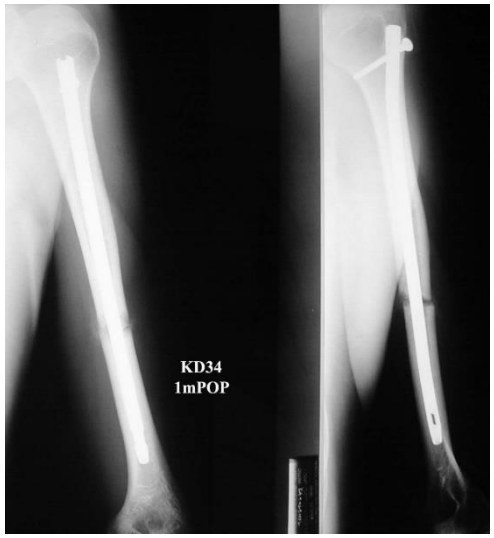
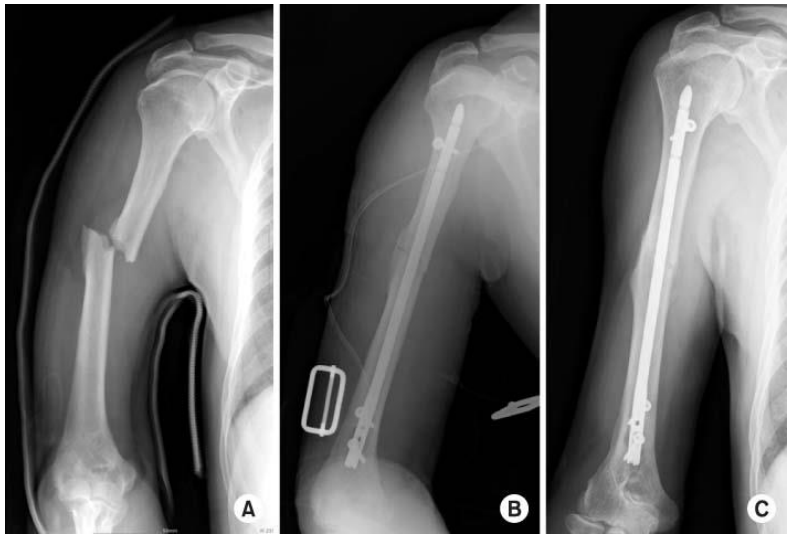
Intramedullary Nailing of Humeral Shaft Fractures

Antegrade or Retrograde approach?





Andreas Panagopoulos, MD, Ph.D.

Assistant Professor in Orthopedics, Medical School, Patras University

Sports Medicine & Knee Fellow, University of Leeds, UK

Shoulder & Elbow Fellow, King's College University, UK

Epidemiology

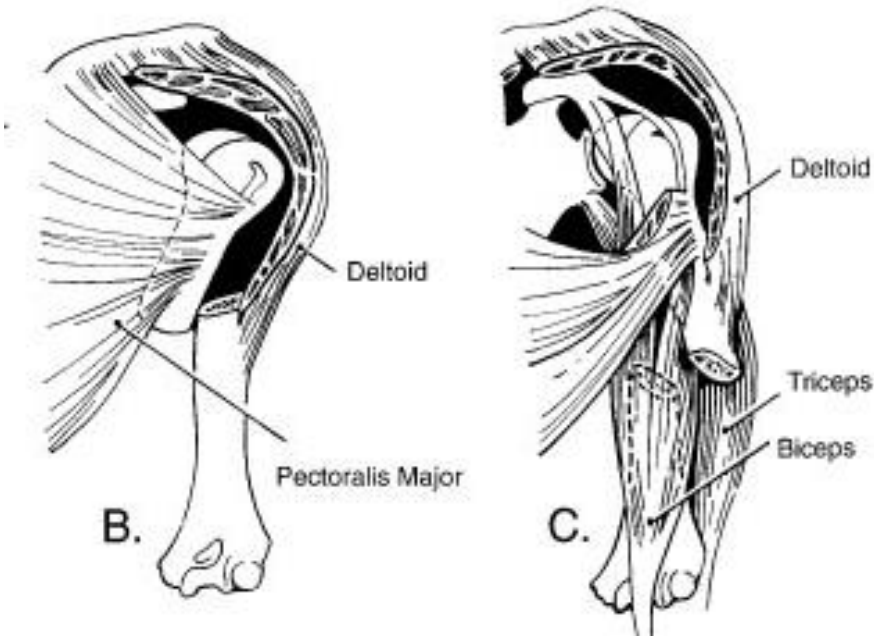
- 1-3% of all orthopaedic fractures
- 20% of shoulder fractures
- bimodal distribution 30 (m) & 70 (w)

Ekholm R, et al. 2006. Fractures of the shaft of the humerus.
An epidemiological study of 401 fractures. J Bone Joint Surg Br 88: 1469–73.

Surgical anatomy

Table 16.1. Position of fracture fragments

Fracture Location	Proximal Fragment	Distal Fragment
Above pectoralis major insertion	Abducted, rotated externally by rotator cuff	Medial, proximal by deltoid and pectoralis major
Between pectoralis major and deltoid tuberosity	Medial by pectoralis, teres major, and latissimus dorsi	Lateral, proximal by deltoid
Distal to deltoid tuberosity	Abducted by deltoid	Medial, proximal by biceps and triceps



Mechanism of injury




- direct blow to the arm
- twisting injuries
- traffic accidents
- pathologic fractures

Injury	Incidence (%)	Age (yr)
Simple fall	*59.2*	65.3
Fall from a height	*7.9*	43.2
Sport	*4.6*	20.5
RTA (pedestrian)	*4.2*	42.2
RTA (vehicular)	*12.9*	29.2
Pathological	*6.2*	53.4
Miscellaneous	*5.1*	36.9

Clinical & radiological evaluation

- Pain, swelling, deformity, haematoma, pathologic motion, crepitus, shortening

- assess motor and sensory function of the radial, median and ulnar nerves

Anteroposterior (AP) and lateral radiographs should be obtained first

The shoulder and elbow should be included on each radiograph

Classification

Low vs high energy

Soft tissue injury

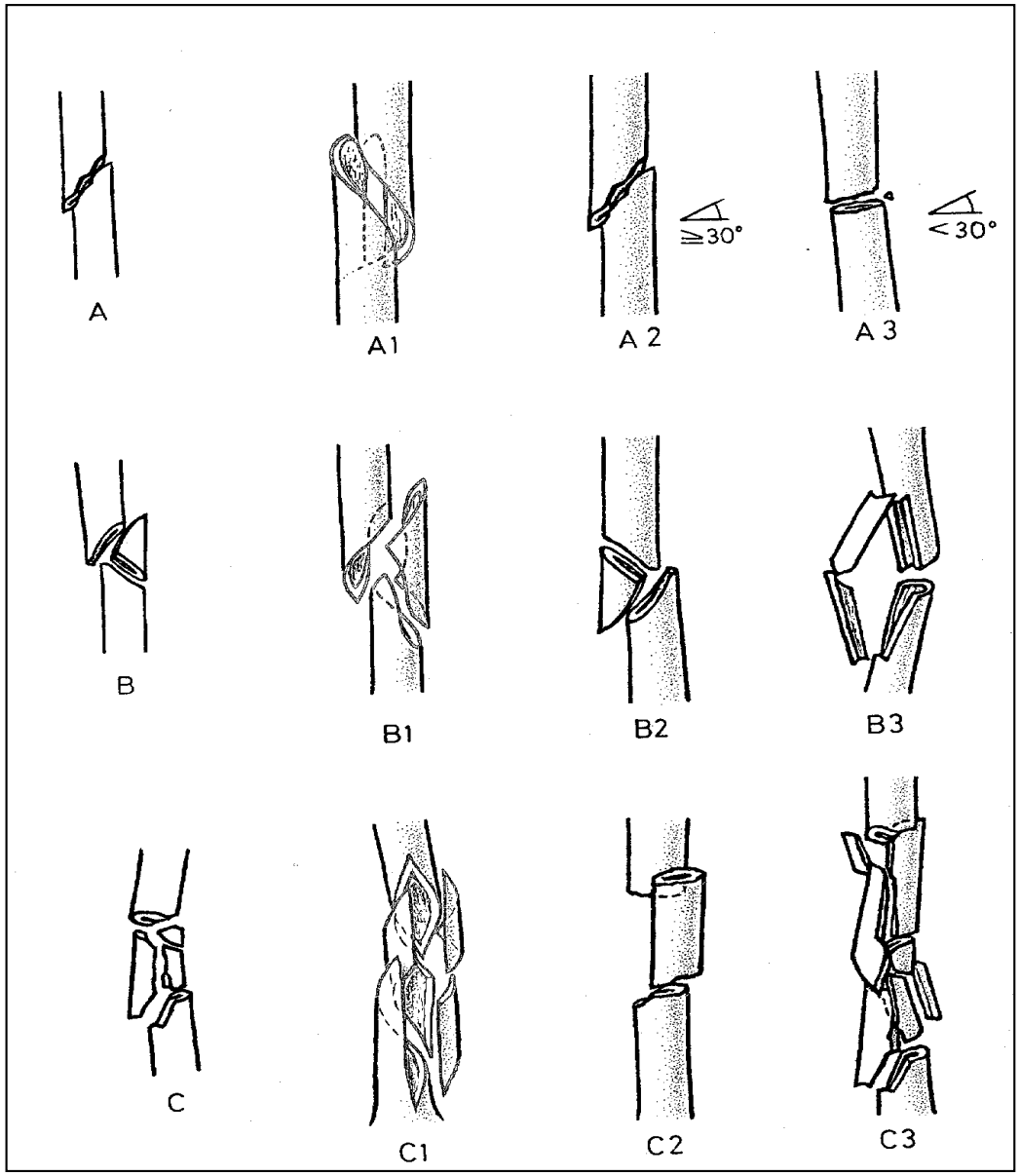
Open fracture grading

Associated injuries

Nerve or vascular injury

Co-morbidity

AO classification



Treatment

Orthopaedics & Traumatology: Surgery & Research xxx (2015) xxx–xxx

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Review article

Acute and chronic humeral shaft fractures in adults

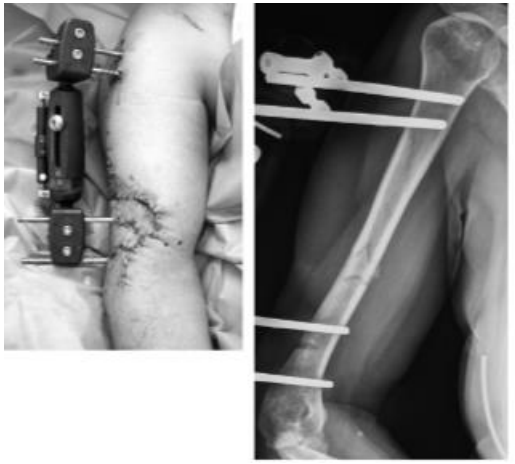
L. Pidhorz*

Conservative

External fixation

Plate fixation

Intramedullary nailing

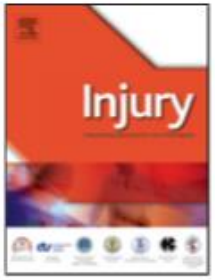


New fixations techniques and the pressure from patients for faster recovery have lead to increase use of surgical treatment

Accepted Manuscript

Title: Factors Predicting Patient Reported Functional Outcome Scores after Humeral Shaft Fractures

Author: Edward Shields Leigh Sundem Sean Childs Michael Maceroli Catherine Humphrey John Ketz John T. Gorczyca



Statistically significant effect on **patient-reported functional outcomes** following treatment of humeral shaft fractures, regardless of treatment modality, injury mechanism, and associated fractures

- patient age,
- history of psychiatric illness,
- insurance type,
- Charlson co-morbidity Index score,
- **fracture location**

Indications for operative intervention

1. Inability to maintain reduction due to obesity, intolerance of orthosis
2. Specific **fracture patterns** (segmental, simple transverse, long spiral, Holstein & Lewis)
3. Patients with multiple trauma
4. Bilateral fractures
5. Open fractures

Indications for operative intervention

6. Pathological fractures
7. Ipsilateral injuries (floating elbow or shoulder)
8. Spinal cord and brachial plexus injuries
9. Fractures associated with major vascular injuries
10. **Progressive** or **new onset** of a radial nerve palsy

Conservative treatment

Fractures of the shaft of the humerus will usually unite, irrespective of the type of the fracture (Sarmiento et al., 2001)

Union rates > 90% are often reported

Acceptable alignment:

- 3 cm of shortening
- 30 of varus / valgus angulation
- 20 of anterior / posterior angulation

J Shoulder Elbow Surg (2015) 24, 210-214

ELSEVIER

JOURNAL OF SHOULDER AND ELBOW SURGERY

www.elsevier.com/locate/ymse

Nonoperative treatment of humeral shaft fractures revisited

Erden Ali, MRCS[a,c,*], Dylan Griffiths, FRCS (T&O)[b], Nnamdi Obi, MRCS[a], Graham Tytherleigh-Strong, FRCS (T&O)[a], Lee Van Rensburg, FRCS (T&O)[a]

207 fractures, 138 fractures 5 y follow up
(24 nonunions – 15 operative treatment)

Overall union rate **83%**

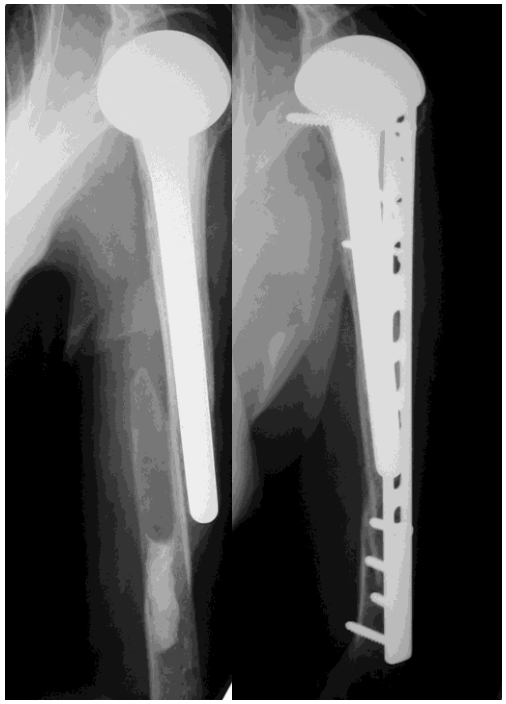
- Proximal third:76%
- Middle third: 88%
- Distal third: 85%

Comminuted fractures: 89% union rate regardless position

Plate osteosynthesis

Strong indications:

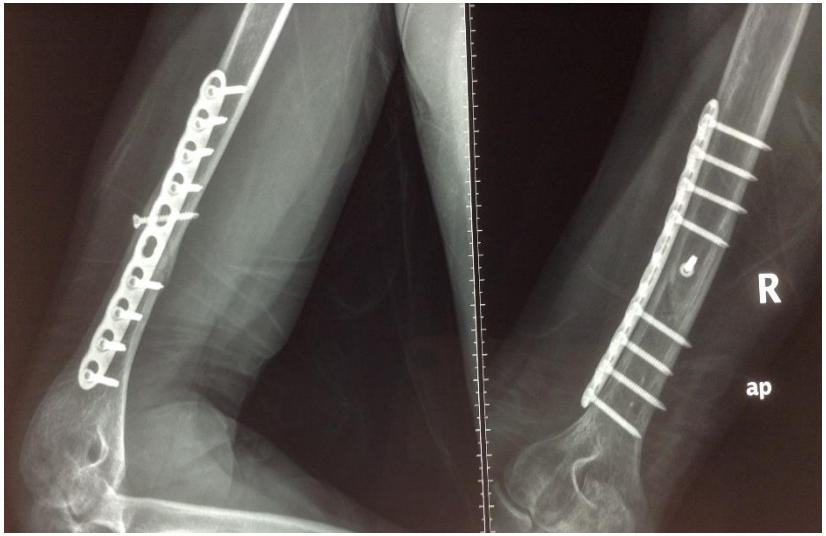
- periprosthetic fractures
- nonunion or delayed union
- ipsilateral arm fractures
- *specific fracture patterns?*



The rates of non-union and hardware failure requiring revision range from 2.5 to 16%

The most common complications are iatrogenic nerve palsy (0–5%) and infection (0–6%)

Holstein-Lewis with radial nerve palsy

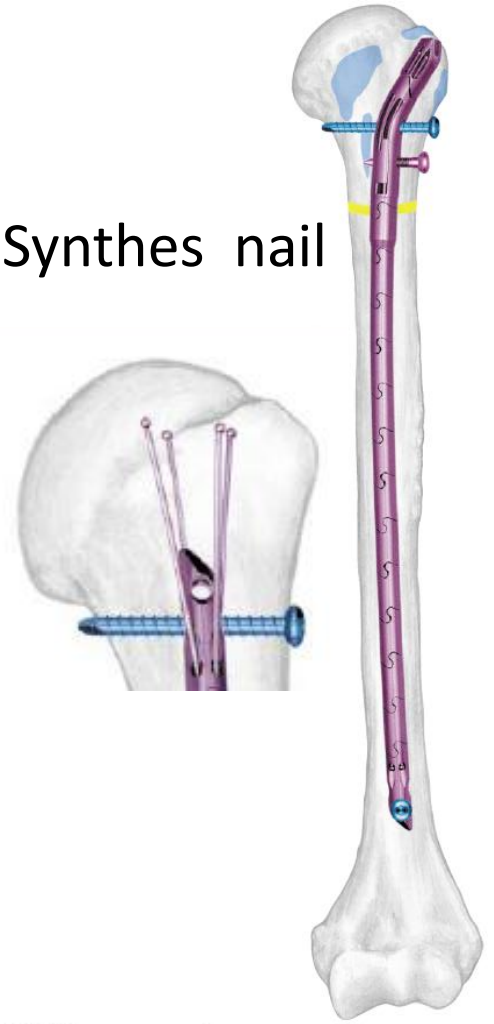


Intramedullary nailing

UHN

Garnavos nail

Synthes nail



Targon H

Uniflex® Humeral Nail System

J Orthop Sci (2011) 16:644–651
DOI 10.1007/s00776-011-0127-2

ORIGINAL ARTICLE

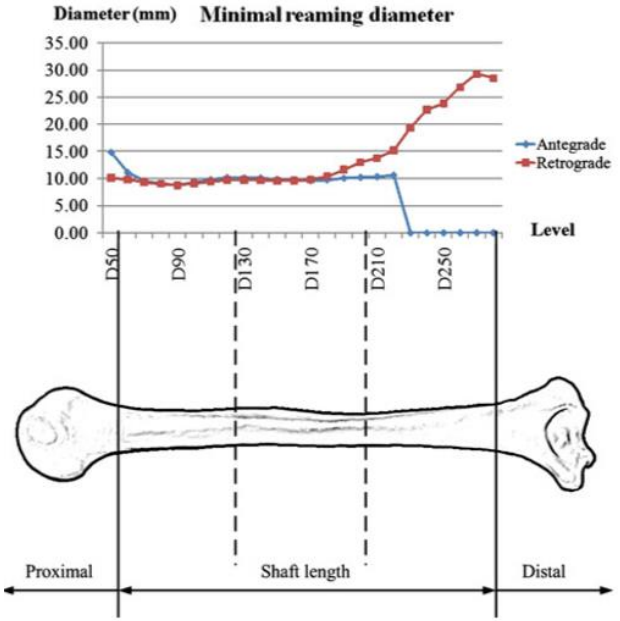
Mismatch analysis of humeral nailing: antegrade versus retrograde insertion

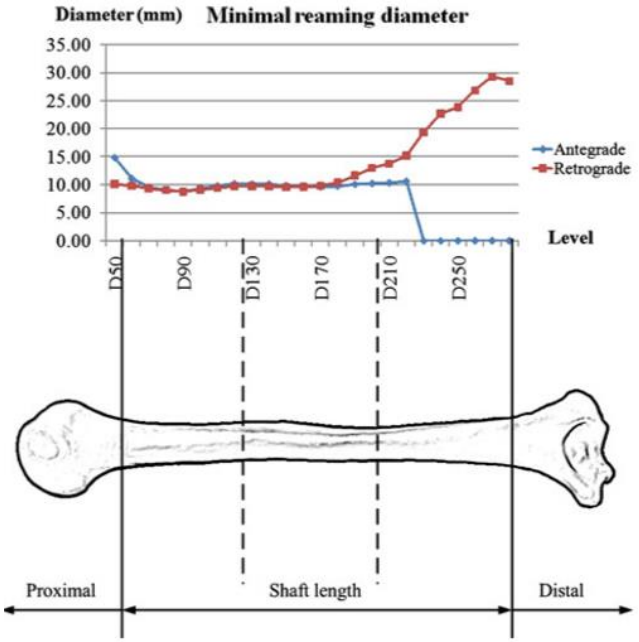
Banchong Mahaisavariya · Pongnarin Jiamwatthanachai · Panya Aroonjarattham · Kitti Aroonjarattham · Marut Wongcumchang · Kriskrai Sitthiseripratip

virtual simulation (CT)
76 Thai cadaveric humeri
Russell-Taylor HN (8 mm 220 mm)

(1) the diameter of the medullary canal averaged 7.9–13.8 mm

(2) Retrograde nailing requires excessive reaming at the distal part of the humerus to accommodate nail insertion





Intramedullary nailing

Success rate as high as that for other methods:

(Ingman and Waters, 1994; Rodriguez-Merchan, 1995; Rommens et al., 1995; Shazar et al., 1998; Sims and Smith, 1995; Brumback, 1996; Redmondet al., 1996; Achecar and Whittle, 1997; Lin et al., 1997; Crates and Whittle, 1998; Tome et al., 1998).

non-union 6%

infection 2%

radial nerve palsies 3%

Intramedullary nailing

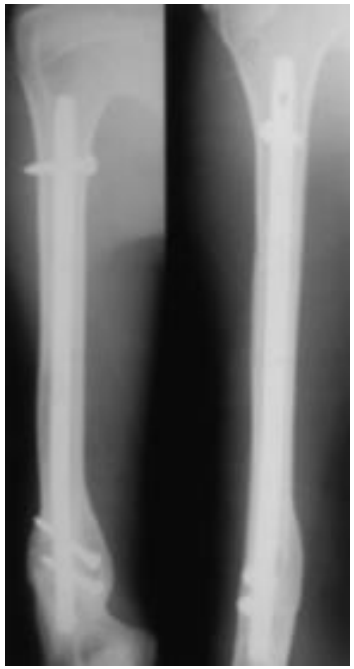
Advantages:

shorter operating time, no need of external support, reduced blood loss, low infection rate, and early recovery of function

Problems:

Antegrade: proximal migration, RC integrity, interlocking, extension of the fracture, diastasis, radial nerve palsy

Retrograde: Eccentric nail insertion, proximal interlocking, axillary nerve, fracture extension

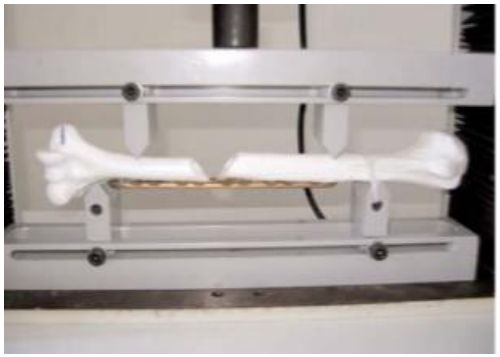


EXPERIMENTAL STUDY

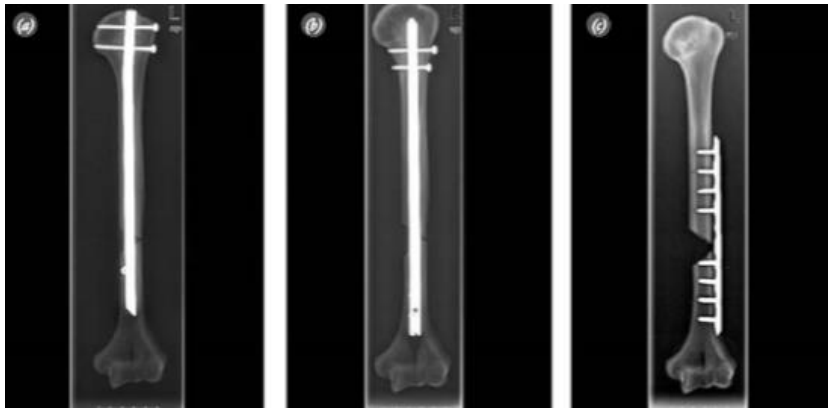
Acta Orthop Traumatol Turc 2013;47(3):173-178
doi:10.3944/AOTT.2013.2701

Biomechanical evaluation of different internal fixation methods for humerus shaft fractures with medial butterfly fragment

Mehmet Aykut TÜRKEN[1], Mehmet AKDEMİR[2], Bora UZUN[3], Mustafa ÖZKAN[4]



The biomechanical stability appears to be similar in the fixation of humerus shaft fractures with medial butterfly fragment.



Injury, Int. J. Care Injured 45S (2014) S9–S15

Contents lists available at ScienceDirect

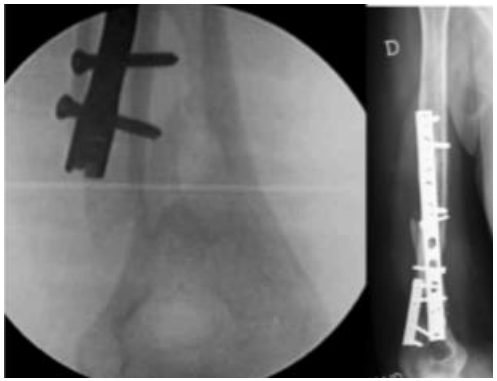
Injury

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

Complications after interlocking intramedullary nailing of humeral shaft fractures

Asen Baltov *, Rashkov Mihail, Enchev Dian

Department of Trauma Surgery, Emergency Trauma Hospital "N.I.Pirogov", Sofia, Bulgaria



111 patients (105 antegrade)

52 **intraoperative** complications in 40 pt (36%)

Distraction 4.5%

Wrong screws 8.1%

Additional fracture 6.3%

Nail protrusion 7.2%

36 secondary surgeries (32.5%)

The Journal of TRAUMA® Injury, Infection, and Critical Care

Complications of Locked Nailing in Humeral Shaft Fractures

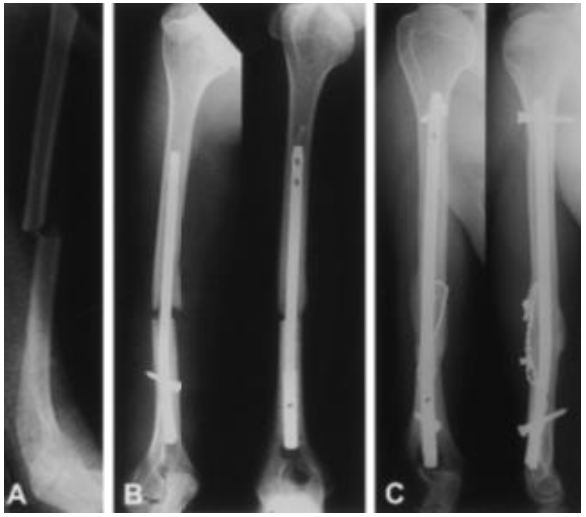
Jinn Lin, MD, PhD, Po-Wen Shen, MD, and Sheng-Mou Hou, MD, PhD

antegrade nailing: 87 fractures (proximal)
retrograde nailing: 74 (distal)

Table 1 Postoperative Complications of Humeral Locked Nailing in 159 Patients

Complications	No. of Patients
Nonunion	9
Protruded proximal screw	2
Shoulder joint impairment	7
Elbow joint impairment	3
Operative comminution (with fracture union)	2
Fracture gap (with fracture union)	3
Transient postnailing radial nerve palsy	3*
Angular malunion	2
Total	31

* One patient had nonunion simultaneously.



significantly higher in risk of operative comminution with retrograde nailing

Indian Journal of Orthopaedics
Medknow Publications

Indian J Orthop. 2011 May-Jun; 45(3): 208–215.

Diaphyseal humeral fractures and intramedullary nailing: Can we improve outcomes?

Christos Garnavos

Antegrade nailing	Retrogade nailing
Violation of RC	Eccentric nail insertion
Distal interlocking	Proximal interlocking
Soft tissues around shoulder	Soft tissue around shoulder
Soft tissues around elbow	

Ream/undreamed, antegrade/retrograde,

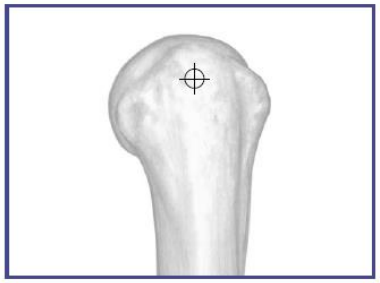
solid/flexible, locking/unlocked?

C. A. Müller · P. Henle · G. Konrad · M. Szarzynski · P. C. Strohm · N. P. Südkamp
Klinik für Unfall-, Hand- und orthopädische Chirurgie, Klinikum Karlsruhe

Der „AO/ASIF-Flexnail“

Klinische Ergebnisse der Marknagelosteosynthese von Humerusschaftfrakturen

34 patients were treated with the flexible nail
mean duration for fracture consolidation was 10 weeks.
Constant score was 93 points



1 Antegrade entry site, through the greater tuberosity.

2 Open the proximal humerus with the Medium Awl.

3 Verify size and shape of entry hole with Nail Trial.

4 Drill entry site with the 8.0 mm and 10.5 mm Flexible Drill Bits, if necessary.

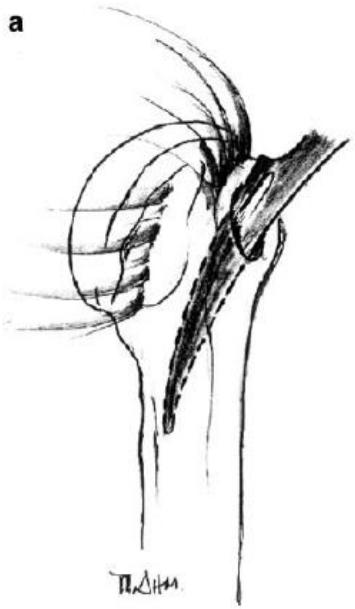
5 Insert the nail. Flex the nail by bending the Insertion Handle towards the nail tip.

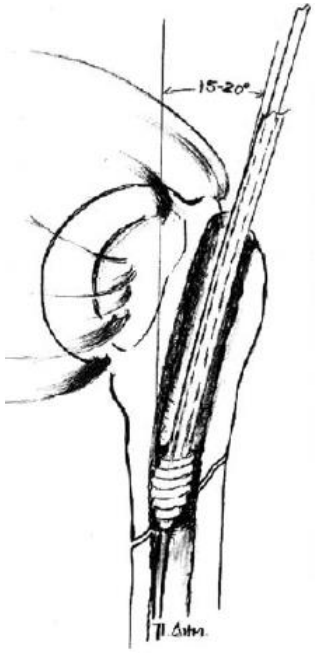
Arch Orthop Trauma Surg (2005) 125: 27–32
DOI 10.1007/s00402-004-0757-3

ORIGINAL ARTICLE

Panayiotis Dimakopoulos · Andreas X. Papadopoulos
Michalis Papas · Andreas Panagopoulos · Elias Lambiris

Modified extra rotator-cuff entry point in antegrade humeral nailing





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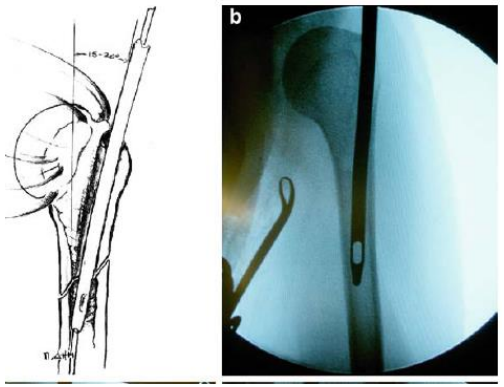
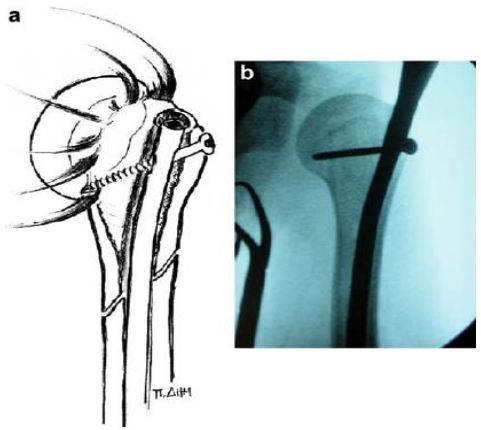
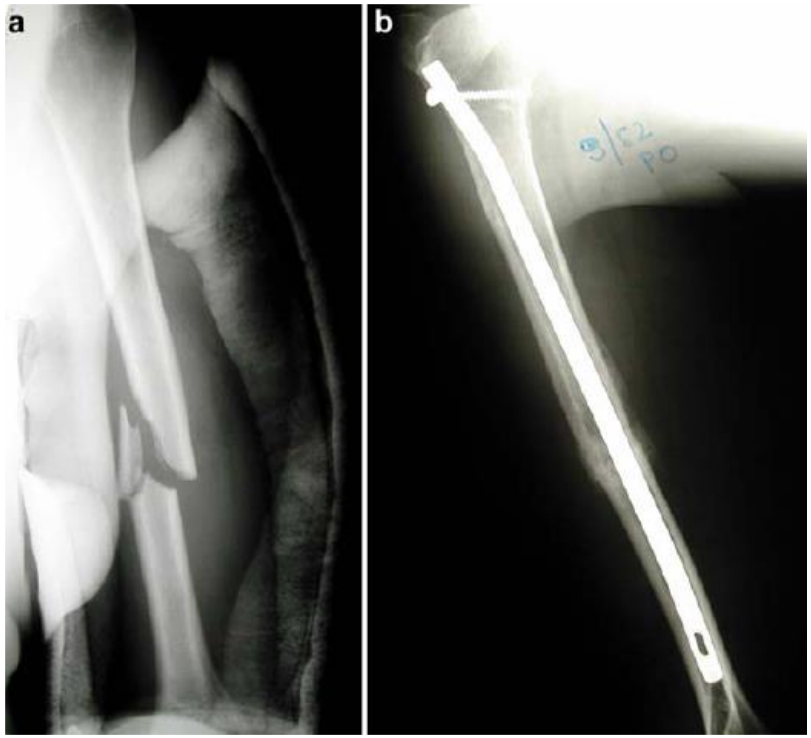






Original Article

Intramedullary nailing of humeral diaphyseal fractures. Is distal locking really necessary?

Minos Tyllianakis, Pantelis Tsoumpos, Kostas Anagnostou, Anna Konstantopoulou, Andreas Panagopoulos

Access this article online
Website: www.internationalshoulderjournal.org
DOI: 10.4103/0973-6042.114233
Quick Response Code:

2 nonunions / 63 fractures

Constant score, at a minimum of 2-year follow-up, was excellent or very good in 93.7% of the patients

New Technique for Humerus Shaft Fracture Retrograde Intramedullary Nailing

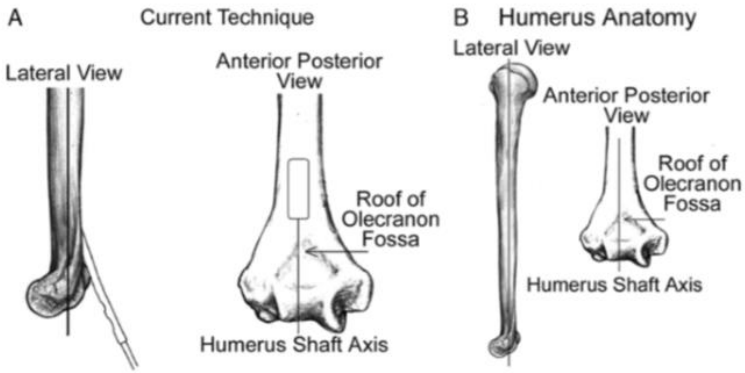
(*Tech Hand Surg* 2011;15: 138–143)

Anne M. Hollister, MD, Carla Saulsbery, OTR, CHT,† Jennifer L. Odom, PA-C,**
Lucas Anissian, MD, PhD, Mark Tyson Garon, MD,* and Jenee' Jordan‡*

TABLE 1. Literature Results

References	No. Patients in Study	% Radial Nerve Palsies	% Iatrogenic Fractures
Blum et al[1]	57	15%	14%
Cheng and Lin[2]	43	4%	Not reported
Rommens et al[3]	190	4.2%	4.2%
Loitz et al[4]	120	Not reported	5.8%
Martinez et al[5]	21	Not reported	5%
Muckley et al[6]	36	Not reported	5.5%
Rommens et al[7]	99	3%	2%
Wang et al[8]	707	4.2%	Not reported

Incidence of perioperative fractures and radial nerve palsy reported in the literature.



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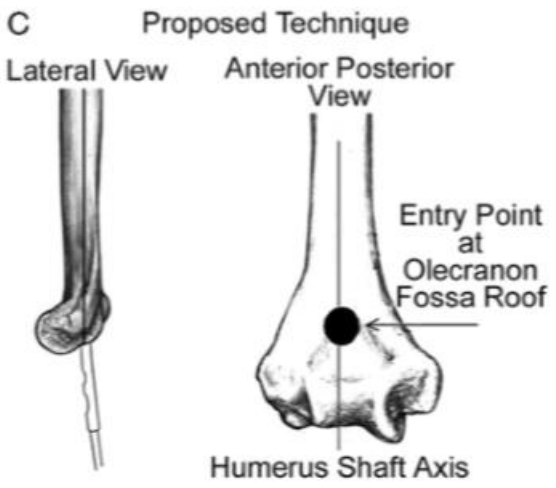
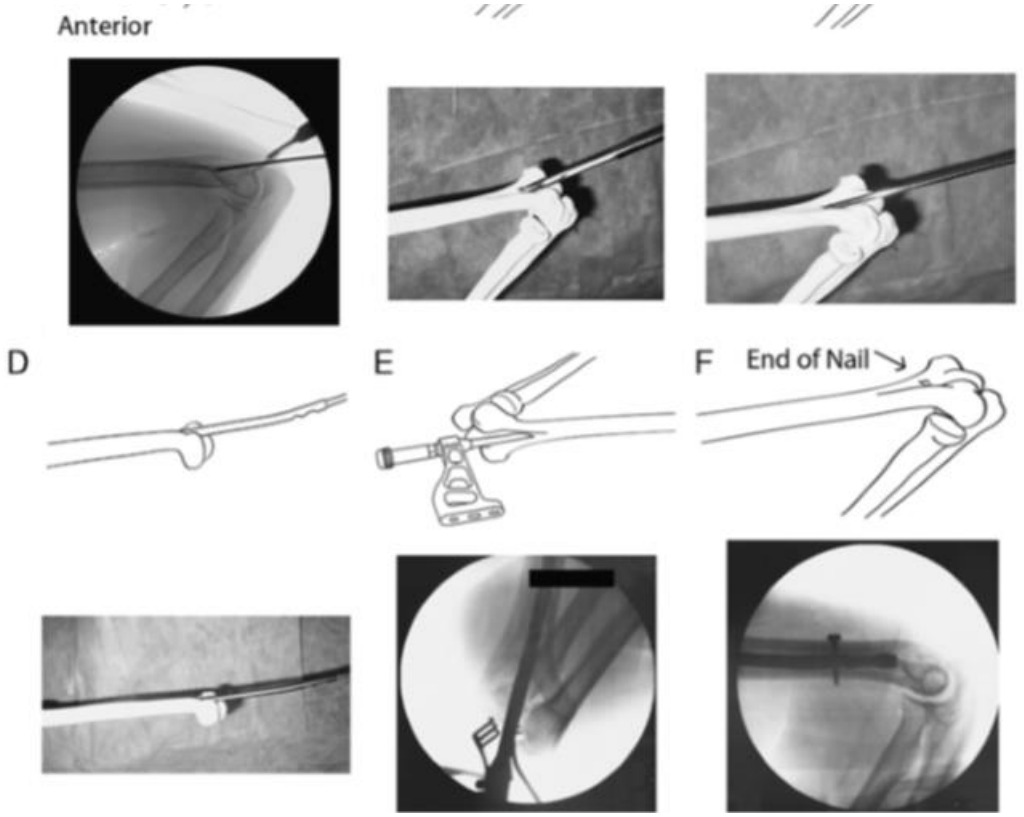




Injury, Int. J. Care Injured 44 (2013) 514–517

Contents lists available at SciVerse ScienceDirect

Injury

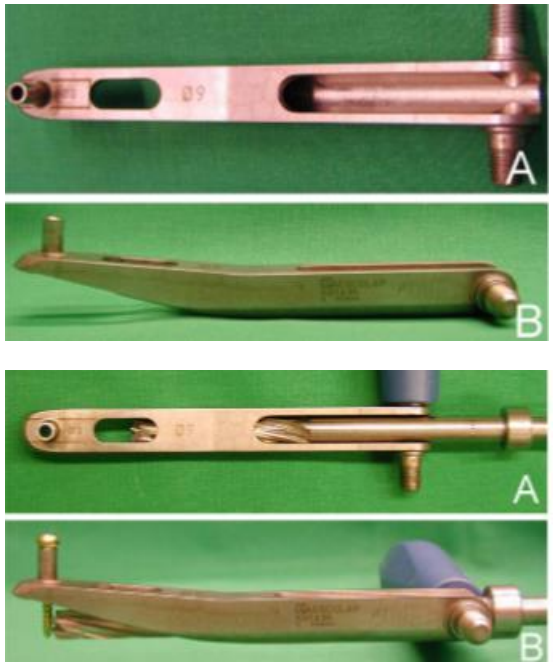
journal homepage: www.elsevier.com/locate/injury

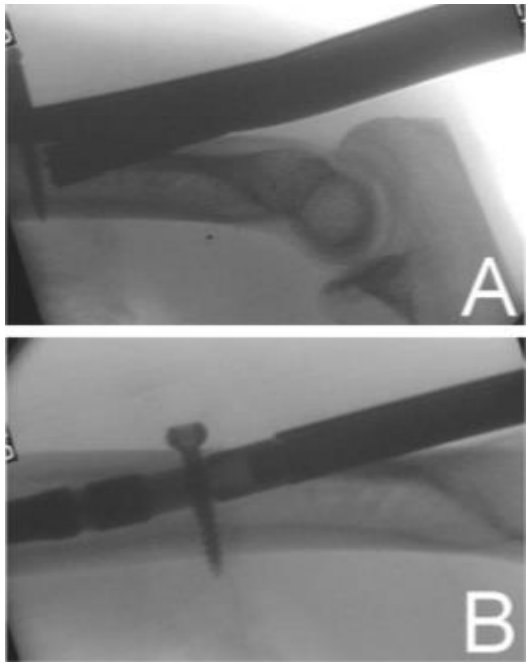
An innovative technique of rear entry creation for retrograde humeral nailing: How to avoid iatrogenic comminution

Roland Biber [a,*], Birgit Zirngibl [a], Hermann Josef Bail [a], Hans-Werner Stedtfeld [b]

[a] Department of Trauma and Orthopaedic Surgery, Klinikum Nürnberg Süd, Breslauer Strasse 201, 90471 Nürnberg, Germany
[b] Department for Trauma and Reconstructive Surgery, University of Rostock, Schillingallee 35, 18057 Rostock, Germany

Special design for Targon nail, no intraoperative fracture in 41 cases





Locking Flexible Nails for Diaphyseal Humeral Fractures in the Multiply Injured Patient: A Preliminary Study

Amir Matityahu, MD and W. Andrew Eglseder, Jr, MD

(*Tech Hand Surg* 2011;15: 172–176)

Antegrade 27 patients
(midshaft to distal)

retrograde 16 patients
(midshaft to proximal)

union rate

antegrade (93%)
retrograde (69%)

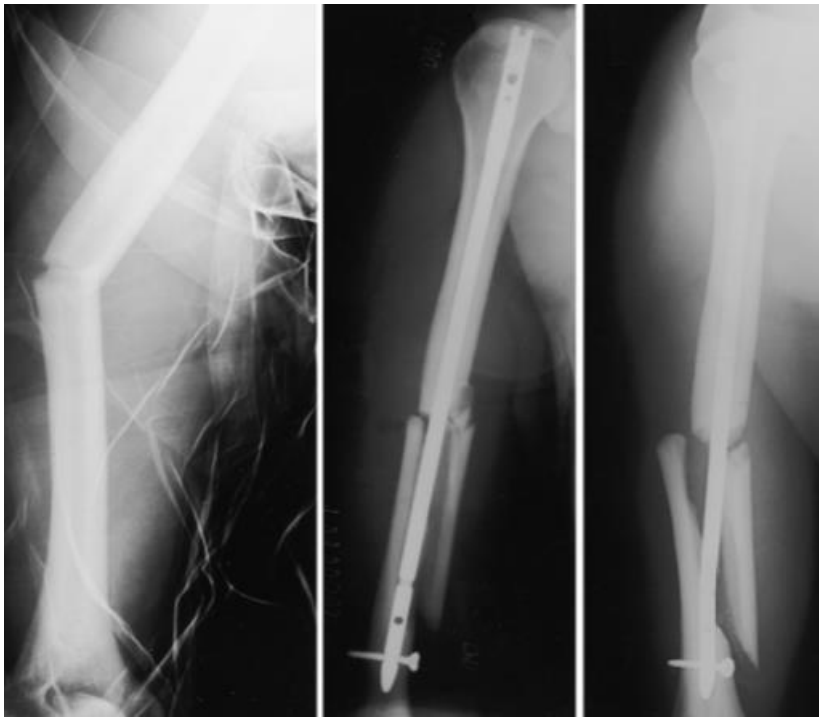
No significant difference in shoulder and elbow pain or range of motion

The Journal of TRAUMA® Injury, Infection, and Critical Care

Functional Outcome after Intramedullary Nailing of Humeral Shaft Fractures: Comparison between Retrograde Marchetti-Vicenzi and Unreamed AO Antegrade Nailing

Thierry Scheerlinck, MD, and Frank Handelberg, MD

J Trauma. 2002;52:60–71.



The Journal of TRAUMA® Injury, Infection, and Critical Care

Functional Outcome after Intramedullary Nailing of Humeral Shaft Fractures: Comparison between Retrograde Marchetti-Vicenzi and Unreamed AO Antegrade Nailing

J Trauma. 2002;52:60–71.

Thierry Scheerlinck, MD, and Frank Handelberg, MD

Table 2 Complications during or after Humeral Nail Insertion and Removal

	MVN (%)	AO-UHN (%)	Total (%)
Complications during or after nail insertion (n)	30	22	52
No complications	21 (70.0)	14 (63.6)	35 (67.3)
Iatrogenic supracondylar fracture	2 (6.7)	0 (0.0)	2 (3.8)
Fracture extension	1 (3.3)	3 (13.6)	6 (11.5)
Proximal nail protrusion	2 (6.7)	4 (18.2)	6 (11.5)
Transient n. radialis paresis	1 (3.3)	0 (0.0)	1 (1.9)
Screw breakage	0 (0.0)	1 (4.5)	1 (1.9)
Nonunion	2 (8.0)*	1 (5.5)*	3 (7.0)*
Frozen shoulder requiring mobilization	1 (5.3)**	1 (5.9)**	2 (5.6)**
Complications during or after nail removal (n)	7	8	15
No complications	4 (57.1)	7 (87.5)	11 (73.3)
Impossibility to remove the nail	1 (14.3)	1 (12.5)	2 (13.3)
Perioperative supracondylar fracture	1 (14.3)	0 (0.0)	1 (6.7)
Postoperative supracondylar fracture	1 (14.3)	0 (0.0)	1 (6.7)

The retrograde approach to the humeral medullary cavity using a MVN resulted in better shoulder function and similar elbow function compared with the antegrade approach using an AO-UHN

The Journal of TRAUMA® Injury, Infection, and Critical Care

Prospective Randomized Comparative Study of Antegrade and Retrograde Locked Nailing for Middle Humeral Shaft Fracture

J Trauma. 2008;65:94–102.

Hao-Ren Cheng, MD, and Jinn Lin, MD, PhD

Table 2 Perioperative and Postoperative Variables

Variable	Antegrade (n = 44)	Retrograde (n = 45)	*p* (95% Confidence Interval)
Time to operation (d)	2.4 ± 1.3	2.6 ± 1.6	0.52 (−0.82 to 0.42)
Operative bleeding amount (mL)	60 ± 20	54 ± 23	0.19 (−3.09 to 15.1)
Fluoroscopic time (min)	1.3 ± 0.3	1.2 ± 0.4	0.19 (−0.05 to 0.25)
Operation time (min)	51.3 ± 13.3	64.8 ± 12.2	<0.01 (−18.9 to −8.12)*
Fracture healing rate	42 (95%)	42 (93%)	0.51 (0.92 to 1.13)
Follow-up time (mo)	18.6 ± 3.1	19.8 ± 3.7	0.1 (−2.64 to 0.24)
Time to healing (wk)	10.8 ± 3.5	12.1 ± 3.9	0.1 (−2.86 to 0.26)
Operative radial nerve palsy	2 (5%)	1 (2%)	0.54 (0.18 to 23.9)
Screw backout	4 (9%)	1 (2%)	0.17 (0.47 to 41.03)

similar treatment results, including healing rate and eventual functional recovery for middle humeral fractures

Strat Traum Limb Recon (2014) 9:133–140
DOI 10.1007/s11751-014-0204-0

ORIGINAL ARTICLE

Internal fixation of shaft humerus fractures by dynamic compression plate or interlocking intramedullary nail: a prospective, randomised study

Mir G. R. Wali · Asif N. Baba · Irfan A. Latoo · Nawaz A. Bhat · Omar Khurshid Baba · Sudesh Sharma

25 patients in each group
mean age 37 years
Road traffic accident

Significant difference:
duration of hospital stay,
operative time and blood loss

No difference in terms of union or complications.

Functional outcome similar at 1 year

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Original research

Meta-analysis of the outcomes of intramedullary nailing and plate fixation of humeral shaft fractures

Guo-dong Liu [a,h,*], Qing-gang Zhang [b,h], Shan Ou [c,**], Le-shun Zhou [c], Jun Fei [d], Hong-wei Chen [e], Guo-xin Nan [f], Jian-wen Gu [g]

10 studies (1990-2012)
459 cases,
231 plating & 228 nailing

No difference:
- nonunion
- infection
- radial nerve palsy
- other complications

Delayed healing rate lower with plate

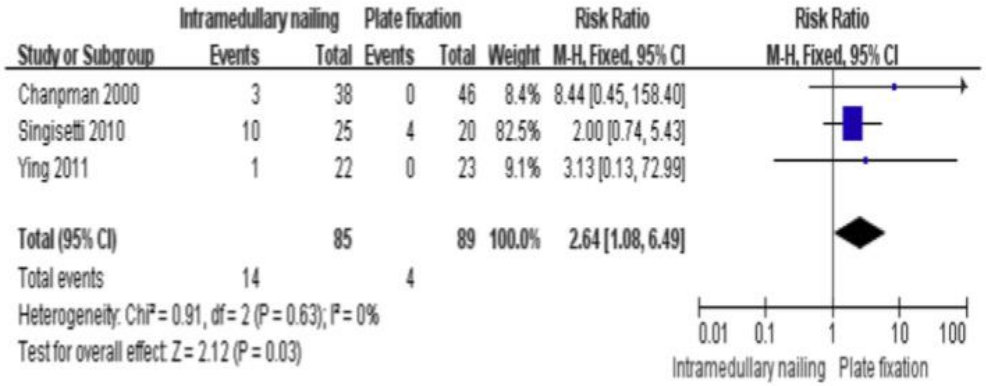


Fig. 2. Meta-analysis results for delayed union incidence rate of humeral shaft fracture between the two groups.

Implant selection

Antegrade	Retrograde
Higher nailing linearity Easier technique Less elbow injury Small medullary canal	Less shoulder injury Fracture compression Less nailing linearity
Avoid shoulders with preexisting problems	Insert nail from upper edge of olecranon fossa
Countersink nail and screw during insertion	Avoid small medullary canal
Meticulously repair rotator cuff and bursa	Create long enough entry portal
Avoid too long nails	Adequately ream and use trial nailing
Compress fracture or use back strike technique	Manually insert nail
Bluntly dissect soft tissue during screw insertion	Avoid elbow with extension contracture

Extended Neviaser Portal Approach to Antegrade Humeral Nailing

MATTHEW F. DILISIO, MD; RYAN E. FITZGERALD, MD; ERIC T. MILLER, MD

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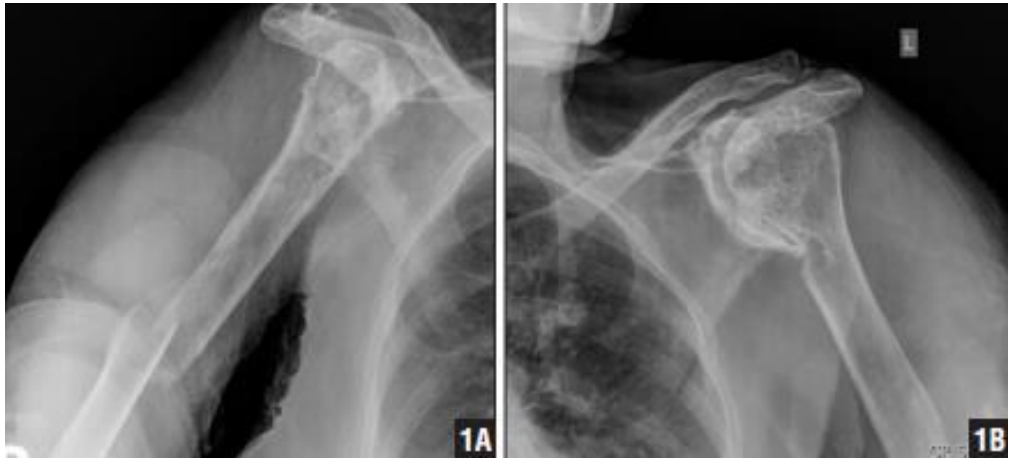
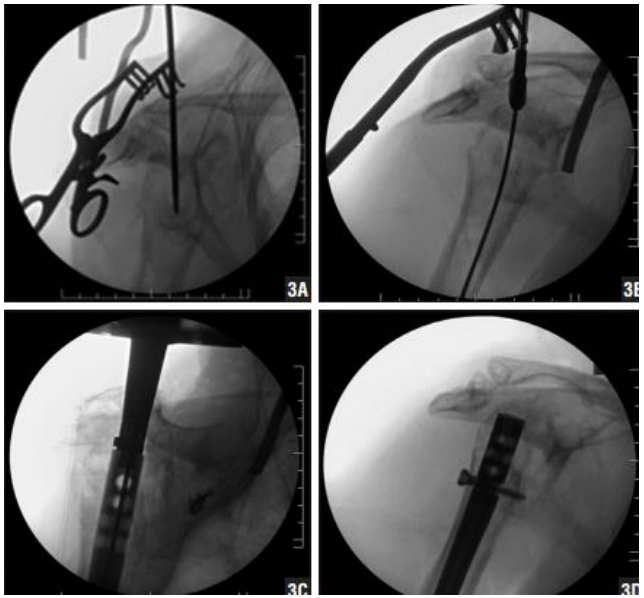
FEBRUARY 2013 | Volume 36 • Number 2



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Conclusions

- Functional bracing/nonoperative care is still the mainstay of treatment

Surgery can give a better XRay and potentially quicker recovery but with the inherent risks of surgery… choose wisely

- Careful patient selection

- Meticulous surgical technique

- Preservation of rotator cuff tendons

- avoid iatrogenic elbow fracture in RHN