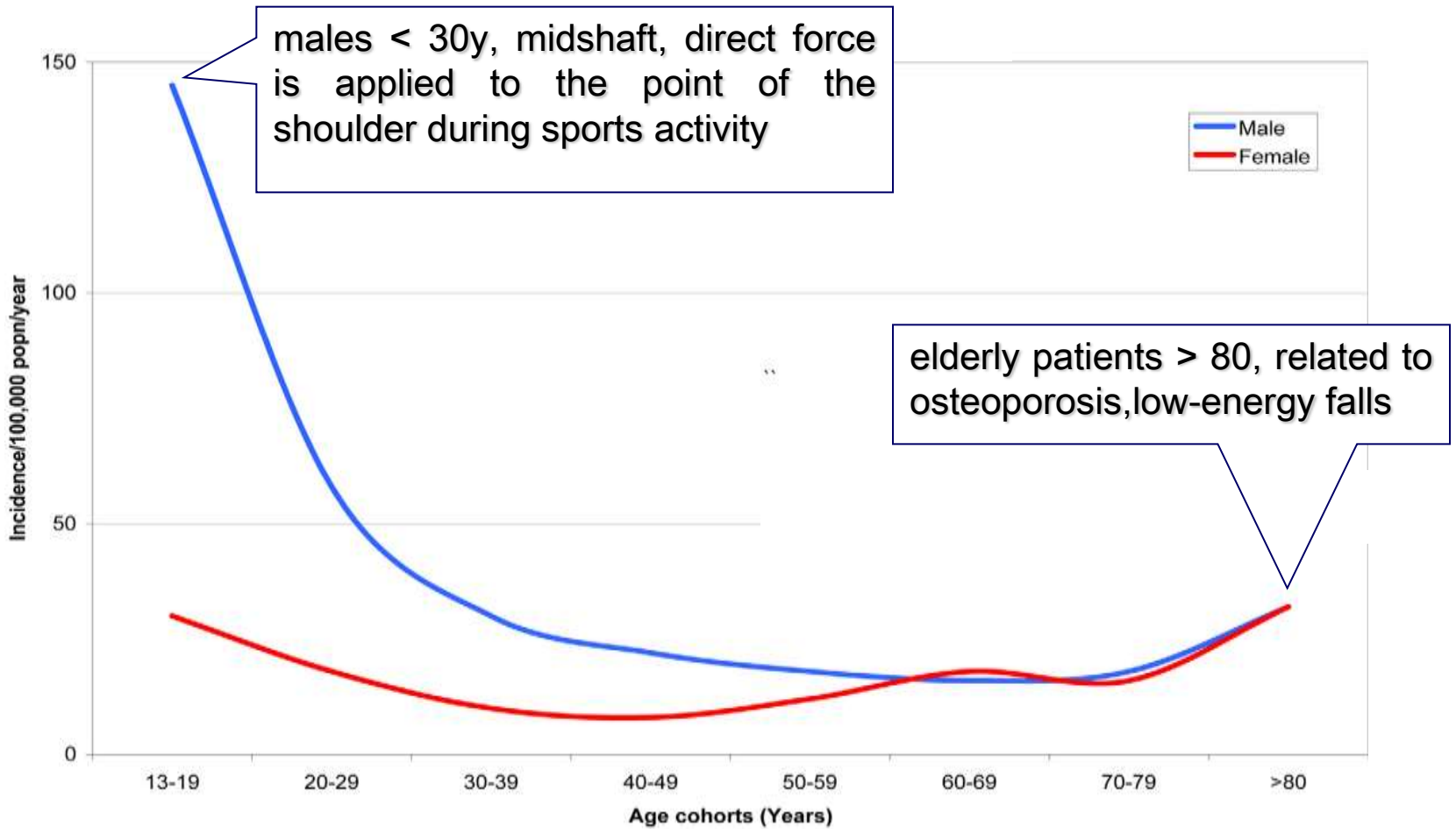
25-30% distal end

70-80% midshaft



3-4% proximal end

Epidemiology



Mechanism of injury

Moderate or high-energy traumatic impacts to the shoulder

- Fall from height
- Motor vehicle accident
- Sports injury
- Rarely a direct injury to the clavicle

Occur in cycling and equestrian sports
(inertia after a sudden stop throws rider forward landing on unprotected shoulder)

Clinical examination

Inspection

- Evaluate deformity and/or displacement
  - Beware of rare inferior or posterior displacement of distal or medial ends
  - Skin penetration?

Palpation

- Evaluate pain
- Look for instability with stress

Clinical examination

Neurovascular examination

Upper extremity motion and sensation

Measure shoulder range-of-motion

A difference in blood pressure between the two upper extremities is suggestive of vascular injury, (arteriography for exclusion)

Radiological examination

Anteroposterior View

30-degree Cephalic Tilt View

Radiological examination

Anteroposterior View

Zanca View-better for distal clavicle

(AP with cephalic tilting of 15° and use of only 50% of the standard shoulder penetration strength)

Optimizing the radiographic technique in clavicular fractures

Jeremy R. P. Sharr, MB ChB, FRACR,[a] and Khalid D. Mohammed, MB ChB, FRACS,[b] *Christchurch, New Zealand*

(J Shoulder Elbow Surg 2003;12:170-2)

Anteroposterior View

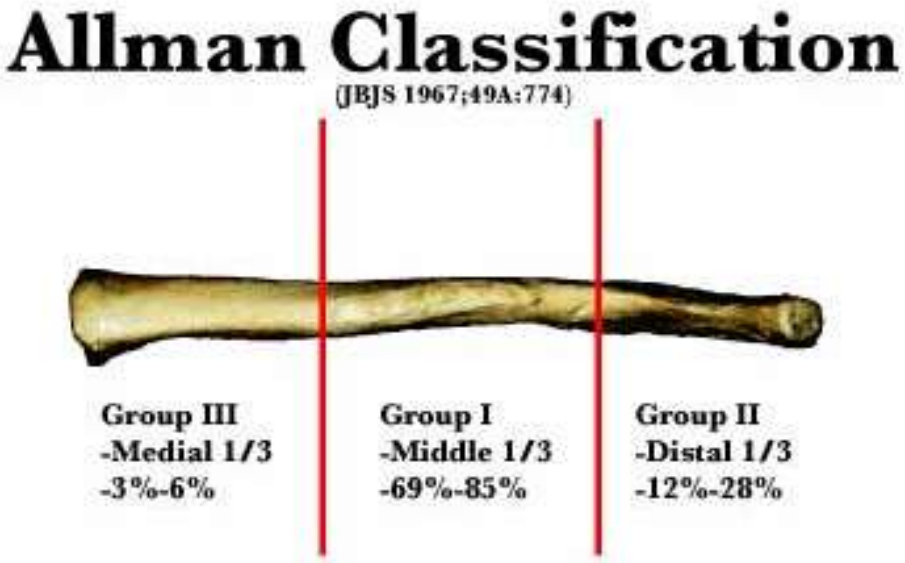
Posteroanterior with 15^{o} caudal tilt – better for shortening estimation)

Radiological examination

3D – CT reconstruction

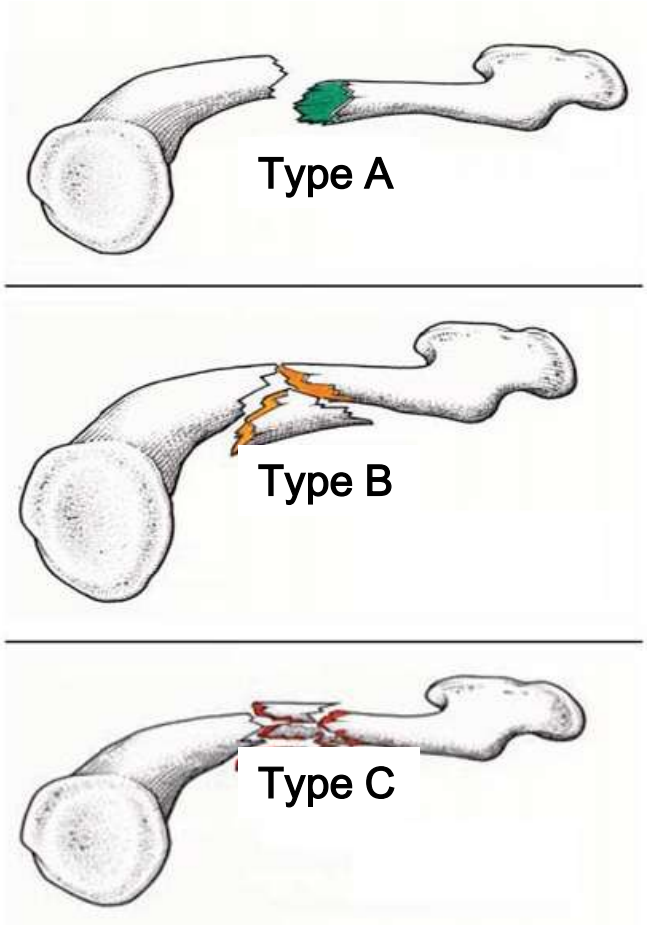
better estimates shortening
and progress of union

Classification



Classification

AO Classification



Fractures of the clavicle in the adult

EPIDEMIOLOGY AND CLASSIFICATION

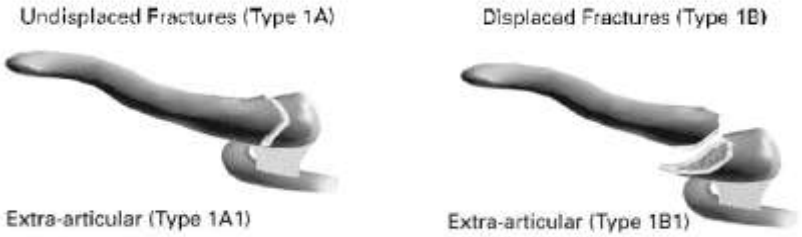
C. M. Robinson

From the Royal Infirmary of Edinburgh, Scotland

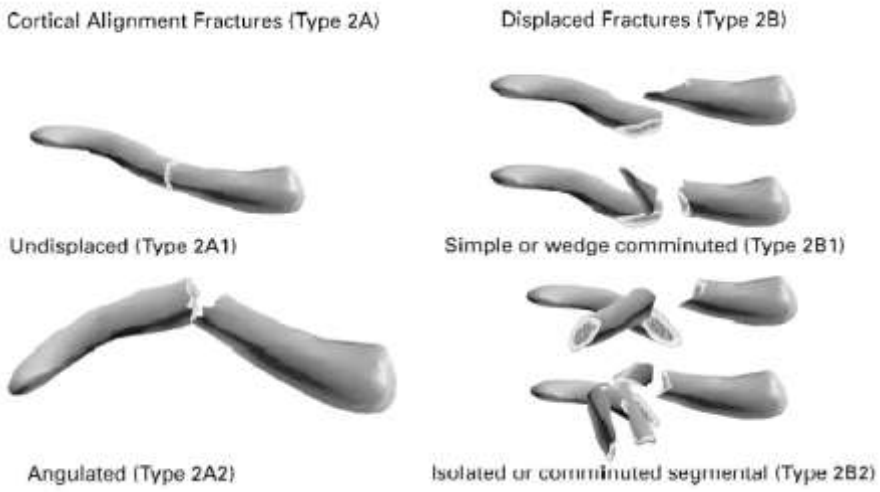
J Bone Joint Surg [Br] 1998;80-B:476-84.

Edinburgh classification

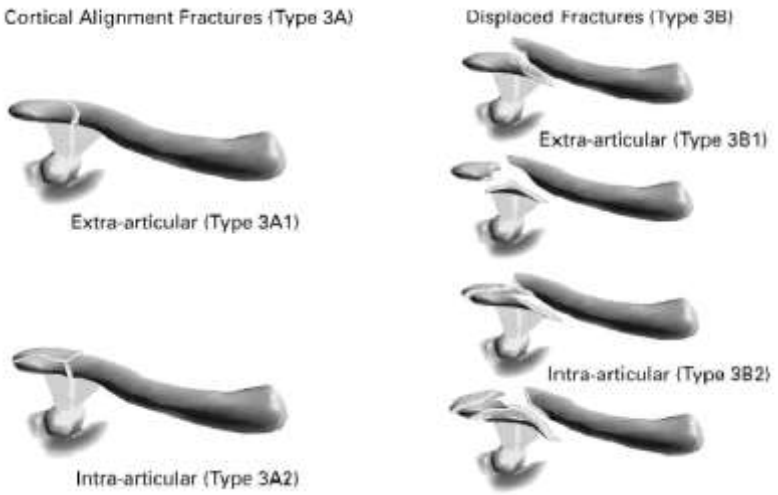
Type 1 (medial third)



Type 2 (midshaft)



Type 3 (distal third)



Treatment options

Nonoperative
- Sling
- Brace

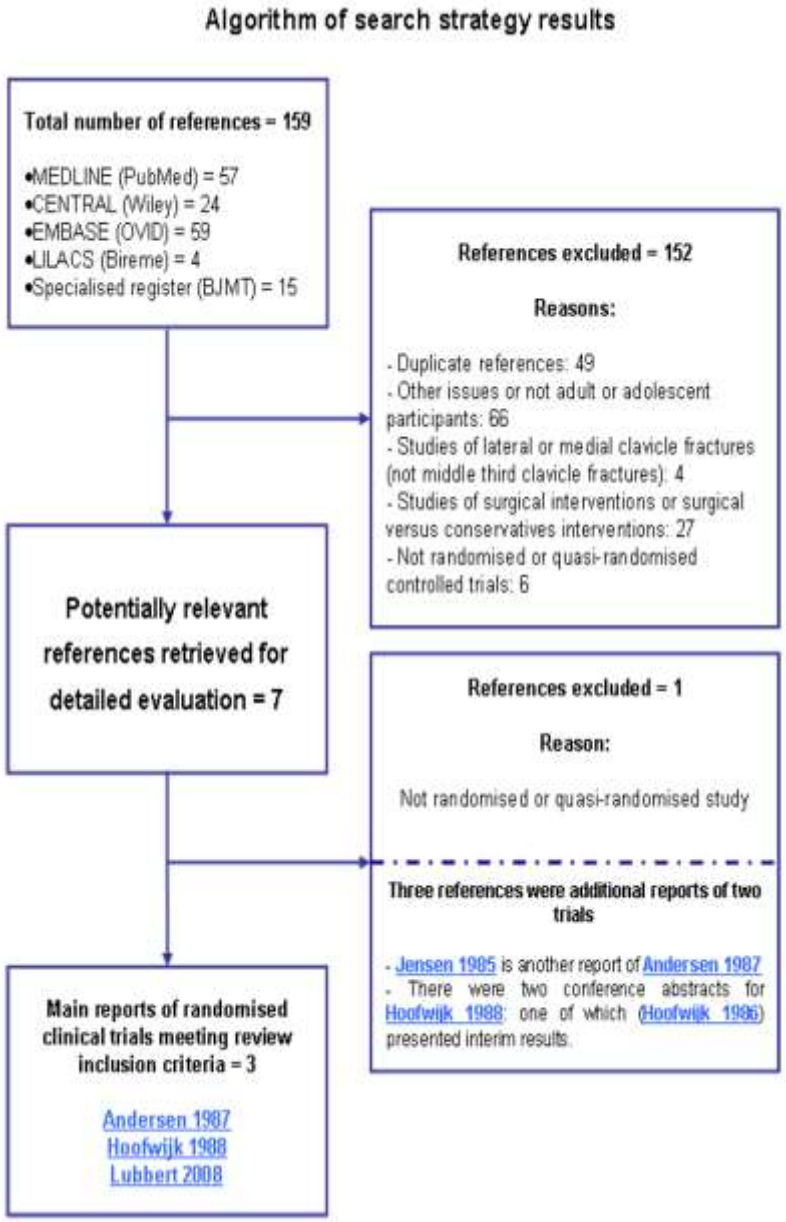
Surgical
- Plate Fixation
- Intramedullary Fixation
- Hook plate
- KW-tension band

Conservative interventions for treating middle third clavicle fractures in adolescents and adults (Review)

Lenza M. et al The Cochrane Collaboration 2009

- Objective: to evaluate the relative effects of different methods of conservative treatment for midshaft clavicle fractures in adolescents and adults
- Search methods / Data collection and analysis

  Electronic searches; selection of studies; data extraction and management; assess of risk of bias; measure the treatment effect; dealing with missing data; assessment of heterogenicity; data synthesis; subgroup analysis; sensitivity analysis;



Treatment of clavicular fractures: Figure-of-eight bandage versus a simple sling

Anderson 1987

Closed treatment of clavicular fractures: A prospective randomized trial

Hoofwijk 1988

Low-intensity pulsed ultrasound in fresh clavicular fractures: A multicenter double blinded randomized controlled trial

Lubbert 2008

Sling vs brace (fig of 8)

Andersen et al., Acta Orthop Scand 58: 71-4, 1987.

- Prospective randomized trial of 61 patients
- Simple sling
  - Less discomfort
- Functional and cosmetic results identical
- Alignment of healed fractures unchanged from the initial displacement in both groups

Conservative treatment

Neer (1960) = 3 nonunions / 2,235 clavicle midshaft fractures

Rowe (1968) = 4 nonunions / 566 clavicle midshaft fractures

These reports of < 1% incidence of nonunion dominated the clinical approach to displaced clavicular fractures for several years

Conservative treatment

There is new evidence that the outcome of nonoperative management of displaced middle-third clavicle fractures is not as good as traditionally thought, with many patients having significant functional problems.

Conservative treatment - problems

- pain,
- loss of strength,
- rapid fatigability,
- paraesthesiae of the arm and hand,
- problems with sleeping on the back
- cosmetic complaints

Hill et al. 1997
Ledger et al. 2005
Nowak et al. 2005
McKee et al. 2006
Rosenberg et al. 2007

Conservative treatment

Estimating the Risk of Nonunion Following Nonoperative Treatment of a Clavicular Fracture

By C. Michael Robinson, BMedSci, FRCSEd(Orth), Charles M. Court-Brown, MD, FRCSEd(Orth), Margaret M. McQueen, MD, FRCSEd(Orth), and Alison E. Wakefield, MSc, MCSP

Investigation performed at the Shoulder Injury Clinic, Orthopaedic Trauma Unit, Edinburgh, Scotland

The Journal of Bone & Joint Surgery · jbjs.org
Volume 86-A · Number 7 · July 2004

Overall prevalence of nonunion in 868 patients, at 24 weeks follow up was 8.3% of the medial end fractures, **4.5%** of the diaphyseal fractures, and 11.5% of the lateral end fractures

Risk of nonunion for

diaphyseal fracture: ↑ age, female gender, displacement, & comminution

lateral end fracture: ↑ advancing age and displacement

Conservative treatment

Journal of Orthopaedic Trauma:
August 2005 - Volume 19 - Issue 7 - pp 504-507
Evidence-Based Orthopaedic Trauma

Treatment of Acute Midshaft Clavicle Fractures: Systematic Review of 2144 Fractures: On behalf of the Evidence-Based Orthopaedic Trauma Working Group

Zlowodzki, Michael MD*; Zelle, Boris A MD†; Cole, Peter A MD*; Jeray, Kyle MD‡; McKee, Michael D MD§

5.9% rate of non-union in 1145 conservatively treated fractures

…nonunion for displaced midshaft clavicular fractures was 2.2% (ten of 460 patients) after plate fixation compared with **15.1%** (twenty-four of 159 patients) after nonoperative care, a relative risk reduction for nonunion of 86%

Reasons for Altered view of clavicular malunion

1. high-energy trauma – more displaced fractures

2. better-designed studies, without inclusion of children,

3. increased patient expectation regarding functional outcome after trauma,

4. outcome is now analyzed with patient-based outcome scores, instead of range of motion and radiographic fracture union only

Conservative treatment

Deficits Following Nonoperative Treatment of Displaced Midshaft Clavicular Fractures

By Michael D. McKee, MD, FRCS(C), Elizabeth M. Pedersen, MD, Caroline Jones, BSc, PT, David J.G. Stephen, MD, FRCS(C), Hans J. Kreder, MD, FRCS(C), Emil H. Schemitsch, MD, FRCS(C), Lisa M. Wild, BScN, and Jeffrey Potter, BSc

The Journal of Bone & Joint Surgery · jbjs.org
Volume 88-A · Number 1 · January 2006

Mean DASH score was 24.6 points, (10.1 normative value)
Mean Constant shoulder score was 71 points, (92 normative value)

Clavicular shortening was associated with a trend toward decreased abduction strength, and shortening of ≥2 cm was associated with a trend toward greater patient dissatisfaction

Conservative treatment

CLINICS 2011;66(4):635-639 DOI:10.1590/S1807-59322011000400019

CLINICAL SCIENCE

Functional outcomes of conservatively treated clavicle fractures

Mohd Yazid Bajuri,[I] S. Maidin,[I] A. Rauf,[II] M. Baharuddin,[III] S. Harjeet[II]

…we recommend treating fractures with a displacement of more than 21 mm, a shortening of more than 15 mm, primarily with open reduction and internal fixation with plates and screws

Conservative treatment

De Giorgi et al. BMC Research Notes 2011, 4:333
http://www.biomedcentral.com/1756-0500/4/333

BMC Research Notes

RESEARCH ARTICLE Open Access

Conservative treatment of fractures of the clavicle

Silvana De Giorgi[1], Angela Notarnicola[1*], Silvio Tafuri[2], Giuseppe Solarino[1], Lorenzo Moretti[1] and Biagio Moretti[1]

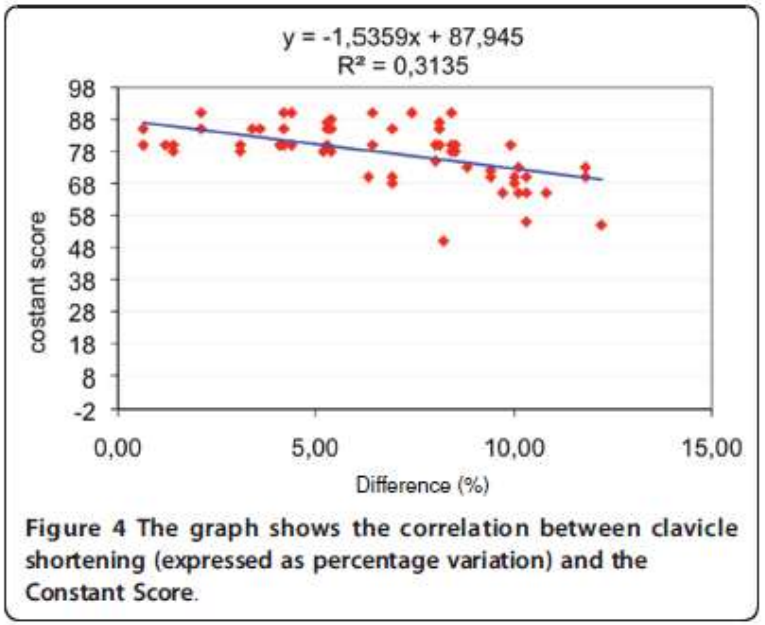


Figure 4 The graph shows the correlation between clavicle shortening (expressed as percentage variation) and the Constant Score.

Shortening more than 9.7% (~ 1,5 cm) should be the **cut-off** for predicting failure of conservative treatment.

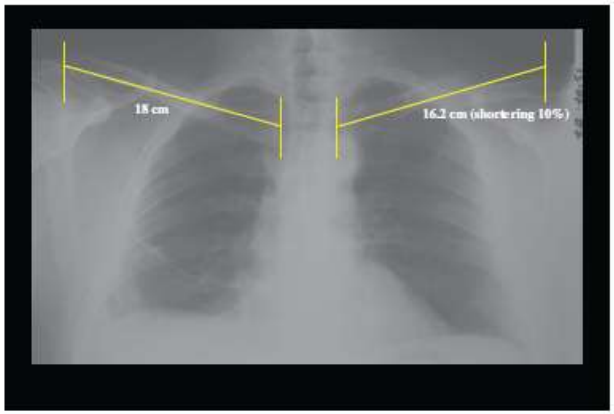


Figure 1 Radiographic image of the clavicle of a dissatisfied patient after conservative treatment of a diaphyseal clavicle fracture. The observed shortening was 18 mm or 10%; the Constant score was 65.

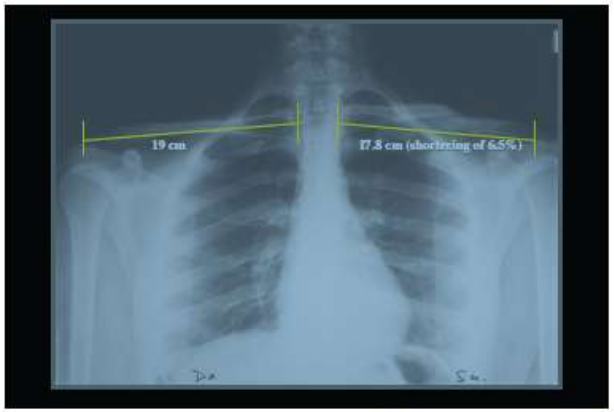


Figure 2 Radiographic image of the clavicle of a satisfied patient after conservative treatment of a diaphyseal clavicle fracture. The observed shortening was 12 mm, or 6.5%; the Constant score was 80.

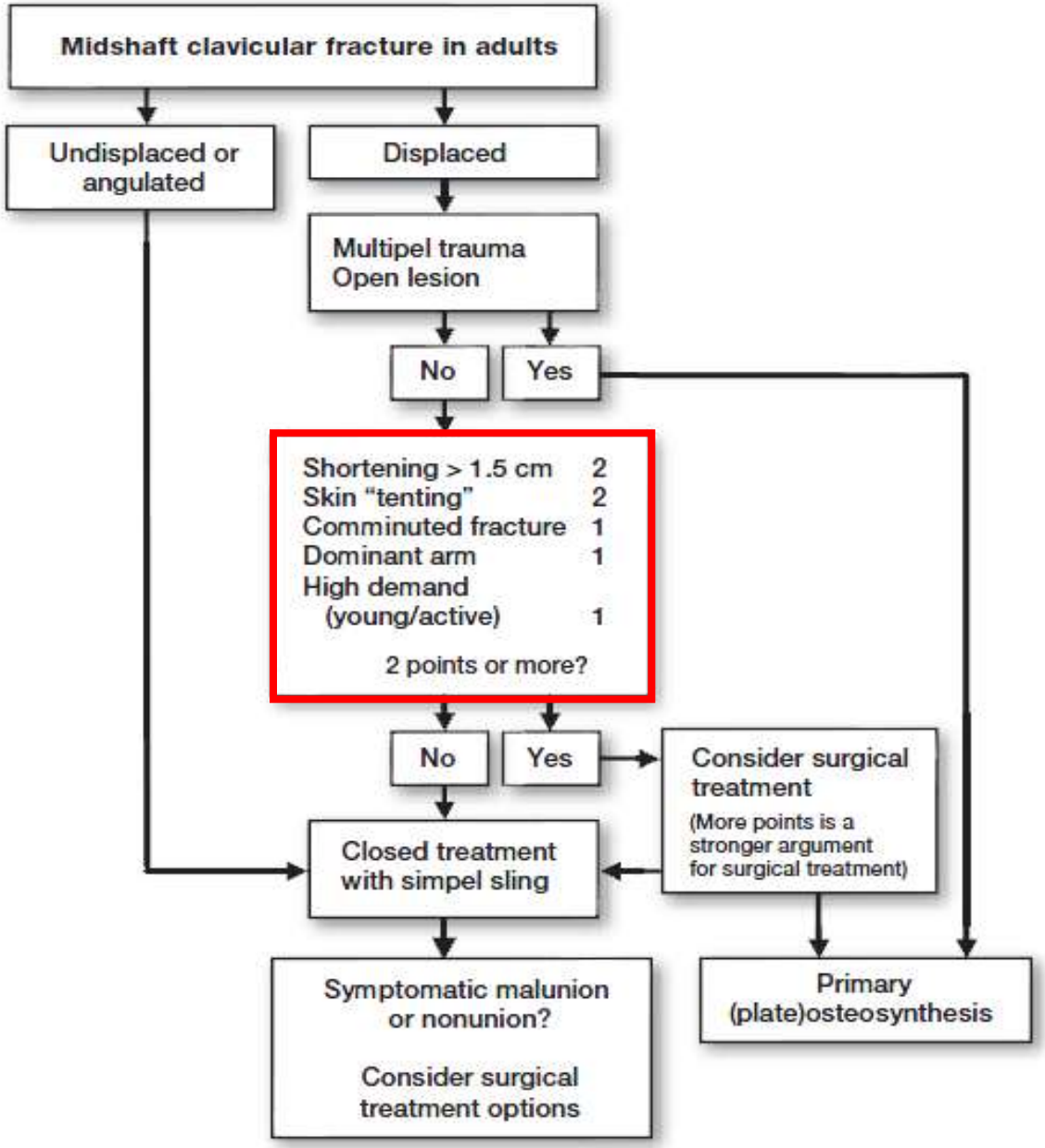
Surgical indications

Acta Orthopaedica 2010; 81 (3): 273–279

Malunion after midshaft clavicle fractures in adults

The current view on clavicular malunion in the literature

Robert J Hillen[1], Bart J Burger[2], Rudolf G Pöll[3], Arthur de Gast[4], and C Michael Ro



examples

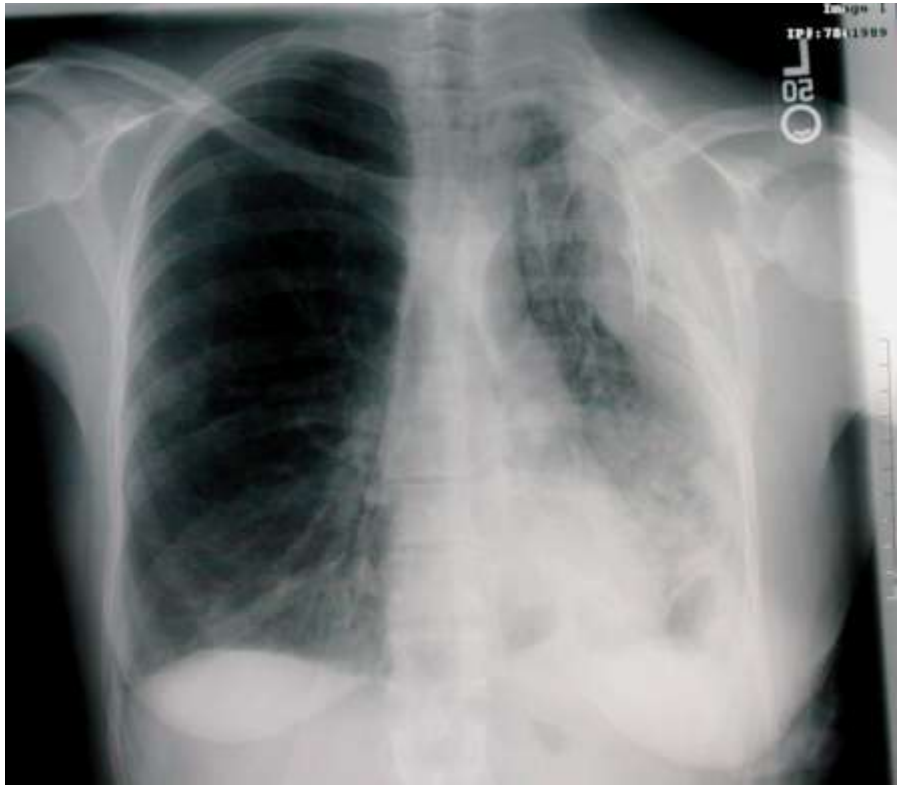
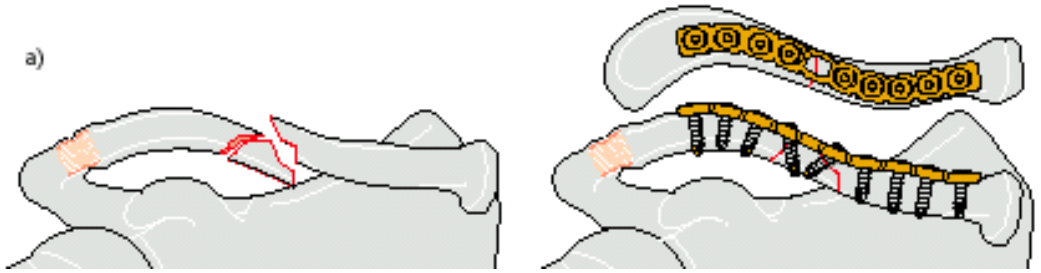


Plate fixation

Reconstruction plates



LC-DCP 3.5 plates

Inferior plating associated with lower risk of hardware prominence

Nonoperative Treatment Compared with Plate Fixation of Displaced Midshaft Clavicular Fractures. A Multicenter, Randomized Clinical Trial

Canadian Orthopaedic Trauma Society
J. Bone Joint Surg. Am. 89:1-10, 2007. doi:10.2106/JBJS.F.00020



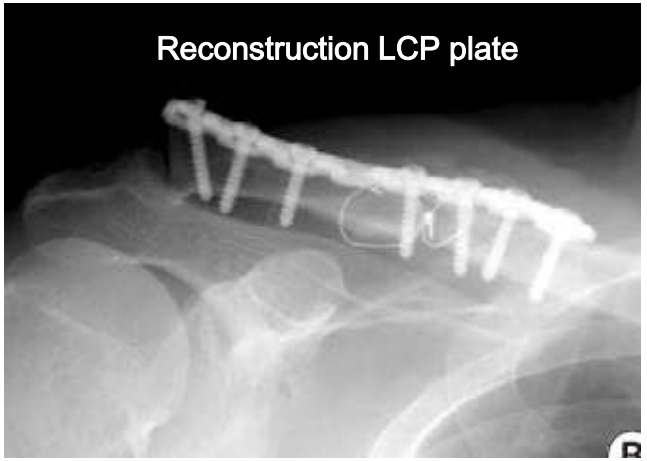
132 patients with a displaced midshaft fracture of the clavicle were randomized to either operative treatment with plate fixation (67 pt) or nonoperative treatment with a sling (65 pt)

Operative fixation results in improved functional outcome and a lower rate of malunion and nonunion compared with nonoperative treatment at one year of follow-up.

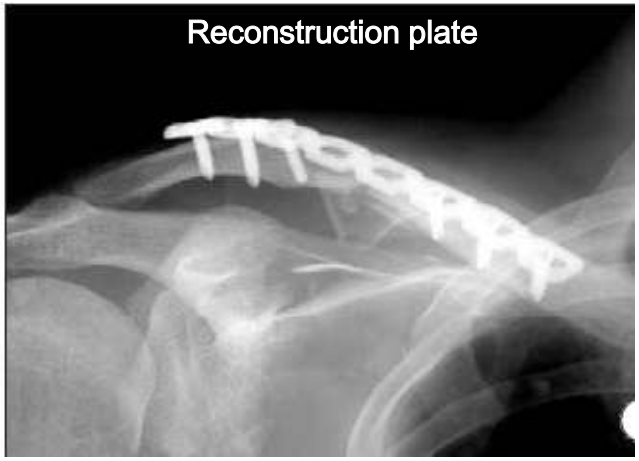
Original Article Clinics in Orthopedic Surgery 2010;2:154-159 • doi:10.4055/cios.2010.2.3.154

Operative Treatment of Clavicle Midshaft Fractures: Comparison between Reconstruction Plate and Reconstruction Locking Compression Plate

Chul-Hyun Cho, MD, Kwang-Soon Song, MD, Byung-Woo Min, MD,
Ki-Cheor Bae, MD, Kyung-Jae Lee, MD



In LCP group, plate contouring was performed with the locking sleeves inserted into the plate holes to prevent deformation



Conclusions: This study showed radiologically and clinically satisfactory results in both groups. Overall, operative treatment with a Reconstruction plate or reconstruction LCP for clavicle shaft fractures can be used to obtain stable fixation.

Intramedullary fixation

Large threaded cannulated screws
Flexible elastic nails
K-wires
Knowels nails
    Associated with risk of migration

Useful when plate fixation contra-indicated
    Bad skin
    Severe osteopenia

Fixation less secure

Fixation of mid-third clavicular fractures with Knowles pins

78 patients followed for 2–7 years

Cheng-Mien Chu, Shyu-Jye Wang and Leou-Chyr Lin

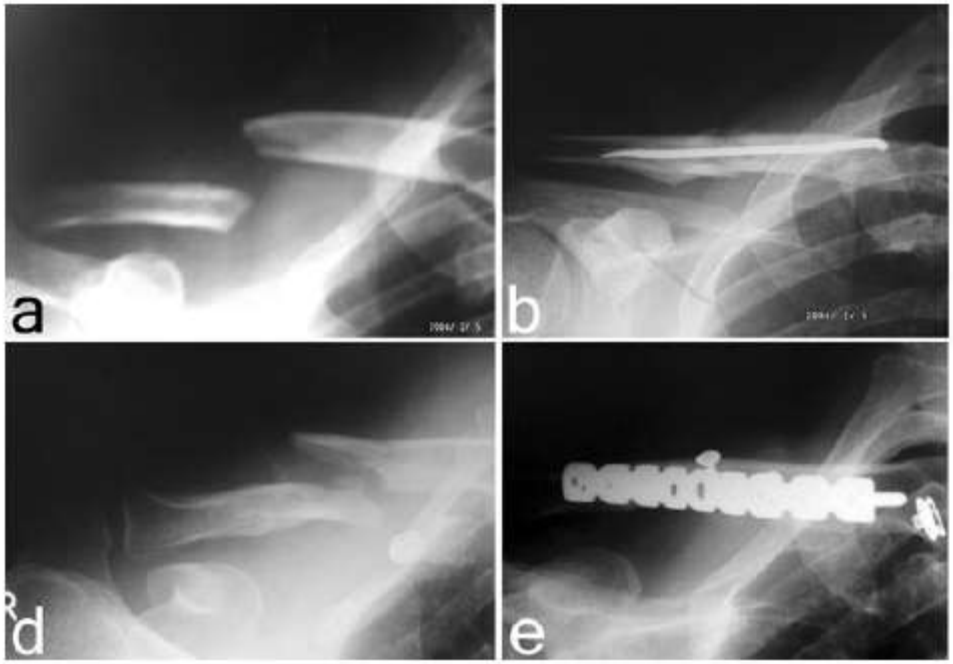
The rate of bone union was 77/78 fractures and the Constant-Murley score, was 97% after a mean follow-up of 49 months

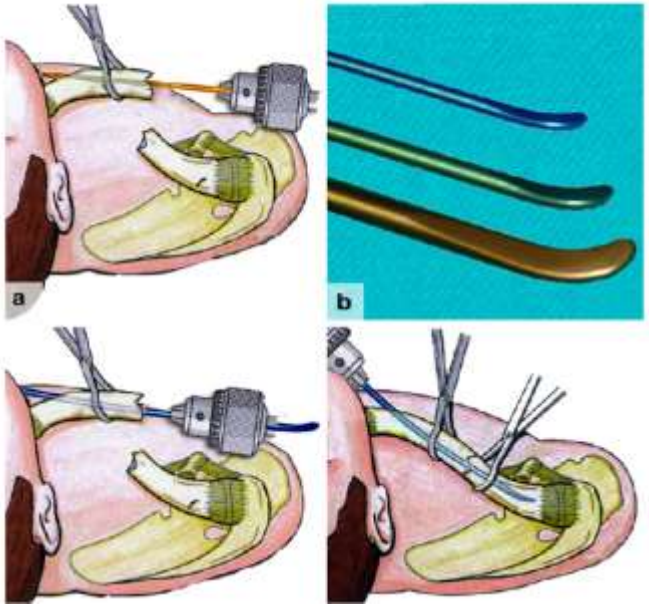
J Orthopaed Traumatol
DOI 10.1007/s10195-011-0158-7

ORIGINAL ARTICLE

Reconstruction plate versus minimal invasive retrograde titanium elastic nail fixation for displaced midclavicular fractures

Jamal E. H. Assobhi





Both techniques are equally effective for displaced midclavicular fractures, and give better function than nonoperative treatment.

The RTEN technique has more advantages and lower complications than plating.

Distal Third Clavicle Fractures

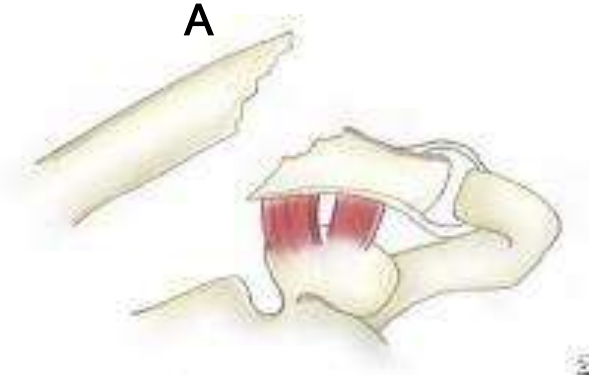
Classification

Neer classification of distal third

Type I

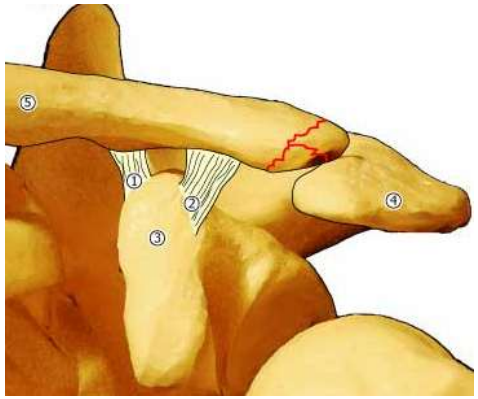
Type II

A



B

Type III (intra-articular)



Treatment of Type II distal clavicle Fractures

Nonoperative treatment

- 22 to 33% failed to unite
- 45 to 67% took more than three months to heal

Operative treatment

- 100% of fractures healed within 6 to 10 weeks after surgery

Surgical techniques

KWs into the distal fragment

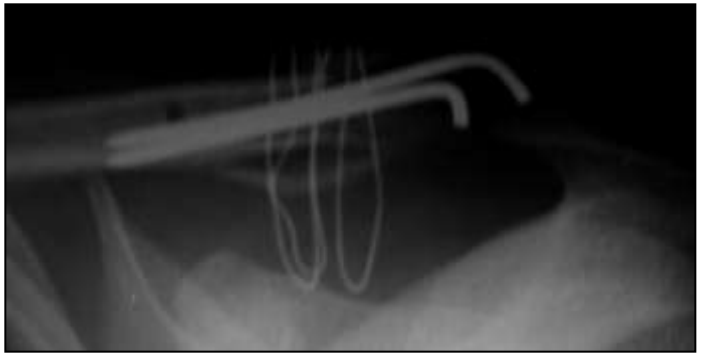
Tension-band wire or suture

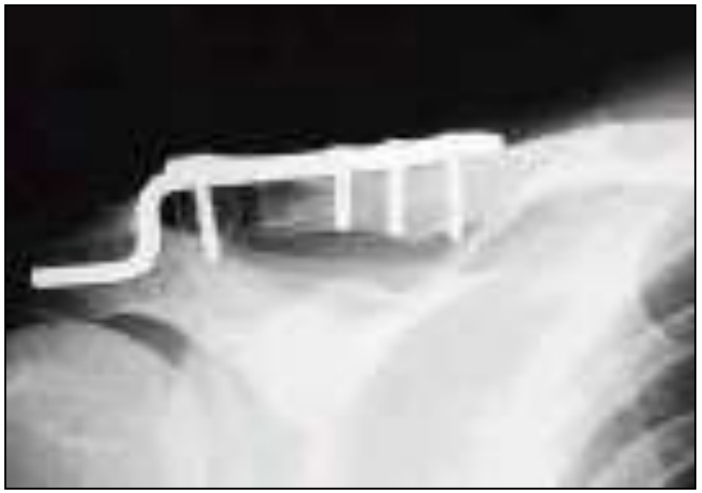
Clavicular Hook Plate

Dorsal plate fixation

CC screw fixation

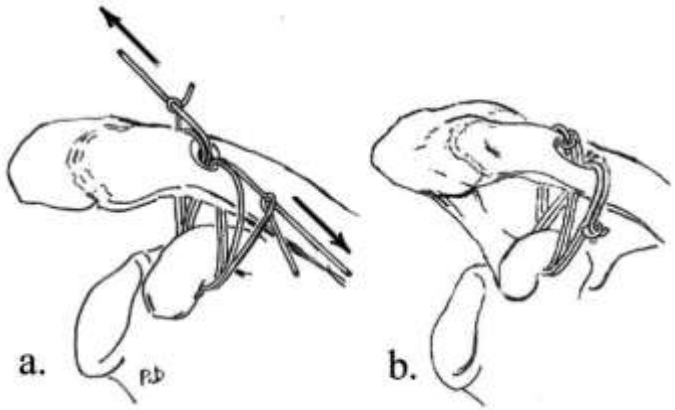
Transfer of coracoid process

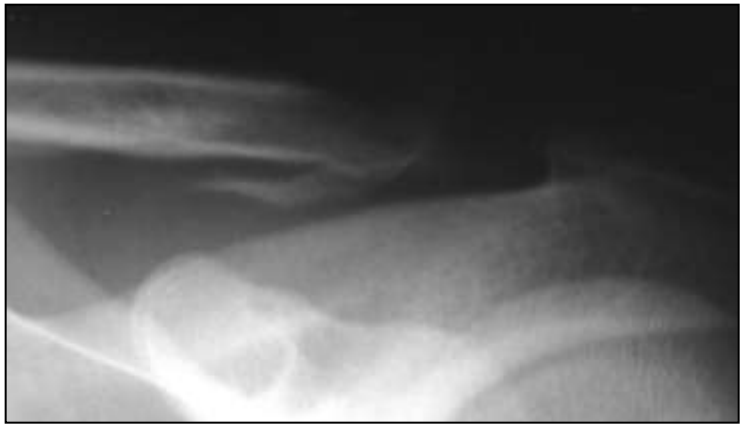




Surgical techniques

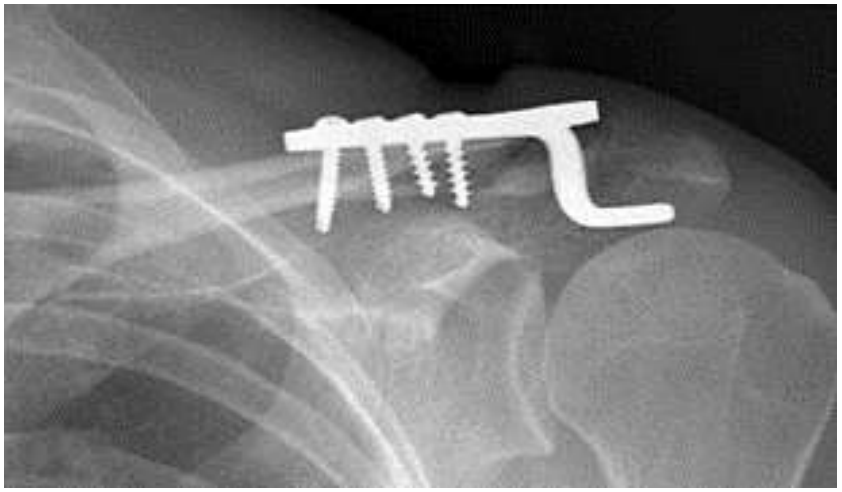
For most techniques of clavicular fixation, CC fixation is also needed to prevent redisplacement of the medial clavicle.





Surgical techniques

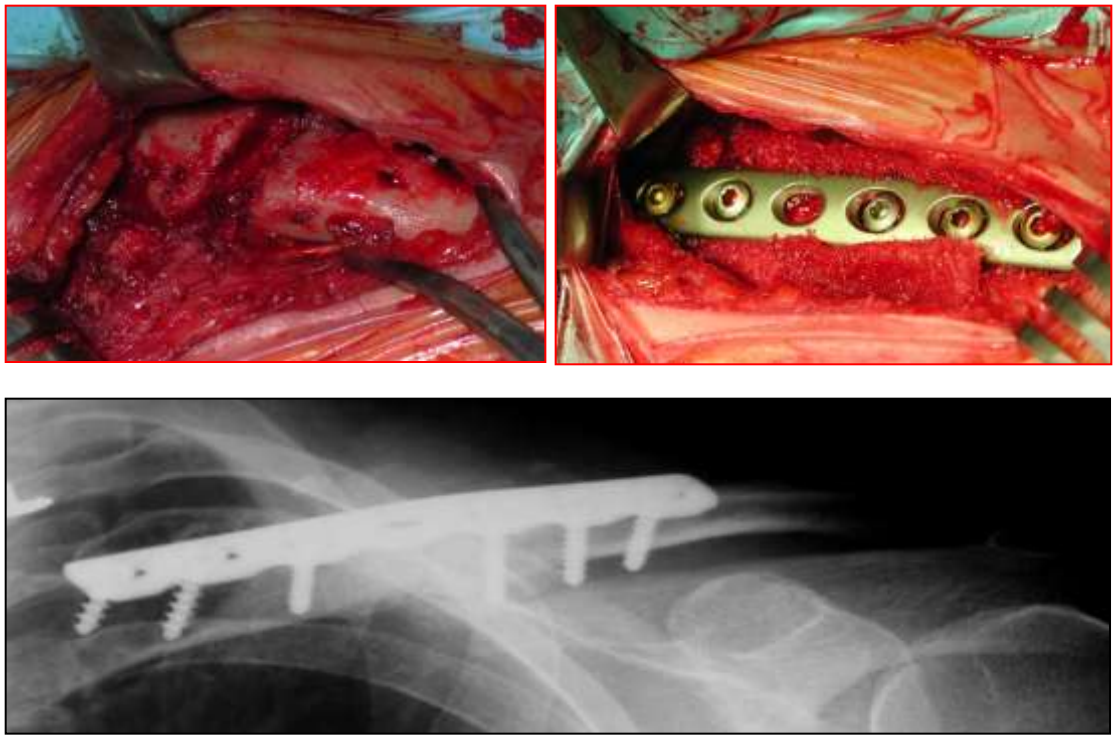
The Hook Plate was specifically designed to avoid this problem of redisplacement and recent series report union rates 80-100%.



Complications include:

new fracture about the implant,
rotator cuff tear, and
subacromial impingement

Complications of Clavicular Fractures



- Nonunion
- Malunion
- Neurovascular Sequelae
- Post-Traumatic Arthritis

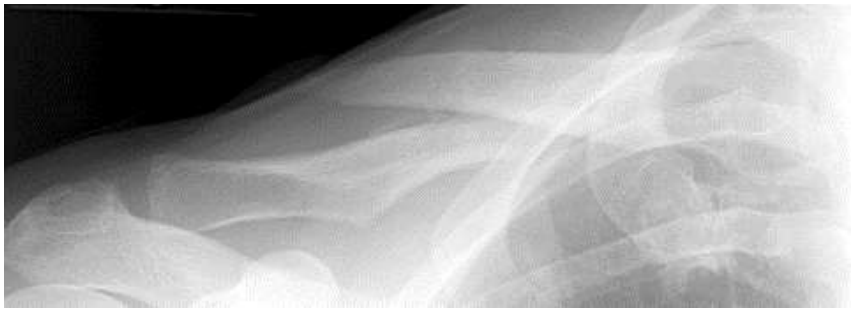
Principles for Clavicular Nonunions

Restore length of clavicle

- May need intercalary bone graft

Rigid internal fixation, usually with a plate Iliac crest bone graft

- Role of bone-graft substitutes not yet defined.

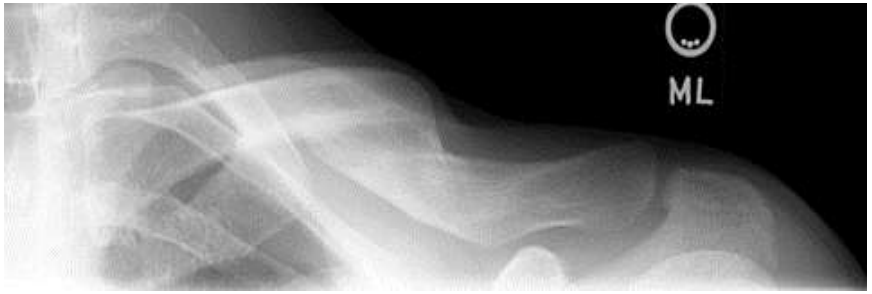


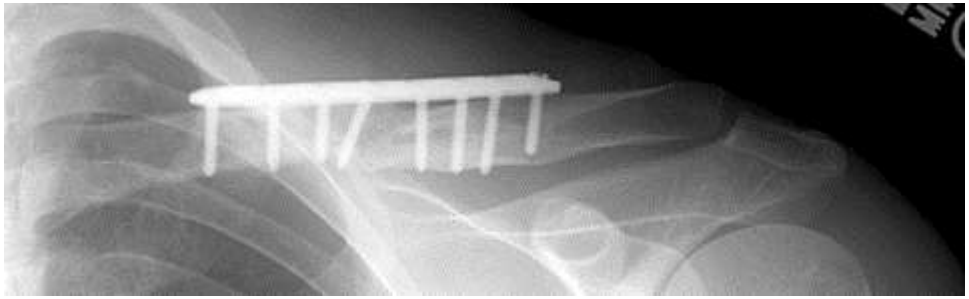
Clavicular Malunion

Symptoms of pain, fatigue, cosmetic deformity.

Initially treat with strengthening, especially of scapulothoracic stabilizers.

Consider osteotomy and internal fixation in rare cases in which nonoperative treatment fails.





REVIEW ARTICLE

Midclavicular Fracture: Not Just a Trivial Injury

Deutsches Ärzteblatt International | Dtsch Arztebl Int 2010; 107(41): 711–7

Current Treatment Options

Gereon Schiffer, Christoph Faymonville, Emmanouil Skouras, Jonas Andermahr, Axel Jubel

KEY MESSAGES

- Precise X-ray positioning of the clavicle in two projections is essential for correct analysis of the fracture type.
- No adequate long-term reduction of a displaced midclavicular fracture can be achieved with a rucksack bandage or other such aid.
- Patients with a displaced midclavicular fracture benefit from surgical treatment.
- Simple midclavicular fractures can be managed very elegantly and with high stability by means of an intramedullary titanium nail.
- Complex midclavicular fractures can be treated surgically by insertion of a bridging angle-stable plate.

Conclusions

The debate is currently centered on the question of whether displaced fractures should primarily be managed surgically, and if so which implant should be selected

Current studies show with a high level of evidence (level 1) that patients with displaced fractures benefit from surgery

Treatment should be tailored to the situation of each individual patient

The patient should be informed in detail of the options available and the potential benefits and risks of each approach

Midclavicular fracture can no longer be considered a trivial injury.