Fractures of midshaft and distal third of the clavicle

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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
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that the vast majority of clavicular fractures heal with good functional outcomes following nonoperative treatment is no longer valid.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.
Midclavicular Fracture: Not Just a Trivial Injury

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.
**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.*

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**THE MECHANICS OF AMBULATORY TREATMENT OF FRACTURES OF THE CLAVICLE**

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

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![Image of orthopedic procedures]
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%.
Epidemiology

males < 30y, midshaft, direct force is applied to the point of the shoulder during sports activity

elderly patients > 80, related to osteoporosis, low-energy falls
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° caudal tilt – better for shortening estimation)
Radiological examination

3D – CT reconstruction

better estimates shortening and progress of union
Classification

Allman Classification

Group III - Medial 1/3
-3% - 6%

Group I - Middle 1/3
-69% - 85%

Group II - Distal 1/3
-12% - 28%

(JBJS 1967;49A:774)
Classification

AO Classification
Fractures of the clavicle in the adult

EPIDEMIOLOGY AND CLASSIFICATION

C. M. Robinson
From the Royal Infirmary of Edinburgh, Scotland


**Edinburgh classification**

**Type 1 (medial third)**
- Undisplaced Fractures (Type 1A)
  - Extra-articular (Type 1A1)
- Displaced Fractures (Type 1B)
  - Extra-articular (Type 1B1)

**Type 2 (midshaft)**
- Cortical Alignment Fractures (Type 2A)
- Displaced Fractures (Type 2B)
  - Simple or wedge comminuted (Type 2B1)
- Undisplaced (Type 2A1)
- Angulated (Type 2A2)
  - Isolated or comminuted segmental (Type 2B2)

**Type 3 (distal third)**
- Cortical Alignment Fractures (Type 3A)
- Displaced Fractures (Type 3B)
  - Extra-articular (Type 3B1)
- Intra-articular (Type 3A2)
  - Intra-articular (Type 3B2)
Treatment options

Nonoperative
  Sling
  Brace

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


- 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

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

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
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 $\geq 2$ cm was associated with a trend toward greater patient dissatisfaction.
...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
Shortening more than 9.7% (~ 1.5 cm) should be the cut-off for predicting failure of conservative treatment.
Surgical indications

Definite indications
1) Open fractures
2) Associated neurovascular injury

Relative indications
- Impending skin compromise
- Shortening > 20mm
- Significant comminution
- Scapulothoracic dissociation
- Neurologic disorders
- Floating shoulder
- Bilateral fx
- Cosmesis
- Ipsilateral UE fx
- Multiple rib fx
- Heavy laborers, athletes

Malunion after midshaft clavicle fractures in adults
The current view on clavicular malunion in the literature

examples
Plate fixation

Reconstruction plates

LC-DCP 3.5 plates

Inferior plating associated with lower risk of hardware prominence
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.
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
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
Neer classification of distal third

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

KW's into the distal fragment
Tension-band wire or suture
Clavicular Hook Plate
Dorsal plate fixation
CC screw fixation
Transfer of coracoid process
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.
Midclavicular Fracture: Not Just a Trivial Injury

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.