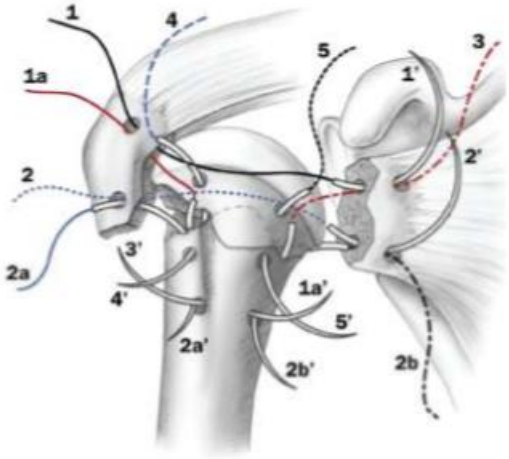
Minimal invasive osteosynthesis of 4-part valgus impacted fractures of the proximal humerus: A systematic review of literature



Panagopoulos A,
Tatani I,
Ntourantonis D,
Seferlis I,
Kouzelis A,
Tyllianakis M.

Department of Shoulder & Elbow Surgery
University Hospital of Patras, Greece

Epidemiology

Fractures of the proximal humerus:

- Increased overall incidence
  (17,1% to 47,9% last 15 years)
- Increase annual incidence 13%
- Increased age of presentation
  (78 ♁ 73 ♂)

Safran MR, et al. CORR, 2002

Current Surgical Treatment Options for Complex Proximal Humeral Fractures

George M Kontakis, MD[1], Theodoros Tosounidis, MD[2], and Kyriakos Kakavelakis, MD[3]

[1]University of Crete, Crete, Greece; [2]Leeds General Infirmary, Leeds, UK; and [3]University Hospital of Heraklion, Crete, Greece.

Adv Orthop 2010;**2**(2):43–50.

What is the fracture pattern?

Does it need to be treated surgically?

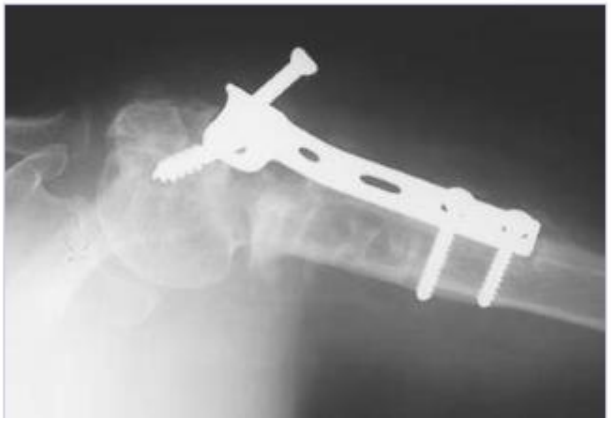
Does the medical status of the patient permit operative treatment?

Could the anatomy can be restored by means of stable and durable fixation?

Is the humeral head viable?

What kind of osteosynthesis?

How much minimal …?



ELSEVIER

Semin Arthro 23:74-82 © 2012

Seminars in Arthroplasty

Proximal Humerus Fractures: Pin, Plate, or Replace?

Charles M. Jobin, MD, and Leesa M. Galatz, MD

Key factors

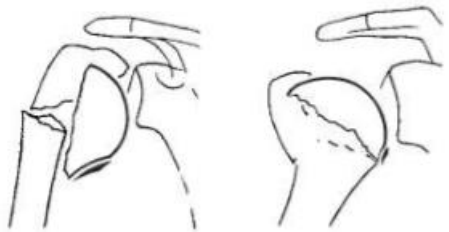
- **fracture type**
- bone quality
- **integrity of the medial calcar**
- tuberosity comminution
- risk of AVN
- joint congruity
- functional demands

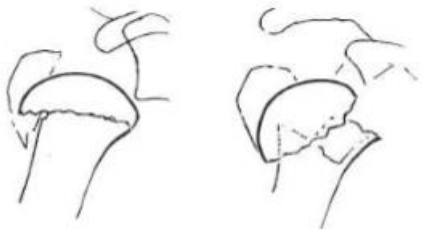
Ischemia predisposing factors

a) length of medial metaphyseal head extension (< 8 mm in ischemic heads)

b) integrity of the medial hinge (43 / 55 ischemic heads > 2 mm)

c) splitting head component

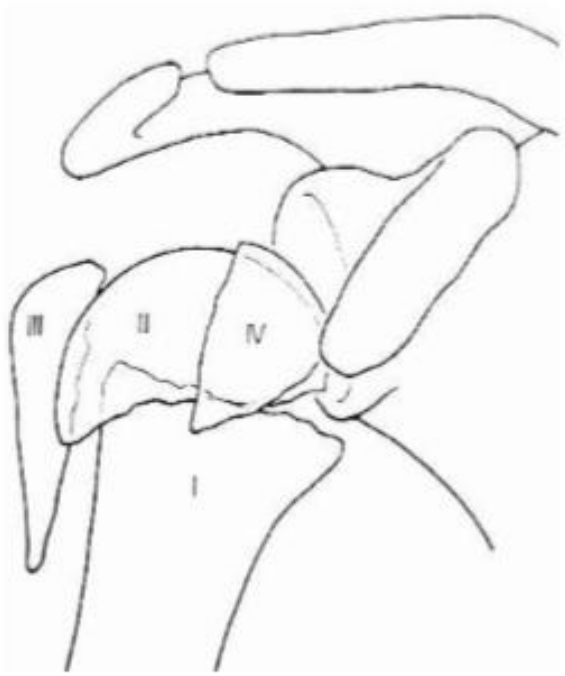


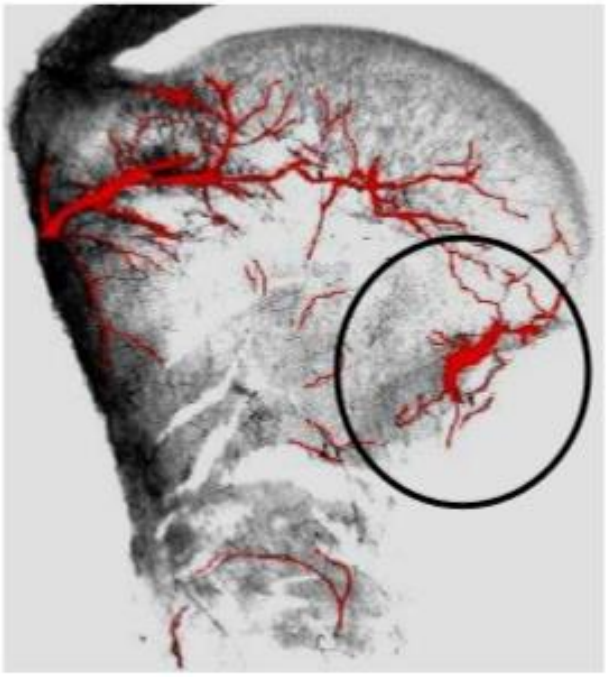


Hertel R, et al. JESS 2004

4-part valgus impacted fracture

Lower incidence of AVN





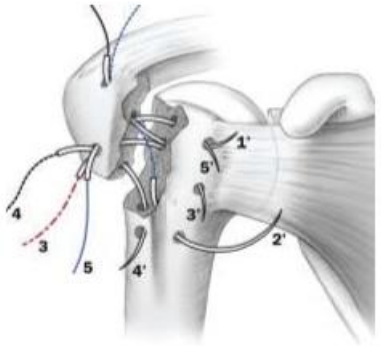
Jacobs 1991

Neer 2002

Transosseous Suture Fixation of Proximal Humeral Fractures

By Panayiotis Dimakopoulos, MD, Andreas Panagopoulos, MD, PhD, and Georgios Kasimatis, MD

Investigation performed at the Shoulder and Elbow Unit, Orthopaedic Department, Patras University Hospital, Patras, Greece



2-part

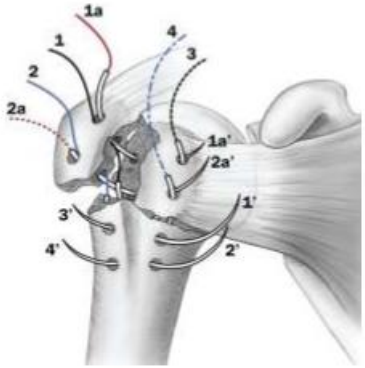
Transosseous Suture Fixation of Proximal Humeral Fractures

Surgical Technique

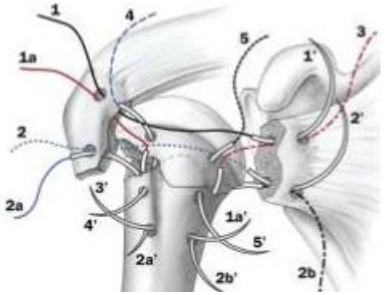
By Panayiotis Dimakopoulos, MD, Andreas Panagopoulos, MD, and Georgios Kasimatis, MD

Investigation performed at the Shoulder and Elbow Unit, Orthopaedic Department, University Hospital of Patras, Patras, Greece

The original scientific article in which the surgical technique was presented was published in JBJS Vol. 89-A, pp. 1700-9, August 2007



3-part



4-part

165 patients, forty-five (27%) four-part fractures with valgus impaction, 7% overall incidence of AVN

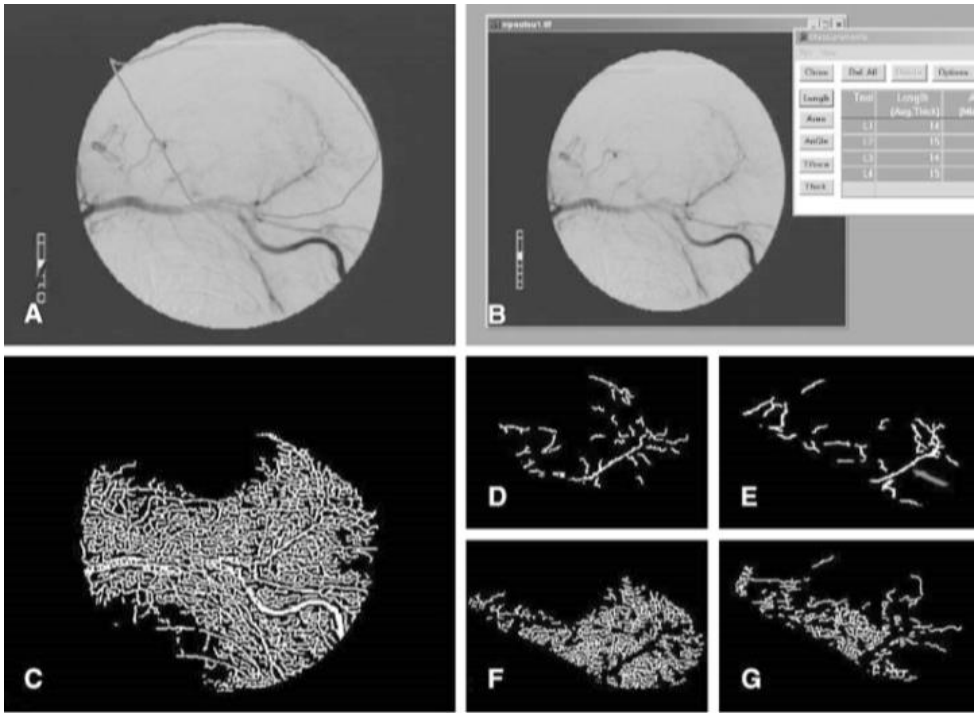
International Orthopaedics (SICOT) (2004) 28: 333–337
DOI 10.1007/s00264-004-0581-y

ORIGINAL PAPER

Andreas M. Panagopoulos · P. Dimakopoulos ·
M. Tyllianakis · D. Karnabatidis · D. Siablis ·
A. X. Papadopoulos · E. Lambiris · P. Kraniotis ·
G. Sakellaropoulos

Valgus impacted proximal humeral fractures and their blood supply after transosseous suturing

transosseous fixation seems to preserve the remaining blood supply of the humeral head



Purpose

We systematically reviewed clinical studies assessing the benefits and harms of minimal invasive osteosynthesis for VI fractures

Included studies had to describe outcomes and complications after primary osteosynthesis with any type of minimal invasive fixation apart from plate-screws and intramedullary nailing

Methodology

Inclusion criteria

- English language,
- 5 or more patients,
- complete demographic data,
- minimal invasive technique
- at least 1 year follow up
- performance score (Constant, Neer, ASES)
- report of complications

Search strategy

Query: four part fractures proximal humerus or 4-part fractures, valgus impacted fractures, 4-part valgus impacted fractures, fractures with valgus impaction, C1.1, C2.1 proximal humeral fractures, minimal invasive osteosynthesis, percutaneous osteosynthesis, percutaneous fixation, osteosuturing, transosseous sutures, minimal internal fixation, **NOT plate, NOT nailing, NOT hemiarthroplasty**
Publication dates: March 1991 to May 2014

292 articles

65 removed after title review

227 relevant articles

188 removed after abstract review due to:
Biomechanical/Anatomical studies (6)
Imaging series (4)
Conservative treatment (8)
External fixation (3)
Nailing (8)
Plate fixation (54)
Hemiarthroplasty (47)
Reviews or Editorial (10)
Case reports (4)
Comparative studies, no minimal techniques (8)
Surgical technique articles (3)
Other types of fractures (31)
[2-,3-part, split head & fracture-dislocations]

41 relevant articles

28 removed to:
2-and 3-part fractures only(12)
Less than 5 cases (3)
No valgus impacted (6)
No clinical score (3)
No minimal technique (2)
Surgical technique (1)
Duplication of results (1)

13 articles for final review

13 eligible studies (all Level IV)

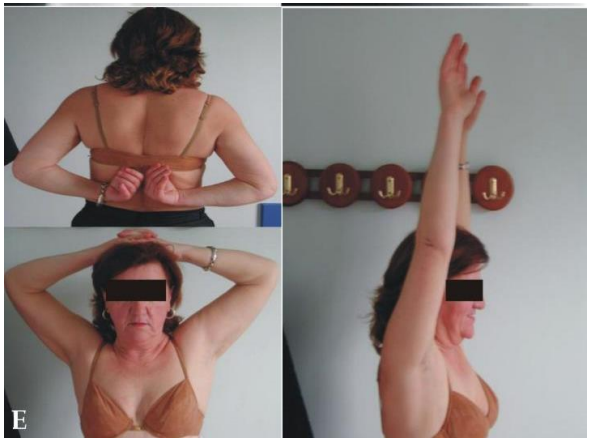
Author	Year	Patients (bilateral)	Mean age (years)	Follow-up (months)	Lost from final follow up
Jakob et al[1]	1991	18 (19)	49.5	50	none
Resch et al[24]	1995	22	52	36	none
§Resch et al[25]	1997	13	54	24	none
Yu et al [21]	2002	8 (9)	56	26	none
Hockings et al [22]	2002	11	55	69	2
Robinson et al [17]	2003	25	67.2	24	4
§Gerber et al[20]	2004	8	48.8	63	none
Panagopoulos et al[19]	2004	15	45	40	1
§Dimakopoulos et al [14]	2007	45	49	52	4
Atalar et al [27]	2007	10	54	38.8	none
§Keener et al [16]	2007	12	56.8	35	n/a
§Bogner et al[23]	2008	16	79#	33.8#	n/a
Ogawa et al [26]	2011	10	55.5	33.8	3
TOTAL (13)		**213 (215)**	**55.5**	**40.4**	14/187 (7.5%)

Clinical results

- **213** patients (**62%** female)
- average age **55.5** years old
- **open** reduction 9/13 studies

  (KW, cerclage wires, screws and osteosutures)
- **closed** reduction 4/13 studies

  (percutaneous fixation)
- mean **follow-up** time 24 to 63 months

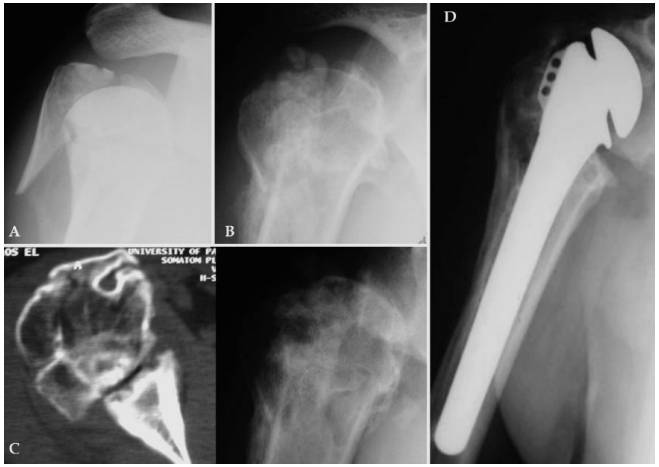


- **Constant score** > 80 in 10/12 studies

Complications

AVN 9.9% (range, 0–26.3%)

- tuberosities displacement
- subacromial impingement,
- osteoarthritis, HO
- adhesive capsulitis



None of the studies reported any case of nerve complications and postoperative infections

The overall **re-operation rate** was 3.2%

Discussion

The designs of the included studies do not allow for quantitative data synthesis of outcome (Level IV)

Risk of biases

fracture classification,

mean age of patients,

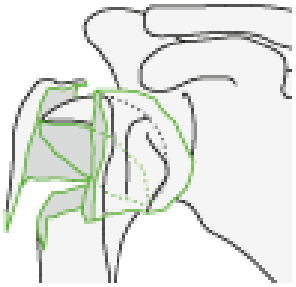
mixed types of surgical techniques

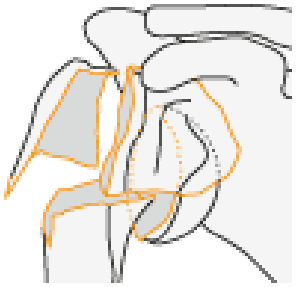
non-adjusted clinical outcome

small follow up periods

Fracture classification

AO C1.1 C1.2 NEER





RESEARCH ARTICLE Open Access

Translation between the Neer- and the AO/OTA-classification for proximal humeral fractures: do we need to be bilingual to interpret the scientific literature?

Stig Brorson[1*], Henrik Eckardt[2], Laurent Audigé[3], Bernd Rolauffs[4] and Christian Bahrs[4]

10 studies with 2530 pairs of data on proximal humeral fractures classified according to both systems:
35% “not plausible” and 34% “problematic” combinations

Fracture classification

8/13 studies were referred solely to 4-part VI fractures but only 2 studies provided details for **degree of rotation** of head fragment and the amount of its **lateral displacement**

In the other five studies data were extracted from a mixed population of fractures including 3- and 4-part fractures

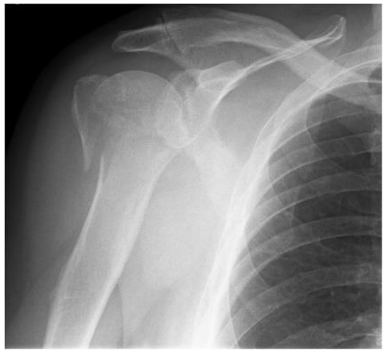
Four-segment classification of proximal humeral fractures revisited: A multicenter study on 509 cases

Kazuya Tamai, MD[a,*], Noriyuki Ishige, MD[b], Shigehito Kuroda, MD[b], Wataru Ohno, MD[a], Hiromoto Itoh, MD[c], Hiroshi Hashiguchi, MD[c], Norishige Iizawa, MD[c], Motohiko Mikasa, MD[b]

J Shoulder Elbow Surg (2009) 18, 845-850

Prerequisites

(1) the humeral head is impacted into the shaft,
(2) the humeral head and the glenoid fossa are in some contact,
(3) the tuberosities are fractured but remain near the humeral head and shaft,
(4) the medial part of the humeral head is in some contact with the medial part of the proximal shaft



True VI fracture

Mean age of patients

The relatively low mean age in the included studies (mean, **55.5** years-old) may indicate an unreported upper limit of age for use minimal invasive surgical techniques.

Different surgical techniques

Overall rate of AVN was slight higher with percutaneous techniques (13.6%) than with open reduction and internal fixation (8.2%) but this was not statistically significant.

Adjustment for clinical outcome

Almost all studies (12/13) utilized the use of Constant score

A higher Constant Score is expected in younger patients

As non-adjusted Constant Score decreases in the very elderly the positive effect of interventions in this group is likely to be underestimated

Duration of follow up

Intermediate Outcomes Following Percutaneous Fixation of Proximal Humeral Fractures

Alicia K. Harrison, MD, Konrad I. Gruson, MD, Benjamin Zmistowski, BS, Jay Keener, MD, Leesa Galatz, MD, Gerald Williams, MD, Bradford O. Parsons, MD, and Evan L. Flatow, MD

Investigation performed at the Mount Sinai School of Medicine, New York, NY, Barnes-Jewish Hospital, St. Louis, Missouri, and the University of Pennsylvania Health System, Philadelphia, Pennsylvania

27 patients - Percutaneous fixation for 2-, 3- and 4-part VI fractures.

The short term results in **19** of them had been previously reported showing an overall AVN 3.2% (8.3% for 4-part VI fractures).

Re-evaluation showed unexpectedly higher rate of AVN, especially in 4-part VI fractures (5/10 patients, 50%), as well as posttraumatic osteoarthritic changes (60%).

Conclusions

- Insufficient study designs and unclear reporting preclude from safe treatment recommendations and quantitative data synthesis of outcome.

- In general, a good clinical result can be expected with a relative low incidence of osteonecrosis, hardware related complications and re-operation rates

- More well designed prospective comparative studies are needed to prove these results

Conclusions

Future studies:

- Use of updated Neer classification system plus the specific criteria for VI fractures
- Measurement of head rotation and lateral displacement of he head
- Age and sex adjustment of outcome scores (especially Constant)
- Definition of specific demographic data for each type of fracture when mixed population is reported
- Long term follow up to check the incidence of AVN and osteoarthritis

Patras University Hospital

Biggest Cable bridge in Europe (Rio-Antirio)