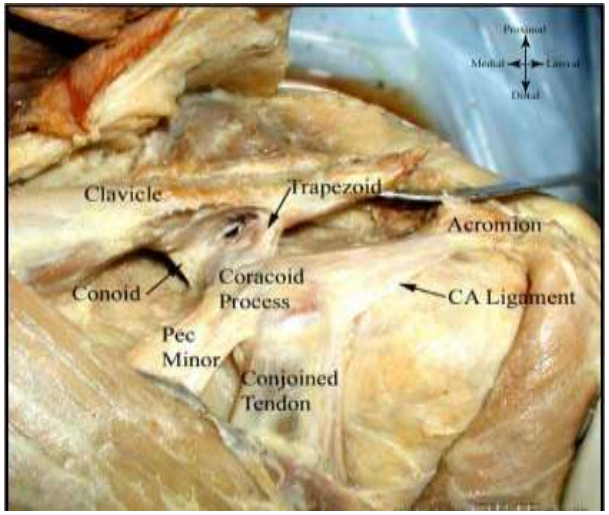
Fractures of the distal third of the clavicle

Andreas Panagopoulos, MD, Ph.D
Upper Limb and Sports Medicine Surgeon
Assistant Professor in Orthopaedics
University Hospital of Patras, GR

Anatomy

- **static stabilizers**: AC ligaments (4), CC ligaments (trapezoid & conoid)

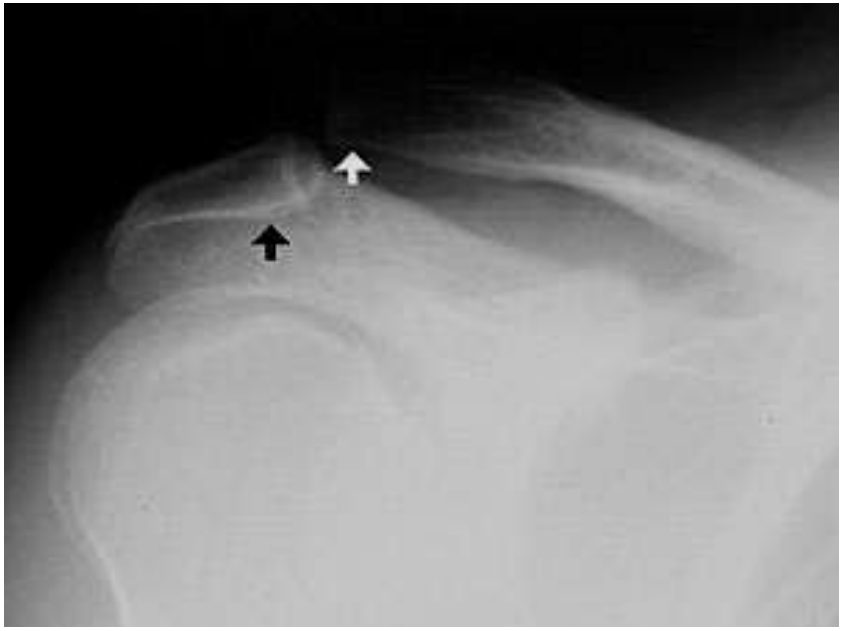


- **dynamic stabilizers:** deltoid and trapezius muscles

Fukuda K, et al. Biomechanical study of the ligamentous system of the acromioclavicular joint. J Bone Joint Surg Am. 1986;68:434-440.

Anatomy

- For **small** displacements the **capsule and AC ligaments** are the primary restraints to posterior (89%) and superior (68%) translation



Fukuda K, et al. J Bone Joint Surg Am. 1986;68:434-440.

Klimkiewicz J, et al. J Shoulder Elbow Surg. 1999;8:119-124.

Anatomy

- For **larger** displacements, the **conoid** ligament is the primary restraint (62%) to superior translation, while the AC ligaments are still the primary restraint to posterior translation

- **Trapezoid** ligament is the primary restraint to **compression** at both small and large displacements

Fukuda K, et al. J Bone Joint Surg Am. 1986;68:434-440.

Klimkiewicz J, et al. J Shoulder Elbow Surg. 1999;8:119-124.

Biomechanics

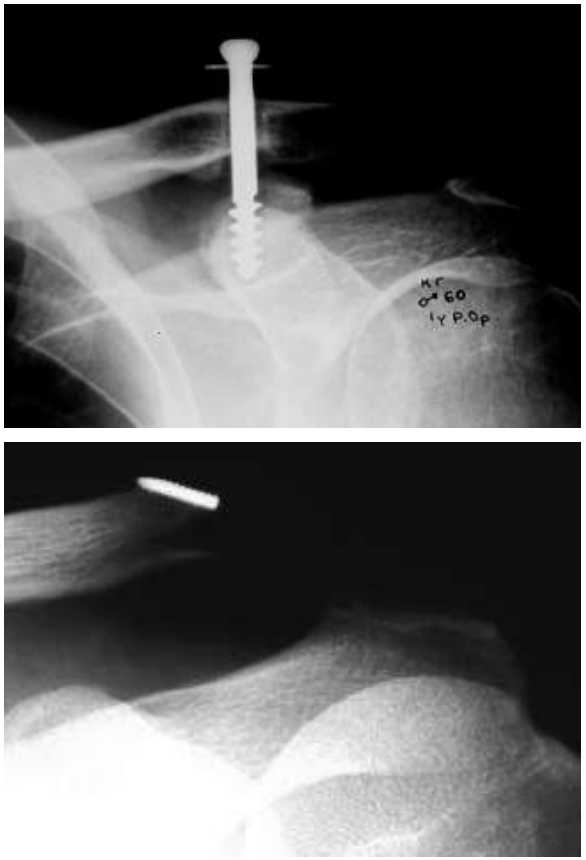
- With forward elevation-abduction to 180° there is **5°** to **8°** of rotation at the AC joint
- During arm elevation, the clavicle, with respect to the thorax, undergoes **elevation** (11° to 15°) and **retraction** (15° to 29°).
- When AC joint is intact, scapular motion (3 planes, 2 translations) is **synchronously coupled** with arm motion by the clavicle

Codman EA. The Shoulder. Malabar, FL: Robert E. Krieger Publishing Company Inc; 1934.

Ludewig PM, et al. Three-dimensional clavicular motion during arm elevation: reliability and descriptive data. J Orthop Sports Phys Ther. 2004;34:140-149.

Biomechanics

- AC joint **should not be fixed**, either by fusion, hardware (screws, plates, pins) or coracoclavicular screws
- Motion will be lost, limiting shoulder function, or the hardware may fail



Mazzocca AD et al Evaluation and Treatment of Acromioclavicular Joint Injuries. Am J Sports Med 2007;35:316-329

Epidemiology

10% to 30% of all clavicle fractures

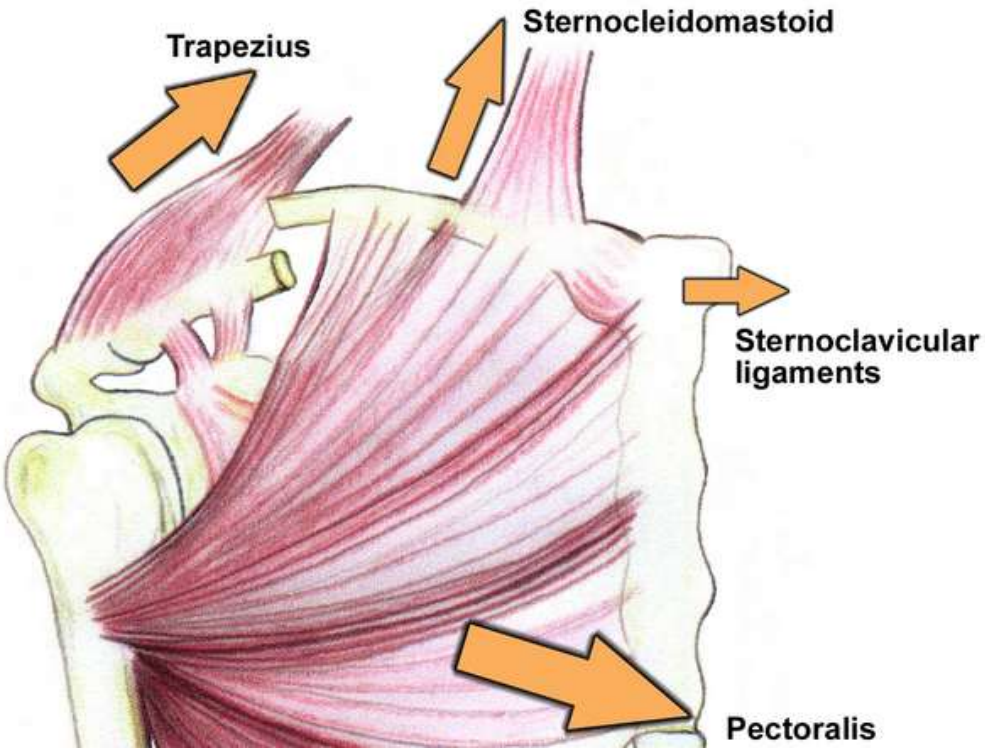
Male>female

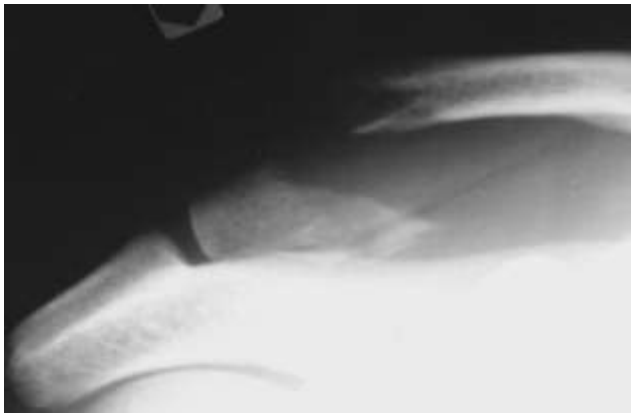
Older patients

Stable fracture patterns generally heal uneventfully with nonsurgical management

Deforming forces

weight of the arm,
scapular rotation





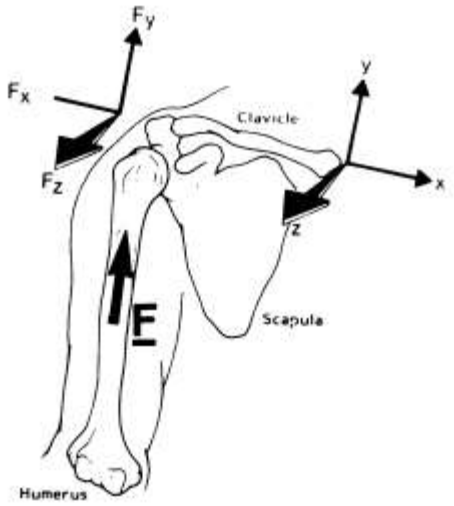
Mechanism of injury

Moderate or high-energy traumatic impact

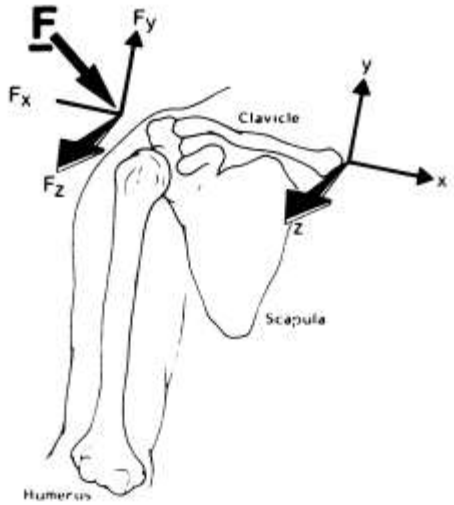
- Falling on the outstretched hand
- a direct blow to shoulder.

Direct impact occurs at the acromion, usually with the arm in an adducted position

(a) FALLING ON THE OUTSTRETCHED ARM



(b) DIRECT BLOW ON THE SHOULDER



Clinical examination

Inspection

Beware of inferior or posterior displacement

Fracture displacement may cause the proximal fragment to tent the skin, as in AC joint separation

Paresthesias resulting from swelling or injury to the supraclavicular nerves are common

Palpation

Evaluate pain

Look for instability with stress

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)

Radiological examination

3D – CT reconstruction

better estimates shortening, displacement and progress of union

Classification

THE JOURNAL OF BONE & JOINT SURGERY (BJ)

Fractures of the clavicle in the adult

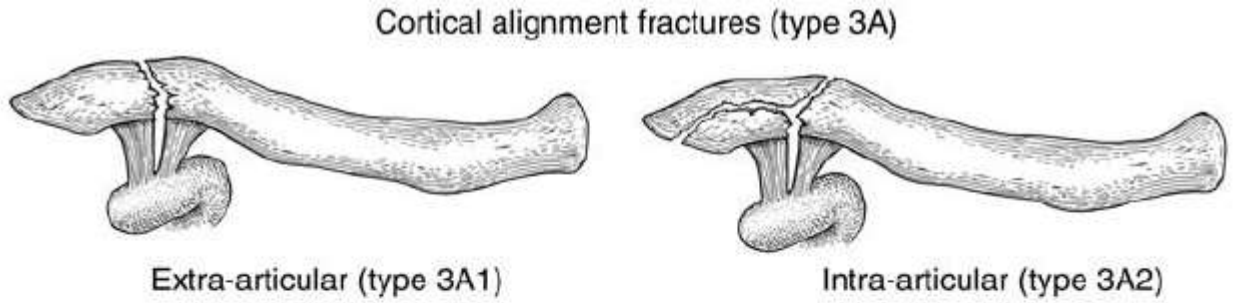
EPIDEMIOLOGY AND CLASSIFICATION

C. M. Robinson

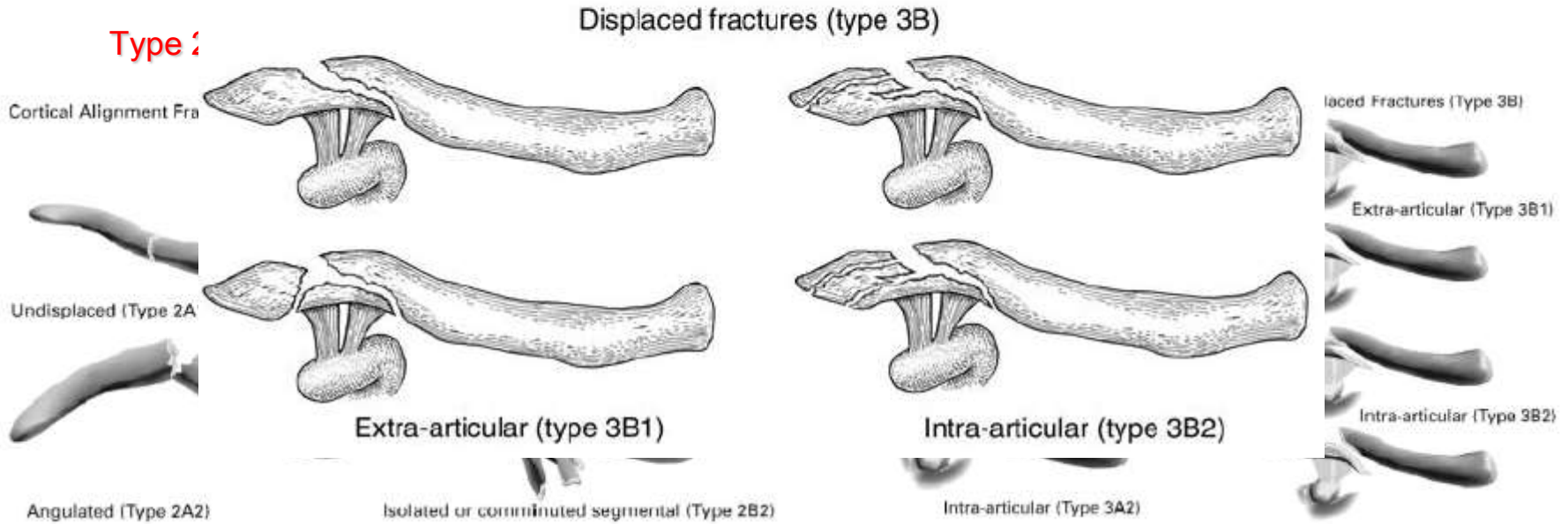
From the Royal Infirmary of Edinburgh, Scotland

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

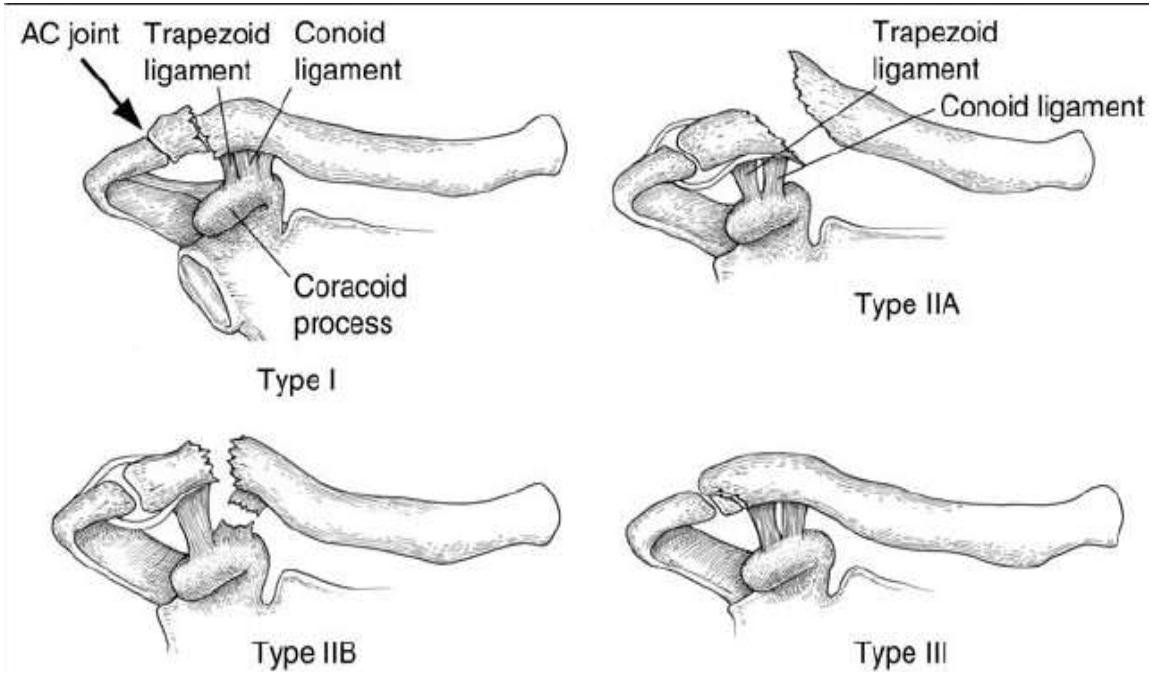
Type 3 (distal third)



Type 2



Classification



Neer CS II: Fractures of the distal third of the clavicle. Clin Orthop Relat Res 1968;58:43-50

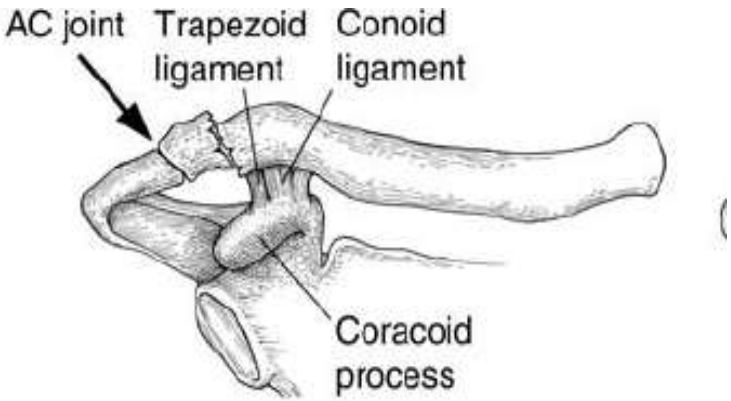
EV: Fractures of the clavicle, in Rockwood CA Jr, et al, eds: Rockwood and Green's Fractures in Adults, ed 4. Philadelphia, PA, Lippincott-Raven, 1996, pp 1109-1193.

Classification

Type I fractures occur lateral to the CC ligaments but spare the AC joint.

The proximal fragment is stabilized to the coracoid process by the CC ligaments and to the distal fragment by the deltotrapezial fascia.

Type I fractures often are only minimally displaced

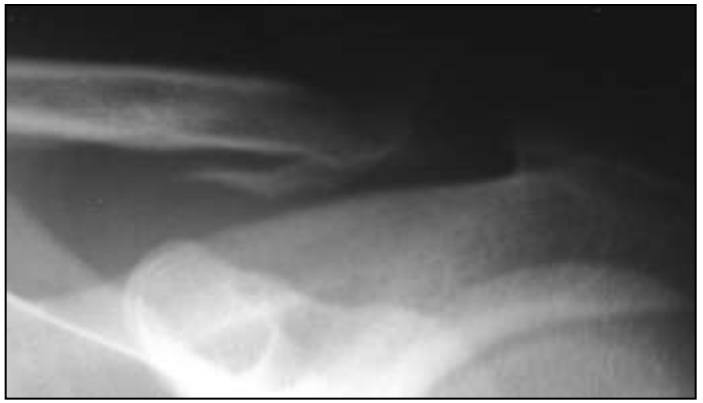


Type I

Classification

Type III fractures are similar to type I fractures in that they also occur distal to the CC ligaments.

Type III fracture extends into the AC joint, but are relatively stable and typically are minimally displaced.



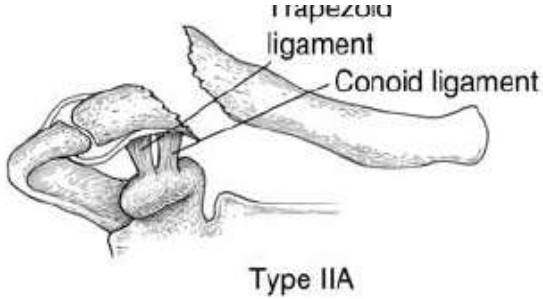
Risk of posttraumatic **AC joint arthropathy**

Classification

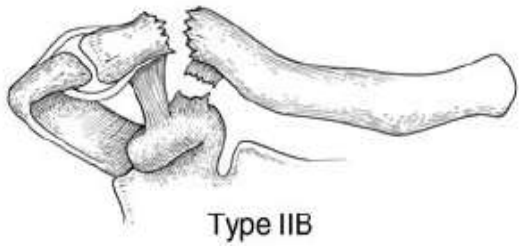
In all **type II** fractures, the proximal fragment is detached from the CC ligaments. The distal fragment remains attached to the scapula via the AC joint capsule.

In **type IIA** fracture, the fracture lies medial to the conoid ligament.

In **type IIB** fracture, the fracture lies between the conoid and trapezoid ligaments.

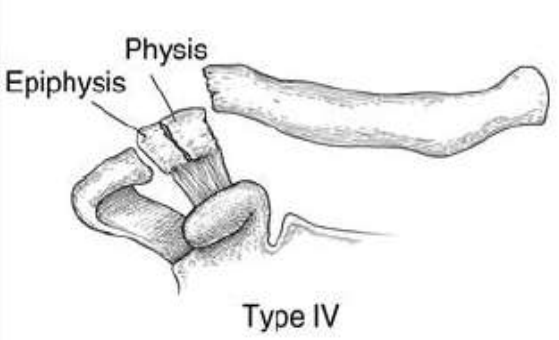


Type IIA

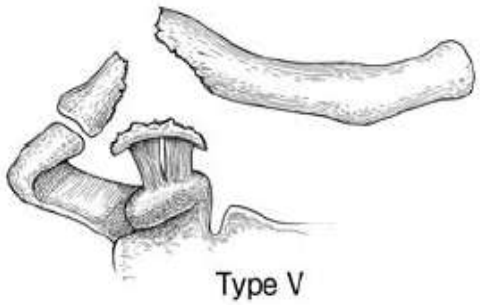

Type IIB

Classification

Type IV involve disruption of the periosteal sleeve. These fractures are injuries to the growth plate in which the epiphysis and physis typically maintain their relationship to the shoulder Joint.



In type V fracture, only a small inferior cortical fragment remains attached to the CC ligaments. The stability of the distal and proximal fracture fragments is compromised.



Treatment options

Nonoperative (Type I & III)

Sling immobilization for 2 weeks and shoulder motion is initiated as soon as the initial pain improves

Repeat radiographs are obtained at 6-week follow-up to monitor for fracture displacement

Risk of delayed-onset symptomatic AC arthrosis, which can be managed with distal clavicle resection

Treatment options

Operative (Type II)

- Transacromial wire fixation
- Modified Weaver-Dunn procedure
- Tension band
- CC screw fixation
- CC loop augmentation
- Plate fixation (Hook, distal radius)
- Arthroscopic treatment
- Other techniques

Review Article

Management of Distal Clavicle Fractures

J Am Acad Orthop Surg 2011;19: 392-401

Rahul Banerjee, MD
Brian Waterman, MD
Jeff Padalecki, MD
William Robertson, MD

Reported Rates of Nonunion Following Nonsurgical Management of Type II Distal Clavicle Fractures

Management	Average Follow-up	Outcome	No. of Symptomatic Nonunions
12 nonsurgical	4 mo[a]	8 delayed union (67%), 4 nonunion (33%)	4
4 excision	NR	N/A	NR
7 ORIF	3 mo[b]	All united	0
Nonsurgical	14.3 mo	3 nonunion (30%)	0
20 nonsurgical	3 y	9 delayed union (45%), 6 nonunion (30%)	6
23 surgical	21 mo	All united	0
Nonsurgical	15 y	5/18 nonunion (28%)	2
16 nonsurgical	53.5 mo	7 nonunion (44%)	2
14 ORIF	59.8 mo	All united	0
72 nonsurgical, 3 excision, 11 delayed surgery	6.2 y	32/86 nonunion (37%)[f]	11
Nonsurgical	24 wk	25.4% nonunion[h]	NR

Studies involving clinical assessment in patients with distal clavicular nonunions have indicated that only **20% to 34**% were symptomatic and eventually required surgical fixation

Review Article

Management of Distal Clavicle Fractures

J Am Acad Orthop Surg 2011;19: 392-401

Rahul Banerjee, MD
Brian Waterman, MD
Jeff Padalecki, MD
William Robertson, MD

(1) The reported rate of radiographic nonunion of all types of distal clavicle fractures reflects that of Neer's original series.

(2) Fracture displacement, as seen in most Neer type II fractures, is associated with the development of nonunion.

(3) Radiographic nonunion does not always correlate with symptomatic nonunion.

(4) Patients who develop symptomatic nonunion may or may not require additional surgery.

Transacromial wire fixation (Neer)

Nonunion

Infection

AC joint arthrosis

KW migration

KW breakage

Shoulder stiffness

Protected full range of shoulder motion before KW removal

J Shoulder Elbow Surg (2011) 20, 414-419

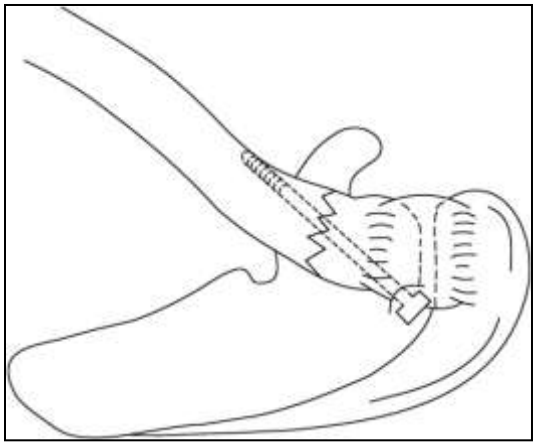
ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Treatment of unstable distal clavicle fractures with Knowles pin

I-Ming Jou, MD, PhD[a], Eric P. Chiang, MD[b], Chii-Jen Lin, MD, PhD[a], Cheng-Li Lin, MD[a], Ping-Hui Wang, MD[c], Wei-Ren Su, MD[a,*]



Extra-articular application to avoid arthrosis

All patients (12) had bony union

Mean period of healing 11.5 weeks

3 patients had proximal or distal skin irritation

Injury, Int. J. Care Injured (2005) 36, 1172–1175

ELSEVIER

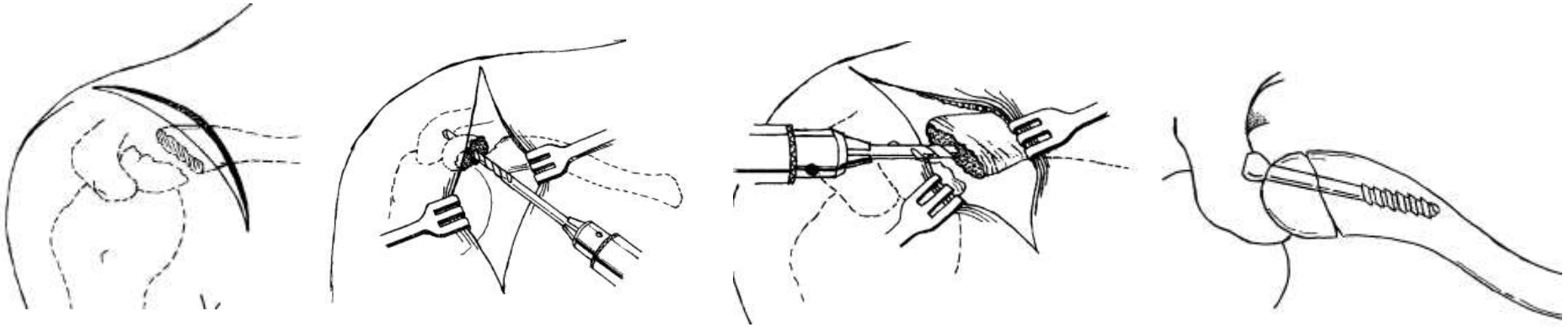
INJURY
INTERNATIONAL JOURNAL OF THE CARE OF THE INJURED

www.elsevier.com/locate/injury

Intramedullary fixation of Neer type 2 fractures of the distal clavicle with an AO/ASIF screw

J.E. Scadden*, R. Richards

4.5 mm AO/ASIF malleolar screw



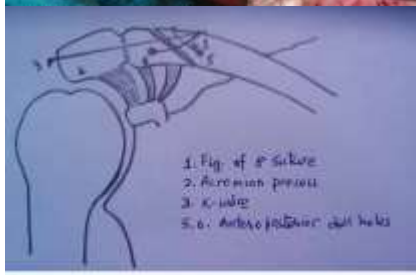
International Orthopaedics (SICOT) (2012) 36:1417–1422
DOI 10.1007/s00264-012-1514-9

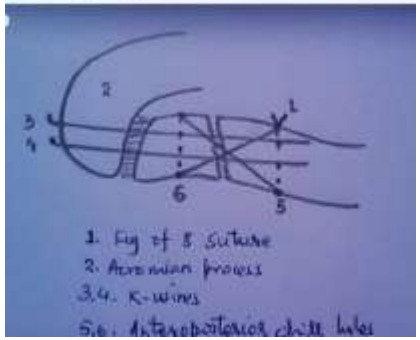
ORIGINAL PAPER

Modified tension band for displaced type 2 lateral end clavicle fractures

Laxman Rijal · Gopal Sagar · Anshumala Joshi · Khima Nand Joshi

16 patients
average age 36.25
No loss of reduction
average time of union 10.75 weeks
near normal range of motion
Skin impingement in four cases
Kirshner wires backed out in one case
No infection or breakage

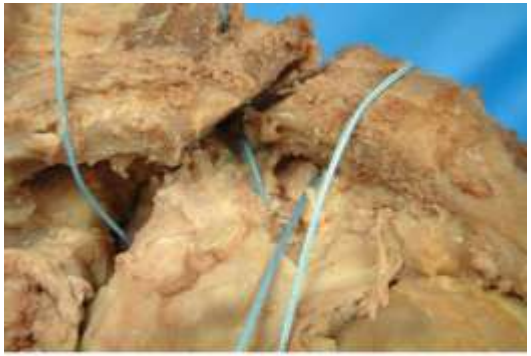


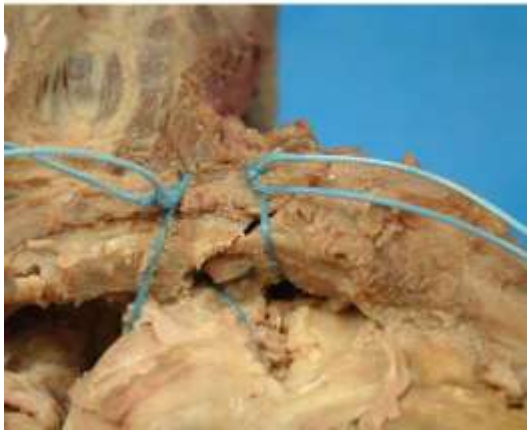


OPERATIVE TECHNIQUES FOR DISPLACED DISTAL CLAVICLE FRACTURES

ROBERT A. ARCIERO, MD

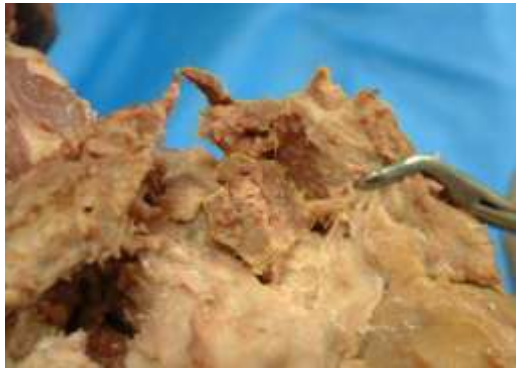
Operative Techniques in Sports Medicine, Vol 12, No 1 (January), 2004: pp 27-31

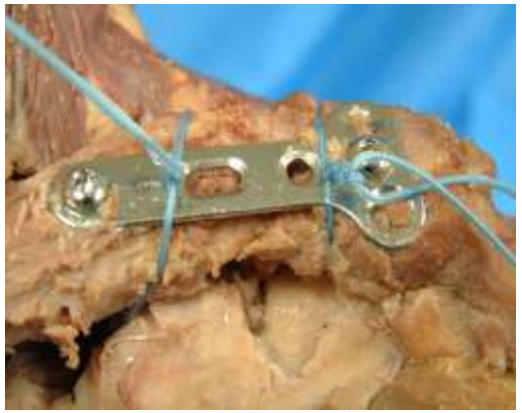




Goldberg technique

Levy technique





Comparison of Clinical Results of Surgical Treatment for Unstable Distal Clavicle Fractures by Transacromial Pins With and Without Tension Band Wire

Yu-Chuan Tsuei[1,2], Man-Kuan Au[1], William Chu[1,2]*

J Chin Med Assoc 2010;73(12):638–643]

6 pin migrations

Combined with:

3 residual displacement &

1 recurrent fracture

1 pin migration

Combined with:

1 residual displacement

Coracoclavicular screw

Technically demanding as a result of the fairly narrow area within the coracoid that is available for screw fixation.

High rate of fixation failure due to screw cutout or loosening

The screw often limits shoulder movement and often needs to be removed once the fracture has unit

J Shoulder Elbow Surg (2010) 19, 121-129

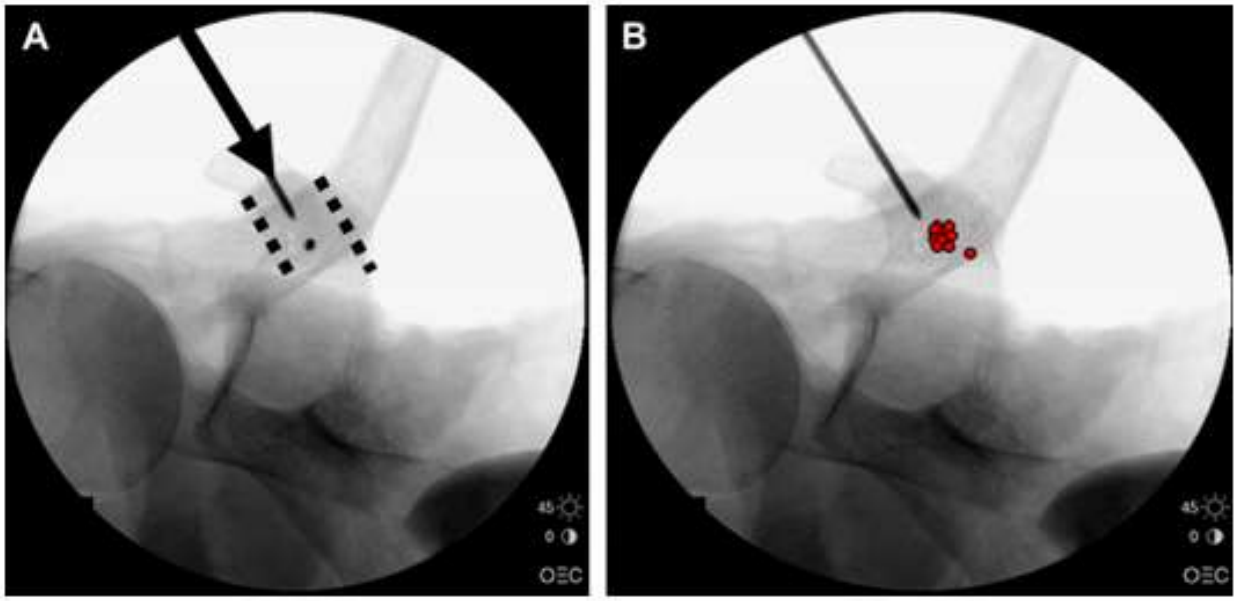
ELSEVIER

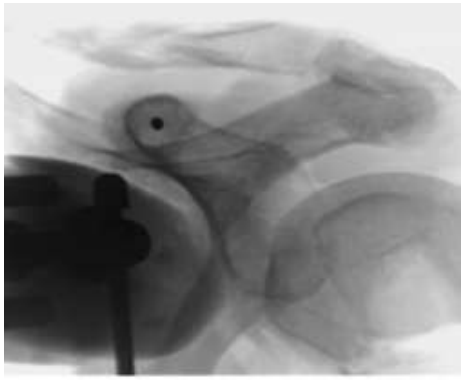
Journal of Shoulder and Elbow Surgery

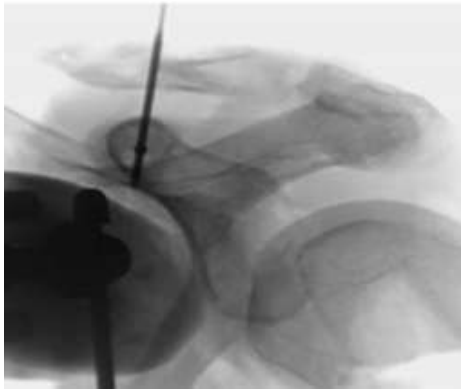
www.elsevier.com/locate/ymse

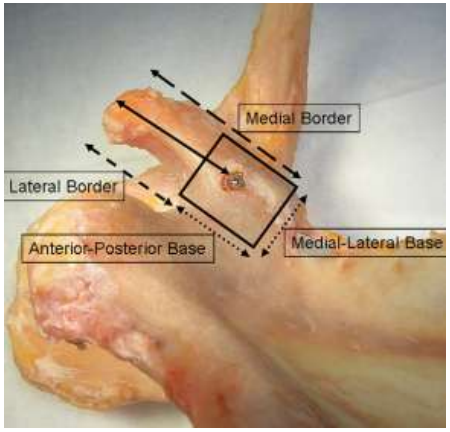
The cortical ring sign: A reliable radiographic landmark for percutaneous coracoclavicular fixation

Grant E. Garrigues, MD[a,*], Milford H. Marchant Jr., MD[b], Gemma C. Lewis, BS[a], Anil K. Gupta, MD, MBA[a], Marc J. Richard, MD[a], Carl J. Basamania, MD[c]







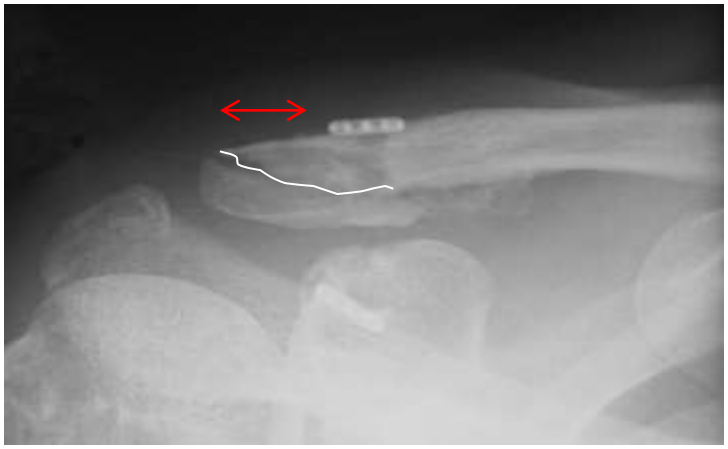


Coracoclavicular Augmentation ± fixation

Indirect reduction of dislocated medial fragment using tapes, sutures, dacron, anchors

Reinforcement of other fixation techniques (KW, plates)

Even new implants (Tight rope) or arthroscopic techniques



Bezer M, Aydin N, Guven O: The treatment of distal clavicle fractures with coracoclavicular ligament disruption: A report of 10 cases. J Orthop Trauma 2005;19(8):524-528.
Chen CH, Chen WJ, Shih CH: Surgical treatment for distal clavicle fracture with coracoclavicular ligament disruption. J Trauma 2002;52(1):72-78.

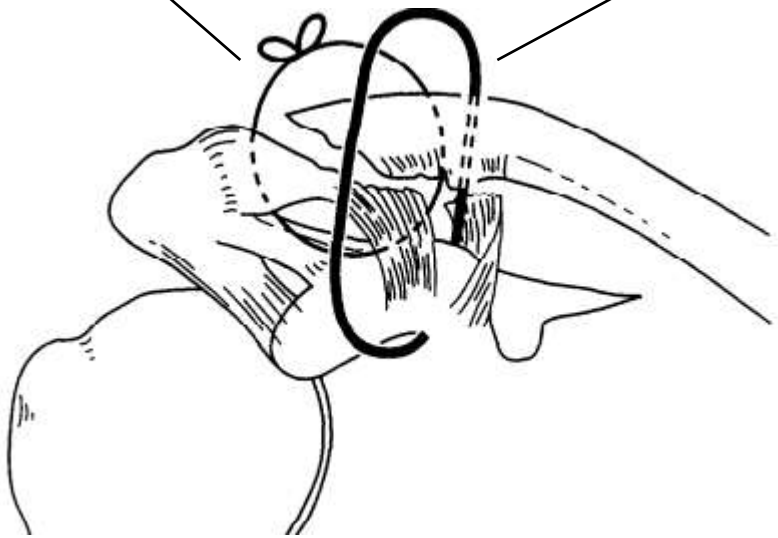
Type 2 fractures of the distal clavicle: A new surgical technique

(J Shoulder Elbow Surg 1997;6:380-2.)

Jerome A Goldberg, MB, BS, FRACS, FA Orth A, Warwick J M Bruce, MB, BS, FRACS, FA Orth A, David H Sonnabend, MB, BS, BSc (med), FRACS, FA Orth A, and William R Walsh, PHD, *Sydney, Australia*

No 5 sutures

Dacron tape



Injury, Int. J. Care Injured 40 (2009) 1308–1312

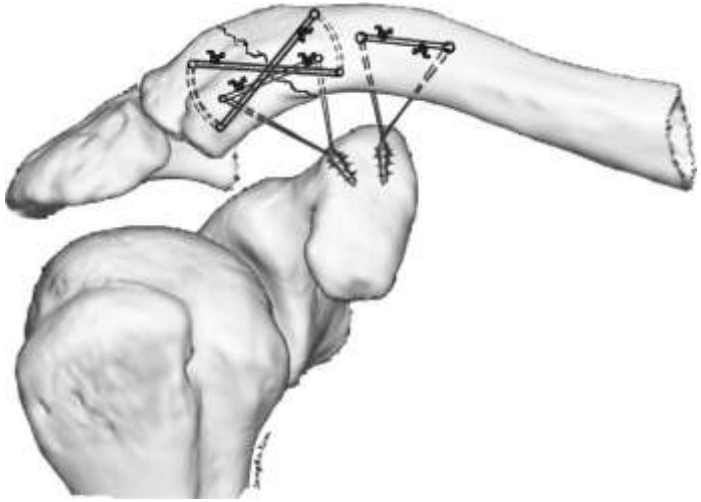
Contents lists available at ScienceDirect

Injury

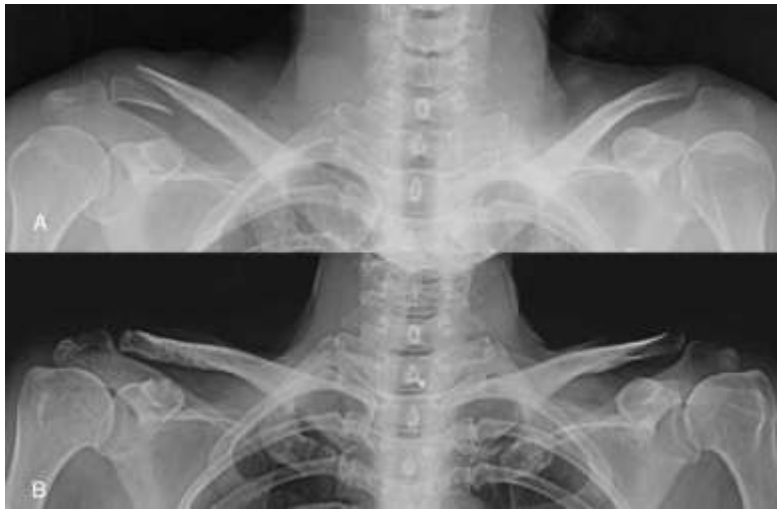
journal homepage: www.elsevier.com/locate/injury

Treatment of unstable distal clavicle fractures using two suture anchors and suture tension bands

Sang-Jin Shin *, Kwon Jae Roh, Jong Oh Kim, Hoon-Sang Sohn



1 nonunion/19 patients,
2 pt delayed union
2 pt clavicular erosion
1 pt with malunion



Clavicular plating

A method for internal fixation of unstable distal clavicle fractures: Early observations using a new technique

Michael Kalamaras, BSc(Anat), BMBS, Ken Cutbush, MBBS, FRACS(Orth), and Mark Robinson, MBBS, FRACS(Orth), *Brisbane, Australia*

Small and mini-fragment locking plates

Injury, Int. J. Care Injured 40 (2009) 455–457

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Technical note

Stable fixation of distal clavicle fracture with comminuted superior cortex using oblique T-plate and cerclage wiring

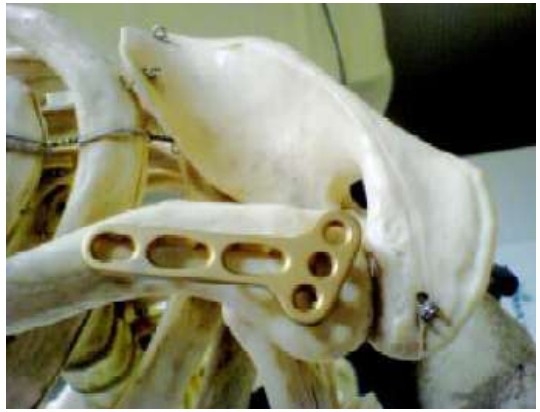
e Hyun Yoo*, Jun Dong Chang, Young Jin Seo, Jae Hyuk Shin

Treatment of distal clavicle fracture with distal radius volar locking compression plate

YU Chao 俞超, SUN Yue-hua 孙月华*, ZHAO Chang-qing 赵长清, SHI Ding-wei 史定伟 and WANG You 王友

Table 1. Clinical data of the 6 patients after surgery

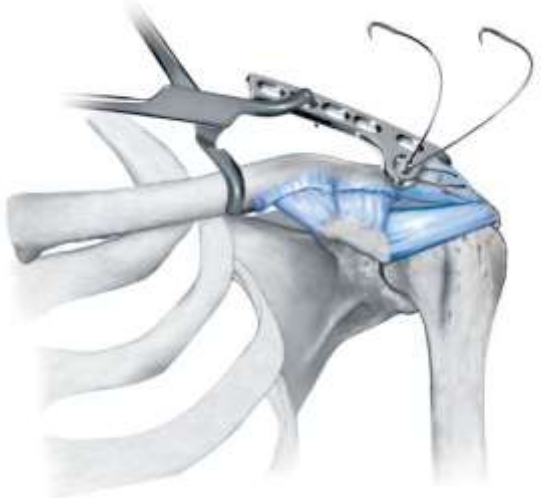
Patient No.	Age (years)	Gender	Total follow-up (weeks)	Bone union (weeks)	Constant score
1	31	Female	25	8	96
2	41	Male	22	8	98
3	23	Male	17	6	100
4	52	Male	16	10	95
5	38	Female	12	8	98
6	34	Male	10	8	98



Clavicular plating

- violation of the AC joint
- need for implant removal
- bending or redislocation
- increased risk of infection
- acromial fracture
- rotator cuff injury

Hook plate



J Shoulder Elbow Surg (2012) 21, 1045-1048

ELSEVIER

Journal of Shoulder and Elbow Surgery

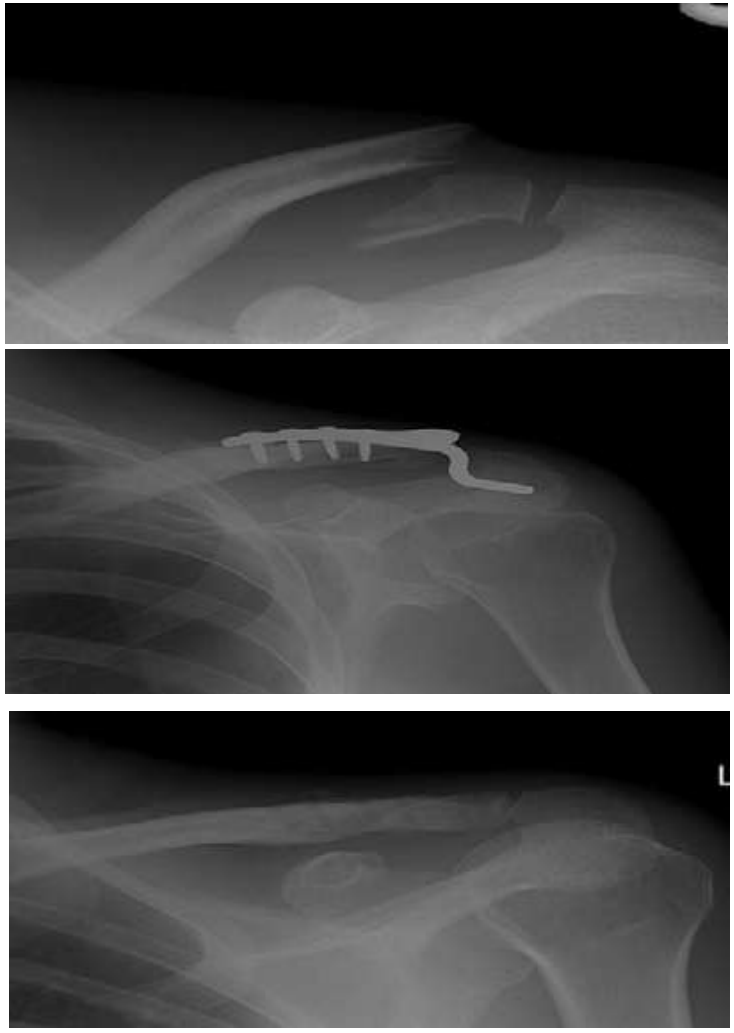
www.elsevier.com/locate/ymse

Clavicle hook plate fixation for displaced lateral-third clavicle fractures (Neer type II): a functional outcome study

Daniel W. Good, BA, MRCSI*, Darren F. Lui, MCh, MRCS, Michael Leonard, MCh, MRCS, Seamus Morris, MCh, FRCS (Trauma Orth), John P. McElwain, FRCS (Trauma Orth)

36 patients
mean age 36.2 years
median follow-up 28 months
mean time to union 3 months
union rate was 95%.
92% of plates were removed.
median time to removal was 4.5 months

Two patients presented months later after falls with fractures around the medial end of the hook plate.



J Exp Clin Med 2012;4(5):270–274

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Journal of Experimental and Clinical Medicine

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ORIGINAL ARTICLE

Clavicular Hook Plate: A Better Implant Choice for Fixation of Unstable Distal Clavicle Fractures?

Tsai-Hsueh Leu [1], Wei-Pin Ho [1], Poo-Kuang Wong [1], Tai-Yuan Chuang [1], Chin-Chean Wong [1,2*]

Table 1 Demographic data of patients receiving either HP fixation or KTBW

Clinical outcomes	HP ($n = 25$)	KTBW ($n = 20$)	p value
Union rate	24/25 (96)	16/20 (80)	0.084
Surgical revision	0/25 (0)	2/18 (11.1)	0.199
Wound infection	0/25 (0)	4/20 (20)	0.035
Distal clavicle osteolysis	1/25 (4)	0/20 (0)	0.258
Coracoclavicular widening	0/25 (0)	6/20 (30)	0.034
Loss of implant fixation	2/25 (8)	4/20 (20)	0.041
Hardware removal	25/25 (100)	20/20 (100)	1.0
Symptomatic hardware	4/25 (16)	9/20 (45)	0.049
Shoulder impingement	9/25 (36)	1/20 (5)	0.03
Functional score (mean ± SD)	85.7 ± 9.2	86.94 ± 4.36	0.56

HP = hook plate; KTBW = K wire and tension band wire; SD = standard deviation.

Clavicular HP did not offer more clinical advantages than with KTBW in treating unstable distal clavicle fracture

IVYSPRING INTERNATIONAL PUBLISHER

International Journal of Medical Sciences

2012; 9(4):301-305. doi: 10.7150/ijms.4425

Research Paper

Surgical Treatment for Unstable Distal Clavicle Fracture with Micromovable and Anatomical Acromioclavicular Plate

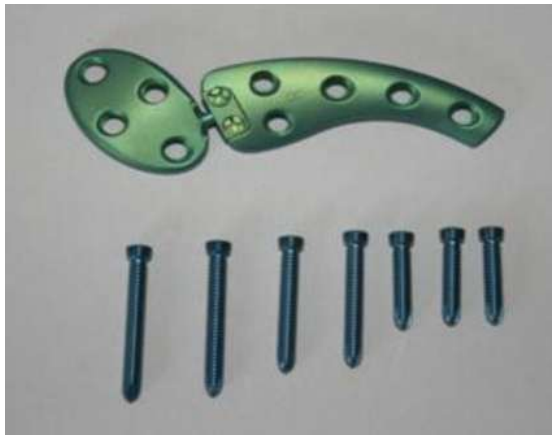
Qingjun Liu*, Jianyun Miao*, Bin Lin✉, Kejian Lian

18 pt

Solid union in all

Follow-up 18 months

No postop complications



Arch Orthop Trauma Surg (2011) 131:525–533
DOI 10.1007/s00402-010-1196-y

TRAUMA SURGERY

Treatment of distal clavicle fracture: a systematic review of treatment modalities in 425 fractures

Joo Han Oh · Sae Hoon Kim · Jung Ha Lee · Seung Han Shin · Hyun Sik Gong

425 cases Neer II fractures
60 conservative, 365 surgically.
105 coracoclavicular stabilization
162 hook plate
42 intramedullary fixation
16 interfragmentary fixation,
40 K-wire plus tension band wiring.

33.3% nonunions in the nonsurgical group

1.6% nonunions, and 22.2% complications

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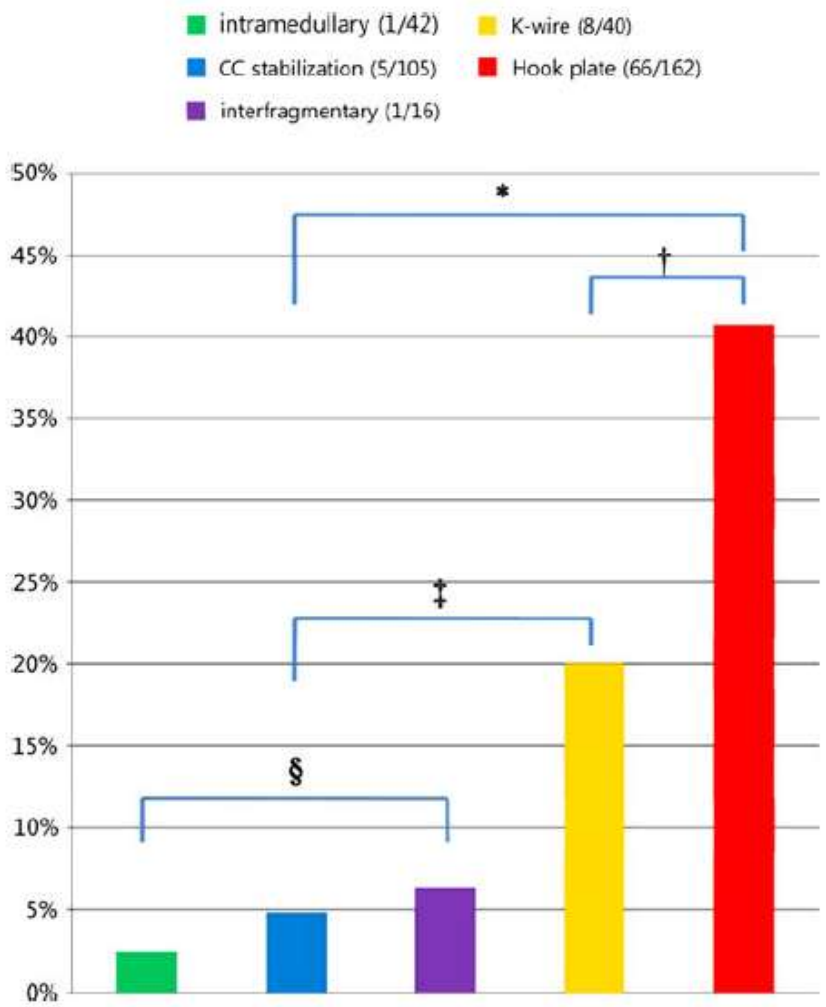

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TRAUMA SURGERY

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- For the nonsurgical treatment, the functional outcomes were generally acceptable despite the high nonunion rate.
- The nonsurgical treatment could be considered as the first line treatment after sufficient counsel with the patient.
- The nonunion rate is high, however, the functional outcome is acceptable in most of the cases with nonunion.
- If the surgical treatment is considered, the **intramedullary screw fixation**, **CC stabilization** and **interfragmentary fixation** would be preferred because of their low complication rate