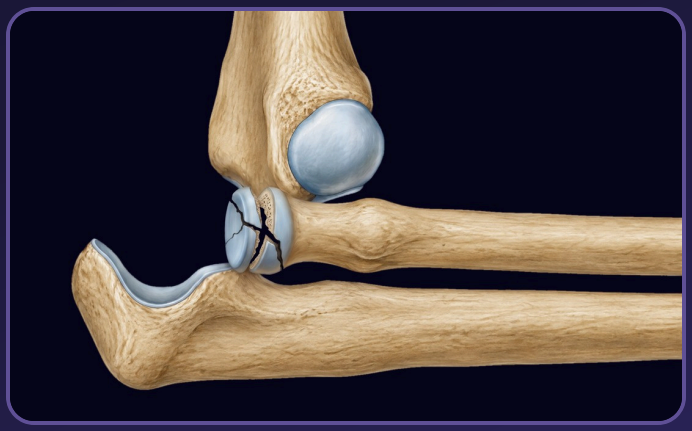
Page Ortho
PDF REFERENCE

FRACTURE CLASSIFICATIONS

FREE SAMPLE · 10 high-yield classifications

A free sample of 10 pages from the full book. One page per classification: the anatomy, **every type drawn as a real break**, the numbers with their sources, and **what to do on call**.



Fracture Classifications

PAGE ORTHO

First edition, November 2026. Free sample: 10 pages from the full book.

EDUCATIONAL REFERENCE, NOT MEDICAL ADVICE

A study aid for medical students and residents. It does not replace your textbook, your local protocol or your attending.

Sources are numbered at the foot of each page.

Illustrations are original Page Ortho art.

Corrections: message @page_ortho on Instagram.

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PEDIATRICS · GROWTH PLATE

SALTER-HARRIS CLASSIFICATION

Fractures through the **physis**, sorted by which of metaphysis, physis and epiphysis the line crosses.

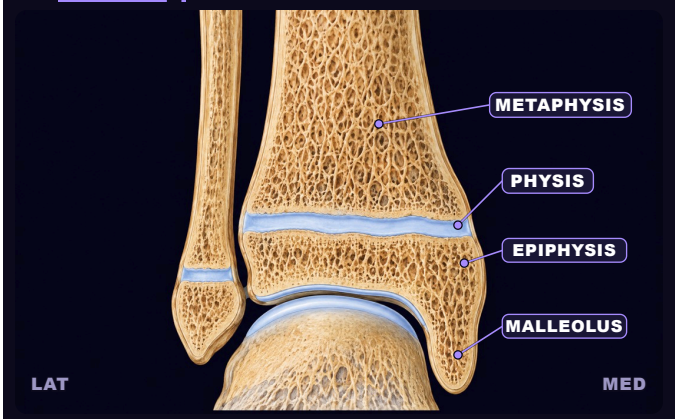
AUTHORS **Salter & Harris**, JBJS Am **1963**

GRADED ON **AP and lateral**; 3-D imaging can change the type[2]

COUNTS Where the line runs around the physis

1 Anatomy

Child's distal tibia, coronal cut, from the front



The physis usually fails through the **hypertrophic zone**, at the zone of provisional calcification.[2] Types I–II tend to spare the epiphyseal blood supply; III–IV can cut it.[2]

HOW TO GRADE

Trace the line. **I** straight along the physis. **II** along the physis, then out through the metaphysis (Thurston-Holland piece). **III** along the physis, then down through the epiphysis into the joint. **IV** straight across metaphysis, physis and epiphysis. **V** a crush of the physis.[1,2]

2 The numbers

growth disturbance by type

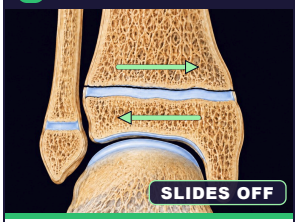
	SH I	SH II	SH III	SH IV
Distal femur: growth disturbance[3] 564 fractures, meta-analysis	36%	58%	49%	64%
Distal tibia: early physeal closure[4] 92 fractures; pairs pooled in the paper	36% I+II	36% I+II	38% III+IV	38% III+IV

- **Gap after reduction:** a physeal gap over 3 mm in a distal tibia SH I–II meant 60% early closure vs 17% without; trapped periosteum was found at open reduction.[4]
- Displaced distal femur fractures had **4×** the odds of growth arrest; 22% (112/506) ended over 1.5 cm short.[3]
- Physeal fractures were 30% of 2,650 long-bone fractures in children.[5] Type II is about 74% of them.[2]

3 The types

same physis, our illustration, broken for each type

I SLIPPED

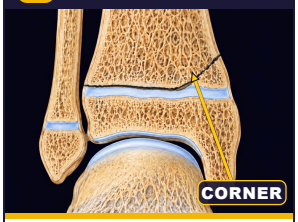


Separation along the physis only.

PATTERN More common in younger children with a thicker physis.[2]

TREAT At the distal femur, 36% had growth disturbance.[3]

II ABOVE



Physis, then out the metaphysis.

PATTERN Corner piece; the most common.[2]

TREAT Gap over 3 mm: open reduction may help.[4] Cast vs surgery unsettled.[6]

III LOWER



Physis, then through the epiphysis into the joint.

PATTERN Joint step; arthritis risk.[2]

TREAT Reduce the joint.[1] Medial malleolus: more displacement, more surgery and bars.[7]

IV THROUGH

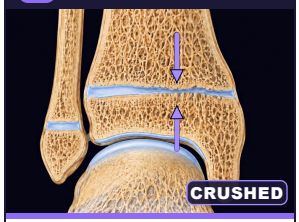


One line across metaphysis, physis, epiphysis.

PATTERN Malreduction can form a bony bar.[2]

TREAT Reduce the joint.[1] Medial malleolus: bar in 30%.[7]

V RAMMED



Crush of the physis.

PATTERN Rare; some authors question that it exists.[2]

TREAT The classification does not guide treatment.[2]

4 Things to worry about

- **Films underestimate displacement**; 3-D can change type.[2]
- **Growth arrest** happens even in low types: 36% after distal femur SH I.[3]
- **Trapped periosteum**: a gap over 3 mm may mean it.[4]
- **Arrest:** complete shortens, partial angulates.[1]

5 Pearls and tidbits

- Type is **not an independent predictor**; reduction matters more.[2]
- **Distal ulna** stunts more: 3 of 6 vs 5 of 157 radial were 1 cm+ short.[8]
- **Peterson I** (metaphysis into physis) and **VI** (physis lost) are add-ons.[2]
- Readers agree moderately: κ 0.57–0.67 at the distal tibia.[2]

6 On call tonight

FILMS
Films underestimate displacement; 3-D can change the type.[2]

GAP
Distal tibia I–II: look for a physeal gap over 3 mm after reduction.[4]

FEMUR
Displaced distal femur fractures had 4× the odds of growth arrest.[3]

FOLLOW
Medial malleolus III–IV: follow films for at least 1 year.[7]

LOOK
Proximal tibia: tender along the physis; full neurovascular exam.[1]

CALL YOUR ATTENDING NOW A displaced type III or IV (more displacement, more bars)[7], or a gap over 3 mm after reduction.[4]

[1] Orthobullets. Physeal Considerations; Proximal Tibia Epiphyseal Fractures (Pediatric). orthobullets.com, Nov 2026.
[2] Cepela DJ et al. Classifications in brief: Salter-Harris. Clin Orthop 2016;474:2531-7.
[3] Basener CJ, Mehlman CT, DiPasquale TG. Growth disturbance after distal femoral physeal fractures. J Orthop Trauma 2009;23:663-7.
[4] Barmada A, Gaynor T, Mubarak SJ. Premature physeal closure after distal tibia fractures. J Pediatr Orthop 2003;23:733-9.
[5] Mann DC, Rajmaira S. Physeal and nonphyseal fractures in 2,650 long bones. J Pediatr Orthop 1990;10:713-6.
[6] Peterson N, Perry DC. Displaced distal tibial Salter-Harris II fractures. Bone Joint J 2023;105-B:471-3.
[7] Roth OS et al. Physeal arrest in Salter-Harris III and IV medial malleolus fractures. J Pediatr Orthop 2026;46:e618-25.
[8] Cannata G et al. Physeal fractures of the distal radius and ulna: long-term prognosis. J Orthop Trauma 2003;17:172-9.

Illustrations: Page Ortho original art (child's distal tibia, coronal cut, intact and one broken version per type). Overlays are labels and arrows only.

Educational reference, not medical advice. Follow your local protocol and your attending.

TRAUMA · OPEN FRACTURES

GUSTILO-ANDERSON CLASSIFICATION

Open fractures, sorted by **wound, energy, soft-tissue cover** and **artery**. Give the final type in the OR.

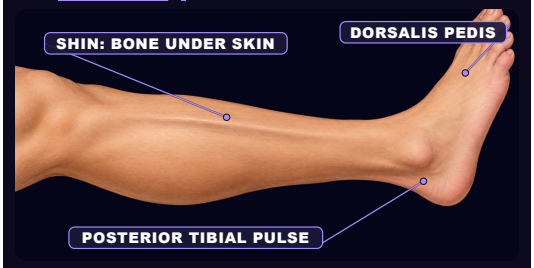
AUTHORS **Gustilo** and Anderson **1976**; III split **1984**

GRADED **After debridement**, not in the ED [1]

COUNTS Size, energy, cover, artery

1 Anatomy

Right lower leg from the inner side



This view shows the **tibia**, the bone in the open-fracture studies cited here. [5,6] The skin wound does not always show the deeper damage. [1]

HOW TO GRADE

I wound under 1 cm, clean. **II** laceration over 1 cm. **III** extensive damage, segmental fracture or traumatic amputation; then **A** bone still covered, **B** periosteum stripped, bone bare, **C** artery needs repair. [1,2,3]

2 The numbers

type III subtypes

	IIIA	IIIB	IIIC
Infection, 1984 series [3] 87 type III fractures	4%	52%	42%
Amputation, 1984 series [3]	0%	16%	42%
Deep infection, 2010 [4] modern protocol; type II 4%	1.8%	10.6%	20%

- **Antibiotics fast:** type III tibias given antibiotics after 66 min had 3.8× the odds of infection. [5]

3 The types

same leg, our illustration, opened for each type

I SMALL, CLEAN



Wound under 1 cm, clean.

TREAT Debride, primary closure. [2]

II LACERATION



Laceration over 1 cm.

TREAT Debride, primary closure. [2]

IIIA HIGH ENERGY, COVERED



Bone still covered; big wound or high energy.

TREAT Type III: delayed closure. [2]

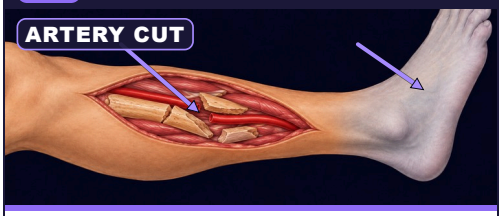
IIIB BONE EXPOSED



Tissue loss, periosteum stripped, bone bare.

TREAT Cover after day 5: 7.4× infection odds. [5]

IIIC ARTERY INJURY



Any open fracture with an artery that needs repair.

TREAT Vascular repair; amputation is common. [3]

III ALWAYS TYPE III

Whatever the wound size: [1,3]

- High-energy trauma [3]
- Segmental fracture
- Traumatic amputation
- An artery that needs repair (IIIC)

WHEN Give the final type after debridement in the OR; the ED often under-grades. [1]

4 Things to worry about

- **Don't miss: arterial injury**: needing repair makes it IIIC; amputation 42%. [3]
- **The skin wound can understate** the deeper damage. [1]
- **Readers disagree**: 245 surgeons agreed on 60% of cases on average. [6]
- **The ED often under-grades** an open fracture; grade in the OR. [1]
- **Gram-negatives** caused 77% of 1976–79 infections (24% before). [3]

5 Pearls and tidbits

- Antibiotics here are **treatment**: the wound is already contaminated. [1]
- LEAP: 27% infected; delay to a trauma center mattered, time to the OR did not. [7]
- **Traditional teaching (and many exams):** add an aminoglycoside for type III; SIS: evidence insufficient. [8,9]
- Antibiotics and cover both early: 2.8% infected, vs 40.5% both late. [5]

6 On call tonight

LOOK
Measure the wound; the surface can understate the damage. An artery needing repair is IIIC. [1,3]

ANTIBIOTICS NOW
First-generation cephalosporin, early. [5,9] Extra gram-negative cover: evidence insufficient. [9]

TETANUS
Toxoid and immunoglobulin in the ED, two sites. [8]

TRANSFER
Reach a definitive trauma center early; delay to one predicted infection. [7]

SPLINT
Splint the limb. ABI if vascular concern; angiogram if under 0.9. [8]

CALL YOUR ATTENDING NOW Suspected arterial injury (IIIC), or exposed bone with no cover (IIIB). [3]

[1] Kim PH, Leopold SS. In brief: Gustilo-Anderson classification. Clin Orthop 2012;470:3270-4 (erratum 2019;477:2388).
[2] Gustilo RB, Anderson JT. Prevention of infection in 1,025 open fractures of long bones. JBJS Am 1976;58:453-8.
[3] Gustilo RB, Mendoza RM, Williams DN. Problems in the management of type III open fractures. J Trauma 1984;24:742-6.
[4] Lenarz CJ et al. Timing of wound closure in open fractures based on cultures. JBJS Am 2010;92:1921-6.
[5] Lack WD et al. Type III open tibia fractures: immediate antibiotic prophylaxis. J Orthop Trauma 2015;29:1-6.
[6] Brumback RJ, Jones AL. Interobserver agreement in classifying open tibia fractures. JBJS Am 1994;76:1162-6.
[7] Pollak AN et al. Time to debridement and infection after high-energy trauma. JBJS Am 2010;92:7-15.
[8] Orthobullets. Open Fractures: Management. orthobullets.com, accessed Nov 2026.
[9] Hauser CJ et al. SIS guideline: prophylactic antibiotics in open fractures. Surg Infect 2006;7:379-405.

Illustrations: Page Ortho original painted art (right lower leg, intact and one injured version per type; no photographs). Overlays are labels and arrows only.

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HIP · FEMORAL NECK

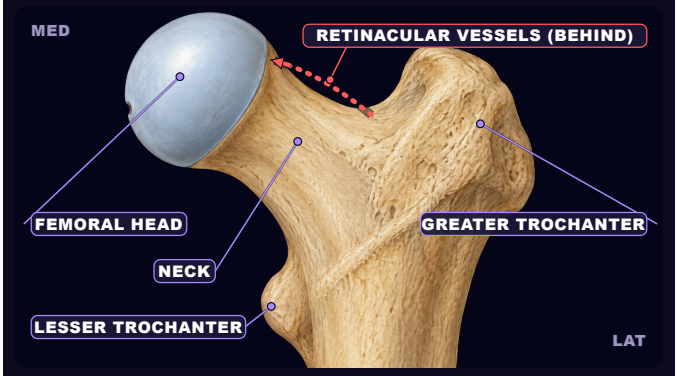
GARDEN CLASSIFICATION

Femoral neck fractures in older adults, sorted by **how displaced** they are on the AP hip.

AUTHOR **R. S. Garden**, JBJS Br **1961**
GRADED ON **AP hip**: complete? displaced?
IN PRACTICE **Two groups**: I–II vs III–IV

1 Anatomy

Proximal femur from the front



The head is fed mainly by the **medial femoral circumflex artery**, which runs up the back of the neck as the retinacular branches (dotted: behind the neck in this front view): displaced fractures carry a higher risk of avascular necrosis. [1,2]

HOW TO GRADE

On the AP hip: **I** incomplete, impacted into valgus; **II** complete, not displaced; **III** complete, partly displaced; **IV** complete, fully displaced.[2] A simpler version says **nondisplaced (I–II)** or **displaced (III–IV)**: readers agree more, and it picks the operation.[2,3]

2 The numbers

older adults, by group

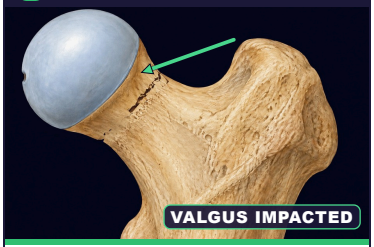
	RESULT
Nondisplaced, screws: nonunion[4] 375 patients	**6.4%** AVN 4.0%; later arthroplasty 7.7%
Nondisplaced, no surgery: failed[4] pooled literature	**19.6%** vs 4.3% with fixation
Displaced, fixed: nonunion, 2 yr[5] 106 reports	**33%** AVN 16%
Displaced: reoperation by 2 yr[5]	**20–36%** fixation; hemiarthroplasty 6–18%
Total hip vs hemi: 2nd surgery[6] 1495 patients, displaced	**7.9 vs 8.3%** no difference

- **Reliability:** kappa 0.33 for the four types, 0.50 for two groups.[3]

3 The types

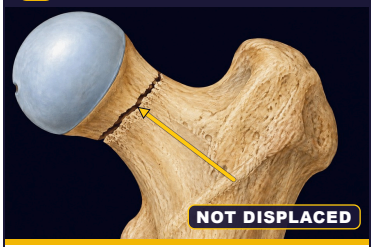
same femur, our illustration, broken for each type

I INCOMPLETE



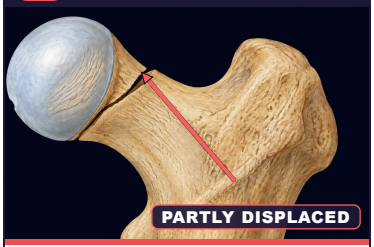
Incomplete break, head impacted into valgus.
PATTERN Nondisplaced group (I–II): nonunion 6.4% after fixation.[4]
TREAT Nondisplaced group: screws or sliding hip screw.[2,4]

II COMPLETE, IN PLACE



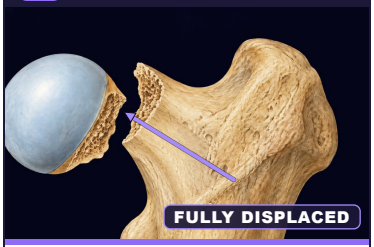
Complete break, not displaced.
PATTERN Nondisplaced group: AVN 4.0%, later arthroplasty 7.7%.[4]
TREAT Screws or a sliding hip screw.[2,7]

III PARTLY DISPLACED



Complete break, partly displaced.
PATTERN Displaced fractures carry a higher risk of AVN.[2]
TREAT Displaced: generally arthroplasty in older patients.[2]

IV FULLY DISPLACED



Complete break, fully displaced.
PATTERN Fixed displaced fractures: nonunion 33%, AVN 16%.[5]
TREAT Hemi or total hip: 2nd surgery 8.3% vs 7.9%; instability 2.4% vs 4.7%.[6]

4 Things to worry about

- **Don't miss:** a **femoral shaft fracture**: 1–9% also have a neck fracture, and 20–50% of those are missed at first.[8]
- **Nondisplaced is not risk-free:** left without surgery, 19.6% failed.[4]
- **Age and walking ability** predicted healing problems after fixing undisplaced fractures.[4]
- **Osteonecrosis** 10–45%, nonunion 5–30%; varus malreduction best matches fixation failure.[1]
- **Displaced + fixed**: nonunion 33%, AVN 16%; reoperation 20–36% vs 6–18% after hemiarthroplasty.[5]

5 Pearls and tidbits

- **Two groups beat four:** kappa 0.50 vs 0.33.[3]
- **Check the lateral:** angulation there predicted failure after fixing undisplaced fractures.[4]
- **Screws vs sliding hip screw:** reoperation 22% vs 20%, not different; AVN 5% vs 9%.[7]
- **Exam trap:** Garden grades displacement; Pauwels is used mainly for high-energy fractures in the young.[2]
- **Hemi vs total:** total hip gave a clinically unimportant function gain, not fewer reoperations.[6]

6 On call tonight

LOOK
Displaced: leg shortened, externally rotated, abducted.[1]

ORDER
AP, cross-table lateral; traction-internal rotation AP best defines type.[1]

GRADE
Call it nondisplaced (I–II) or displaced (III–IV); readers agree more.[3]

SHAFT
With a femoral shaft fracture, look for the neck: internal-rotation AP hip and fine-cut CT.[8]

TIMING
Fixation delayed beyond 24 h raised nonunion odds.[9]

CALL YOUR ATTENDING NOW A neck fracture with a shaft fracture (20–50% of necks are missed at first),[8] or fixation that will pass 24 h.[9]

[1] Orthobullets. Femoral Neck Fractures. orthobullets.com, accessed Nov 2026.
[2] Kazley JM et al. Hip fractures: anatomy, classification, biomechanics. Geriatr Orthop Surg Rehabil 2019.
[3] Masionis P et al. Reliability of Garden, AO and two-stage classifications. OTSR 2019;105:29-33.
[4] Conn KS, Parker MJ. Undisplaced intracapsular hip fractures: 375 patients. Clin Orthop 2004;421:249-54.
[5] Lu-Yao GL et al. Displaced FNF: meta-analysis of 106 reports. J Bone Joint Surg Am 1994;76:15-25.
[6] HEALTH Investigators. Total hip arthroplasty or hemiarthroplasty. N Engl J Med 2019;381:2199-208.
[7] FAITH Investigators. Sliding hip screw vs cancellous screws. Lancet 2017;389:1519-27.
[8] Tornetta P et al. Neck fractures with a femoral shaft fracture. J Bone Joint Surg Am 2007;89:39-43.
[9] Papakostidis C et al. Timing of internal fixation of FNF: meta-analysis. Injury 2015;46:459-66.

Illustrations: Page Ortho original art (proximal femur, intact and one broken version per type; same femur as the Pauwels page). Overlays are labels and arrows only.

Educational reference, not medical advice. Follow your local protocol and your attending.

FOOT & ANKLE · ANKLE

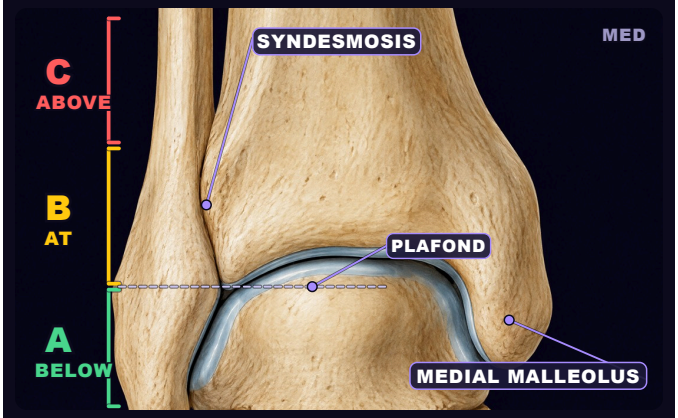
WEBER CLASSIFICATION

Ankle fractures sorted by **where the fibula breaks**: below, at or above the syndesmosis.

AUTHOR **Danis** 1949, **Weber** 1972
GRADED ON **AP or mortise**: fibula line vs plafond
THEN Check the **medial side**; Weber ignores it [1,2]

1 Anatomy

Right ankle from the front



The **syndesmosis** holds the fibula in the tibial notch just above the joint. The higher the fibula breaks, the more often the syndesmosis is torn. [4]

HOW TO GRADE

On the AP or mortise, find the fibula line and the tibial plafond. **Below** the plafond = A. Starts **at** the plafond and runs up obliquely = B. **Above** the syndesmosis = C. [2] Then look medially: a medial clear space of 5 mm or more on external rotation stress, or talar shift, means not stable, whatever the letter. [3,4]

2 The numbers

syndesmosis torn, by type

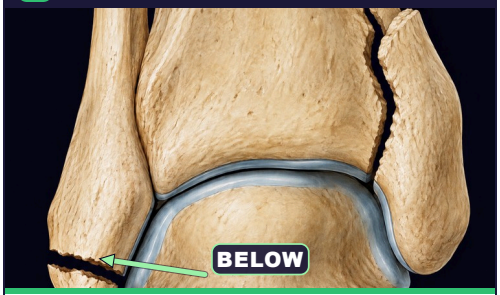
	A	B	C
Syndesmosis disrupted [9] 234 fixed Weber fractures seen by arthroscopy; only 6 type A	0% 0/6	52% 92/177	92% 47/51

- **Stable isolated B** (medial clear space under 5 mm on stress): 3 wk in a cast or brace did as well as 6 wk in a cast; 247 patients. [3]
- **Over 60, unstable:** close-contact casting matched surgery at 6 mo (620 patients). Wound problems 1% vs 10%; malunion 15% vs 3%; 19% of casts went on to surgery. [5]
- **Readers agree fairly well:** kappa 0.61 between readers, 0.74 for the same reader. [6]

3 The types

same ankle, our illustration, broken for each type

A BELOW THE SYNDESMOSIS

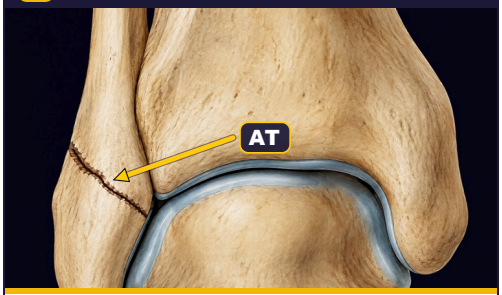


Fibula breaks below the plafond; syndesmosis torn in 0 of 6. [9]

PATTERN Transverse, low. Shown here with a vertical medial malleolus (SAD 2). [2]

TREAT Stable, no medial clear space widening: CAM boot. [4]

B AT THE SYNDESMOSIS

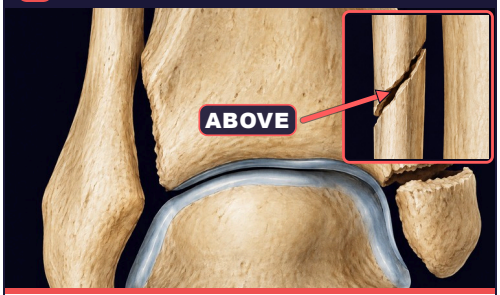


Starts at the plafond and runs up obliquely. The commonest type. [2,3]

PATTERN Syndesmosis torn in about half. [9] Shown isolated; stability is judged on stress. [3]

TREAT Stable on stress: 3 wk was enough. [3] Unstable: reduce and splint. [4]

C ABOVE THE SYNDESMOSIS



Fibula breaks above the syndesmosis (inset: higher up the fibula).

PATTERN Syndesmosis torn in 92%. [9] Maisonneuve: medial side injured in 90%. [7]

TREAT Unstable: reduce and splint. [4] Maisonneuve: 67 of 70 operated. [7]

4 Things to worry about

- **Don't miss: Maisonneuve**: the break sits at the fibular neck. In 70 cases, 24% showed only on the lateral leg film. [7]
- **Don't miss:** a **deep deltoid tear** went with syndesmosis disruption in Weber B. [9]
- **Talar shift**: 1 mm of lateral shift cut contact area by 42% (cadavers). [8]
- **Posterior malleolus**: broken in 77% of Maisonneuve injuries; CT is indispensable. [7]

5 Pearls and tidbits

- **Weber ignores the medial side** and predicts outcome only for single-malleolus fractures. [2]
- **Lauge-Hansen match:** A = SAD, B = SER, C = PER or PA. [2]
- **Stress view:** medial space under 5 mm on stress = stable B. [3]
- **Medial tenderness** and bruising do not show stability; stress views do. [1]
- **Exam trap:** the level of the fibula break sets the letter, not its shape. [2]

6 On call tonight

LOOK
Skin first: open wounds, tenting or marked swelling may need urgent action. [4]

REDUCE
Unstable: closed reduction and splinting come first; knee flexed; a regional block is central to pain control. [4]

SPLINT
Posterior slab plus U-slab; repeat AP, mortise, lateral. [4]

ORDER
AP, mortise, lateral; add tibia and fibula views to exclude other injuries; stress views if unsure. [4]

DISPO
Stable: CAM boot, outpatient follow-up. [4] Over 60, unstable: casting matched surgery at 6 mo. [5]

CALL YOUR ATTENDING NOW Open wound, skin tenting or marked swelling, [4] or a lost reduction (19% of AIM casts went on to surgery). [5]

[1] Orthobullets. Ankle Fractures. orthobullets.com, accessed Nov 2026.
[2] Tartaglione JP et al. Classifications in Brief: Lauge-Hansen. Clin Orthop Relat Res 2015;473:3323-8.
[3] Kortekangas T et al. 3 vs 6 wk immobilization, stable Weber B. BMJ 2019;364:k5432.
[4] Ngatuvai M et al. ED management of ankle fractures: a narrative review. Cureus 2026;18:e116211.
[5] Willett K et al. Close contact casting vs surgery, older adults (AIM). JAMA 2016;316:1455-63.
[6] Malek IA et al. Reliability of the Weber classification. J Bone Joint Surg Br 2006;88:1204-6.
[7] Kašper Š et al. Maisonneuve fracture: 70 cases. Rozhl Chir 2020;99:77-85.
[8] Ramsey PL, Hamilton W. Tibiotalar contact and lateral talar shift. J Bone Joint Surg Am 1976;58:356-7.
[9] Chan KB, Lui TH. Ankle arthroscopy in acute ankle fracture. Arthroscopy 2016;32:2373-80.

Illustrations: Page Ortho original art (right ankle from the front, intact and broken below, at and above the syndesmosis; the same art as the Lauge-Hansen page). Overlays are labels, brackets and arrows only.

Educational reference, not medical advice. Follow your local protocol and your attending.

KNEE · TIBIAL PLATEAU

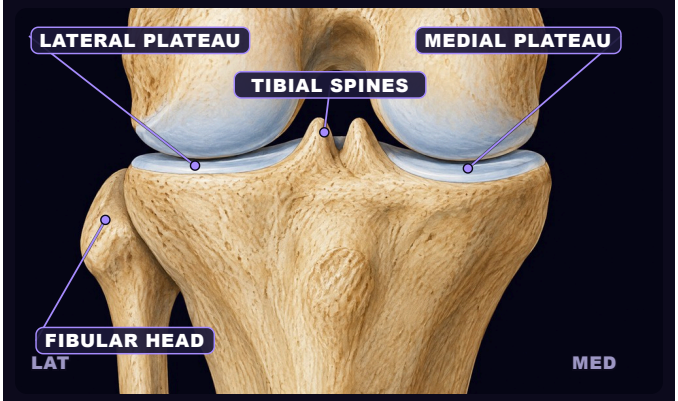
SCHATZKER CLASSIFICATION

Tibial plateau fractures, sorted by **which condyle** breaks and **how**: split, depression or both sides.

AUTHOR Joseph Schatzker et al., 1979
GRADED ON AP knee; CT raises agreement[2]
SIDES I–III lateral, IV medial, V–VI both

1 Anatomy

Right knee from the front



I–III break the lateral plateau, **IV** the medial, **V–VI** both.[1,2] The lateral split-depression (II) was the commonest operative pattern: 60% of 103.[3]

HOW TO GRADE

On the AP (CT raises agreement): **lateral split** = I; **split + depression** = II; **depression only** = III; **medial plateau** = IV; **both condyles** = V; plateau **separated from the shaft** (metaphysis from diaphysis) = VI.[2] Built from the AP films of 94 patients.[2]

2 The numbers

what comes with the fracture

	RESULT
Share of all fractures[2]	**1.2%** young high energy, older low energy
Any soft-tissue injury on MRI[3] 103 operative fractures	**99%** lateral meniscus 91%, medial 44%
Complete ligament tear or avulsion[3]	**77%** posterolateral corner 68%
Compartment syndrome, type VI[4] spanning frame within 48 h	**18%** medial fracture-dislocation 53%
Posteromedial piece, bicondylar[2]	**59–74%** system built on AP films

- **Readers agree moderately:** kappa 0.38–0.68 on films, 0.46–0.75 with CT.[2]

3 The types

same knee, our illustration, broken for each type

I SPLIT



Lateral split, no depression.
PATTERN Unicondylar, lateral.[2]
TREAT Lag screws, plate, or both.[2]

II SPLIT-DEPR.



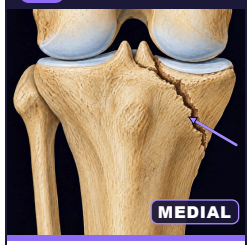
Lateral split + depression.
PATTERN Commonest; meniscus and MCL injuries.[2,3]
TREAT Elevate, graft, buttress.[2]

III DEPRESSION



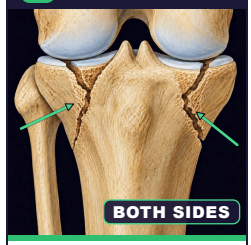
Lateral depression only.
PATTERN Low energy, osteopenic bone; rare.[2,3]
TREAT Elevation and bone graft.[2]

IV MEDIAL



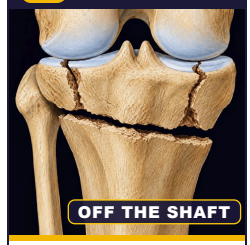
Medial plateau fracture.
PATTERN May reflect a transient knee dislocation.[2]
TREAT ABI and neurologic exam.[2]

V BICONDYLAR



Both condyles.
PATTERN Posteromedial piece in 59–74%.[2]
TREAT Dual incisions.[2]

VI DISSOCIATED



Plateau split off the shaft.
PATTERN Compartment syndrome in 18%.[4]
TREAT Often ex-fix, then fixation.[4]

4 Things to worry about

- **Don't miss: compartment syndrome**: 27% of 67 spanned VI and fracture-dislocations; most found after the frame.[4]
- **Don't miss:** a **medial (IV) fracture** may be a knee that dislocated and went back: pulses, ABI, full nerve exam.[2]
- **Soft tissue is the rule**: 77% had a complete ligament tear or avulsion.[3]
- **Posteromedial piece** in 59–74% of bicondylar fractures; AP-based system misses it.[2]
- **Late compartment syndrome:** 3 were found only after they had run their course; all 3 frames spanned the foot.[4]
- **Young, high energy:** more nonunion, infection, stiffness and arthritis.[2]

5 Pearls and tidbits

- **IV and VI:** compartment syndrome in 7–20% (treat: emergent fasciotomy); ACL injury in 25%.[1]
- **Exam trap:** III is the low-energy one (osteopenic bone).[2]
- **Pure depression may not exist:** all 103 MRIs showed a cortical split.[3]
- **AP-only system:** coronal and posterior fractures fall outside it; CT column models fill the gap.[2]
- **II and IV** carry the most meniscus and MCL injury.[2]
- **Medial fractures by exit point** (small series, n=28): compartment syndrome 14% medial to the spines, 33% within, 67% lateral.[5]

6 On call tonight

LOOK
Skin, wounds, swelling; ABI if pulses differ; tibial and peroneal nerves.[1,2]

COMPARTMENTS
Feel the compartments; monitor closely after a spanning frame.[1,4]

ORDER
Knee AP, lateral, oblique;[1,3] CT if films are negative but suspicion is high, or to plan.[1]

FRAME
VI or medial dislocation: ex-fix until soft tissues allow fixation.[4]

CALL YOUR ATTENDING NOW Compartment syndrome (18% of VI, 53% of medial dislocations),[4] or a medial fracture with a possible knee dislocation.[2]

[1] Orthobullets. Tibial Plateau Fractures. orthobullets.com, accessed Nov 2026.
[2] Zeltser DW, Leopold SS. Classifications in Brief: Schatzker. Clin Orthop Relat Res 2013;471:371-4.
[3] Gardner MJ et al. Soft-tissue injury in operative plateau fractures: MRI of 103. J Orthop Trauma 2005;19:79-84.
[4] Stark E et al. Compartment syndrome in Schatzker VI and medial fracture-dislocations. J Orthop Trauma 2009;23:502-6.
[5] Wahlquist M et al. Medial tibial plateau fractures: a new classification system. J Trauma 2007;63:1418-21.

Illustrations: Page Ortho original art (right knee from the front, intact and one broken version per type). Overlays are labels and arrows only.

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SHOULDER · PROXIMAL HUMERUS

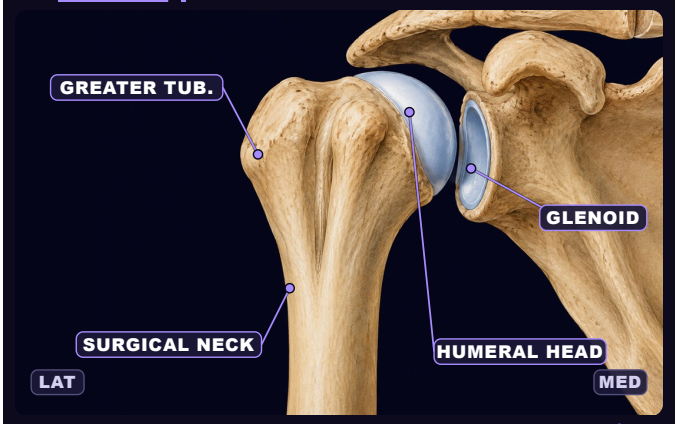
NEER CLASSIFICATION

Proximal humerus fractures, sorted by how many of the **four segments** are displaced.

AUTHOR **Charles Neer**, JBJS Am **1970**
GRADED ON **AP, scapular Y, axillary**
COUNTS Segments displaced **>1 cm** or angled **45°+**

1 Anatomy

Right shoulder from the front



Four segments (Codman): head, greater tuberosity, lesser tuberosity, shaft.[1] In cadavers the **posterior circumflex** artery gave 64% of head perfusion, the anterior 36%.[2]

HOW TO GRADE

Find the four segments on the trauma series (scapular AP, scapular lateral, axillary).[3] A segment is a separate **part** only if it is displaced more than **1 cm** or angled **45° or more**. Count displaced parts, not fracture lines.[1,4] Fracture-dislocations and head-split or impression fractures are filed as their own groups.[1]

2 The numbers

what the evidence says

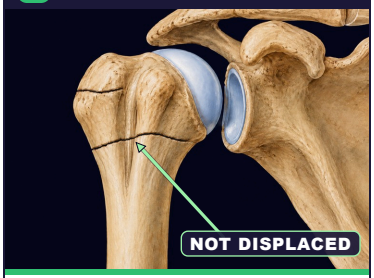
	RESULT
Minimally displaced[5] 1,027-fracture series; a 2013 review says over 80%[1]	**about half**
One-part: good or excellent[6] 104 patients, sling + therapy, 41 mo	**77%** 80/104
Nerve damage on EMG[7] displaced; nondisplaced 59% (55/93)	**82%** 41/50
Head ischemia predicted (PPV)[8] short calcar + broken hinge + anatomic neck	**up to 97%**

- **Surgery is not automatic:** in the PROFHER RCT (250 adults, surgical-neck fractures), surgery gave no better Oxford Shoulder Score over 2 yr (39.1 vs 38.3).[9]

3 The types

same shoulder, our illustration, broken for each type

1 ONE-PART

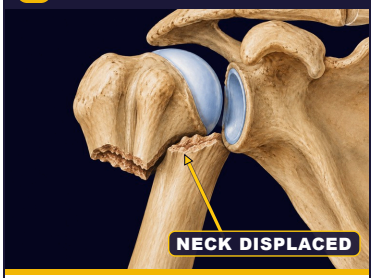


Any number of lines, but nothing past 1 cm or 45°.

PATTERN The biggest group: over 80% of fractures in one review.[1]

TREAT Sling, early motion; 77% good or excellent.[6]

2 TWO-PART

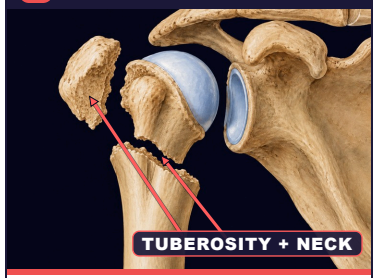


One segment displaced; here the shaft at the surgical neck.

PATTERN Head and both tuberosities stay together.

TREAT In PROFHER (surgical-neck fractures) surgery gave no gain over a sling.[9]

3 THREE-PART

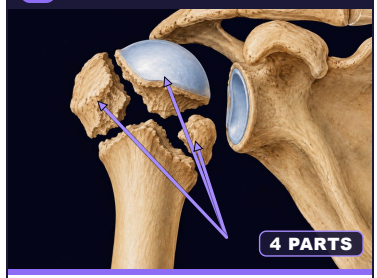


Surgical neck plus one tuberosity displaced.

PATTERN Cuff on the attached tuberosity rotates the head.[1]

TREAT Varus, medial comminution or poor bone: arthroplasty or nonop weighed more.[1]

4 FOUR-PART



Head, both tuberosities and shaft all displaced.

PATTERN Classic: head off the glenoid. Valgus-impacted: head sunk between the tuberosities.[1]

TREAT Neer advised arthroplasty for the classic form.[1]

4 Things to worry about

- **Don't miss:** a **fracture-dislocation** or **head-split**: Neer files them outside the part count.[1]
- **Axillary nerve**: EMG found axillary damage in 58%, and the clinical exam alone missed many lesions.[7]
- **Head ischemia**: calcar piece under 8 mm or a broken medial hinge.[8] Varus and medial comminution make fixation fail more.[1]

5 Pearls and tidbits

- **Parts are not lines:** four lines with nothing displaced is still one-part.[1]
- The 1 cm / 45° cutoffs came at the editor's request; Neer called them arbitrary.[1]
- **Reliability:** five readers agreed on only 32% of films.[3]
- **Lesser tuberosity fracture:** assume posterior dislocation.[10]

6 On call tonight

LOOK
Deltoid sensation; exam misses many nerve lesions.[7] Arterial injury (5-6%) can hide behind normal pulses.[10]

FILMS
Scapular AP, scapular lateral and axillary.[3] CT if head-split is a worry.[10]

SLING
Minimally displaced: sling 2-3 weeks, early therapy at once.[10] Within 14 days did better.[6]

GROUP
Fracture-dislocation and head-split are their own groups in Neer's system.[1]

CALL YOUR ATTENDING NOW A fracture-dislocation or head-split, which sit outside the one- to four-part count.[1]

[1] Carofino BC, Leopold SS. Neer classification. Clin Orthop 2013;471:39-43.
[2] Hettrich CM. Humeral head vascularity. JBJS Am 2010;92:943-8.
[3] Sidor ML. Neer reliability. JBJS Am 1993;75:1745-50.
[4] Neer CS. Displaced humeral fractures. JBJS Am 1970;52:1077-89.
[5] Court-Brown CM. Epidemiology. Acta Orthop Scand 2001;72:365-71.
[6] Koval KJ. Minimally displaced fractures. JBJS Am 1997;79:203-7.
[7] Visser CP. Nerve lesions. J Shoulder Elbow Surg 2001;10:421-7.
[8] Hertel R. Head ischemia. J Shoulder Elbow Surg 2004;13:427-33.
[9] Rangan A. PROFHER trial. JAMA 2015;313:1037-47.
[10] Orthobullets. Proximal Humerus Fractures. orthobullets.com, accessed Nov 2026.

Illustrations: Page Ortho original art (right shoulder from the front, intact and one broken version per type). Overlays are labels and arrows only.

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PEDIATRIC ELBOW · SUPRACONDYLAR HUMERUS

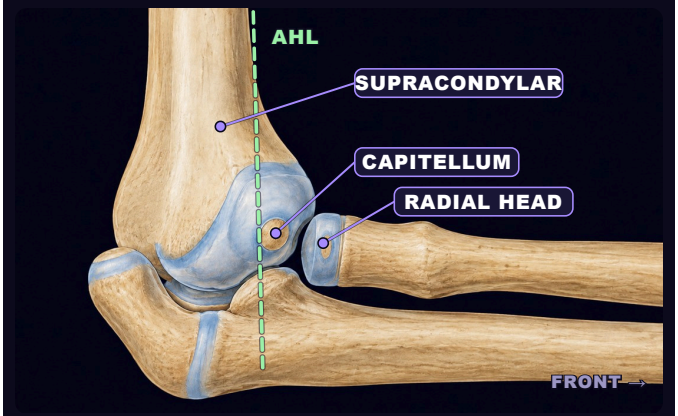
GARTLAND CLASSIFICATION

Extension-type supracondylar fractures in children, sorted by **displacement on the lateral**.

AUTHOR **Gartland**, Surg Gynecol Obstet **1959**[1]
MODIFIED **Wilkins** IIA/IIB; **Leitch 2006** type IV
GRADED ON **True lateral** elbow

1 Anatomy

Child's right elbow from the lateral side



The **anterior humeral line** normally crosses the capitellum; in type II it passes in front of it.[2] **Baumann angle** on the AP: normal 9–26°.[2]

HOW TO GRADE

Draw the anterior humeral line on a true lateral. **I**: not displaced. **II**: tipped back, line in front of the capitellum, **posterior cortex still in contact**; **IIA** no rotation or shift, **IIB** rotated or translated. **III**: no cortical contact. **IV**: unstable into both flexion and extension, found under anesthesia.[2,3]

2 The numbers

nerves, vessels, type IV

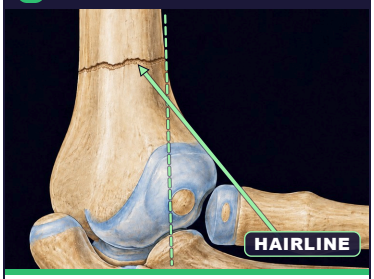
	RESULT
Nerve injury at presentation[4] 5,148 children; AIN = 34.1% of extension-type	11.3%
Radial pulse absent at presentation[2]	7–12%
Artery injured, still pulseless after reduction[5] pooled cases; pink but pulseless: 70%	82%
Type IV among displaced fractures fixed[3]	3% 9/297

- **Pins:** nerve injury 3.4% lateral-only vs 4.1% with a medial pin, which puts the ulnar nerve at risk.[4] In an RCT of type III, both constructs held.[6]
- **Timing:** waiting more than 8 h did not raise complications in 198 children.[7]

3 The types

same elbow, our illustration, broken for each type

I NONDISPLACED

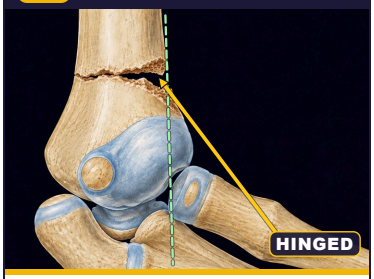


No displacement; line still crosses the capitellum.

PATTERN May show only fat pad elevation.[2]

TREAT Long-arm cast 3–4 weeks, films at 1 week.[2,8]

IIA HINGED

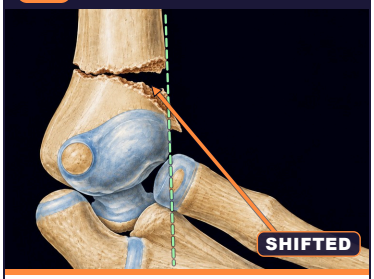


Tipped back; posterior cortex intact; no rotation.

PATTERN Line passes in front of the capitellum.[2]

TREAT Closed reduction and cast, or pins.[2]

IIB ROTATED

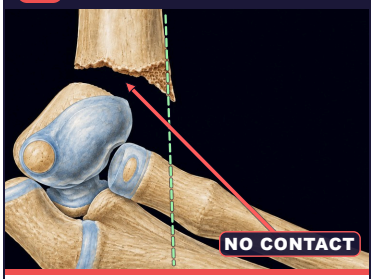


Some cortical contact, but rotated or shifted.

PATTERN Less stable; risks coronal or rotational malunion.[2]

TREAT Closed reduction and pinning.[2]

III NO CONTACT



Fully displaced, distal piece usually behind.

PATTERN Radial pulse absent in 7–12% at presentation.[2]

TREAT Pinning; open if closed fails or the hand is not perfused.[2]

4 Things to worry about

- **Don't miss:** a **white, pulseless hand**: a dysvascular hand needs open reduction.[2]
- **Pink but pulseless**: 70% had an artery injury.[5]
- **AIN** is 34.1% of extension-type nerve injuries.[4]
- **Compartment syndrome** still develops in 0.1–0.3%.[2]
- **Perfusion lost after pinning**: pull the pins.[8]

5 Pearls and tidbits

- **Flexion type**: nerve injuries are mostly ulnar (91.3%).[4]
- Reliability 0.74; most disagreement is I vs II.[2]
- Medial column comminution with lost Baumann angle: pin it.[2]
- Explore on **perfusion**, not pulse; skip angiography.[8]
- **Most common** child elbow fracture; 86–100% of nerve injuries recover.[2]

6 On call tonight

LOOK
Hand color and pulse. Pulse absent in 7–12%.[2,5]

NERVES
Neurovascular exam before any reduction.[4,8]

FILMS
True lateral elbow: grade on it.[2]

SPLINT
Cast at 75–80°; over 90° risks Volkmann.[2,8]

TIMING
Perfused: over 8 h wait, no more complications.[7]

CALL YOUR ATTENDING NOW A dysvascular hand (pulseless, not pink) or an open fracture.[2]

[1] Gartland JJ. Management of supracondylar fractures of the humerus in children. Surg Gynecol Obstet 1959;109:145-54.
[2] Alton TB, Werner SE, Gee AO. Classifications in brief: the Gartland classification. Clin Orthop 2015;473:738-41.
[3] Leitch KK et al. Multidirectionally unstable supracondylar fractures: type IV. JBJS Am 2006;88:980-5.
[4] Babal JC, Mehlman CT, Klein G. Nerve injuries with supracondylar fractures: meta-analysis. J Pediatr Orthop 2010;30:253-63.
[5] White L, Mehlman CT, Crawford AH. Perfused, pulseless, and puzzling. J Pediatr Orthop 2010;30:328-35.
[6] Kocher MS et al. Lateral vs medial and lateral pins, RCT. JBJS Am 2007;89:706-12.
[7] Mehlman CT et al. Surgical timing and perioperative complications. JBJS Am 2001;83:323-7.
[8] Orthobullets. Supracondylar Humerus Fracture - Pediatric. orthobullets.com, accessed Nov 2026.

Illustrations: Page Ortho original art (child's elbow from the lateral side, intact and one broken version per type). Overlays are the anterior humeral line, labels and arrows only.

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PELVIS · PELVIC RING

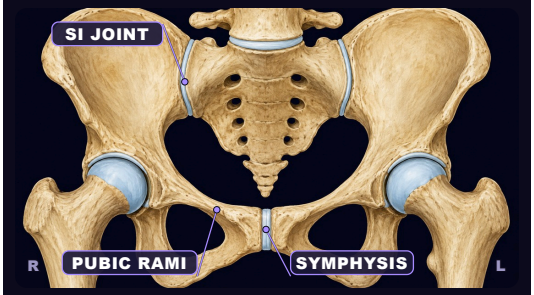
YOUNG-BURGESS CLASSIFICATION

Pelvic ring injuries, sorted by the **direction of force**: front-to-back, side, vertical or combined.

AUTHORS Young 1986; Burgess 1990
GRADED ON AP pelvis + CT
COUNTS Force vector, then grade 1–3

1 Anatomy

Pelvis from the front



SI ligaments hold the back, **sacrospinous and sacrotuberous** ligaments brace the floor, and the **symphysis** closes the front.[1]

HOW TO GRADE

APC: symphysis opens. I under 2.5 cm; II anterior SI opens (floor ligaments torn); III the whole SI is torn. **LC**: rami break across, sacrum buckles in front; II adds an iliac crescent or SI injury; III adds an open book on the other side. **VS**: one hemipelvis driven up. **CM**: two different force patterns, e.g. VS with APC.[1,2]

2 The numbers

210 high-energy patients, 1985–88; 162 with full charts

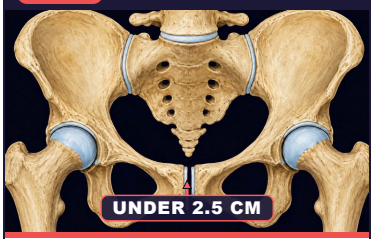
	APC	LC	VS	CM
Blood given, units[2] average per patient	14.8	3.6	9.2	8.5
Died[2]	20%	7%	0%	18%

- **1,248 patients later**: mortality 9.1%, even LC1 8.2%; LC3, APC2 and APC3 needed the most blood.[3]

3 The types

same pelvis, our illustration, broken for each type

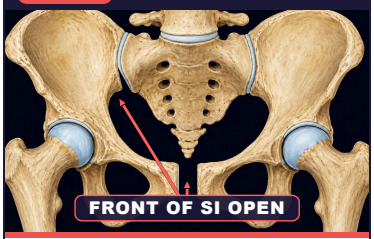
APC I SPRUNG



Symphysis open under 2.5 cm; SI intact.

TREAT Stable: nonop, early weight bearing.[4]

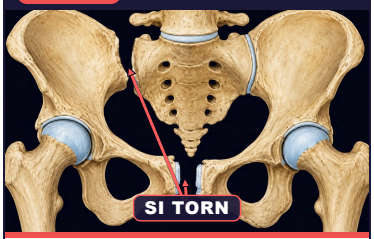
APC II OPEN BOOK



Over 2.5 cm; front of SI open, back holds.

TREAT Rotationally unstable: fix. Plate alone lost reduction in 22%.[1,4]

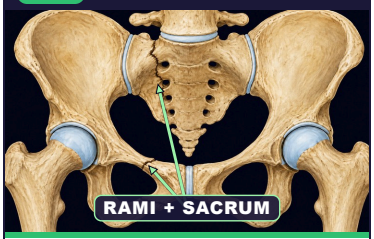
APC III SI TORN



Whole SI torn; hemipelvis free.

TREAT Surgical fixation.[4]

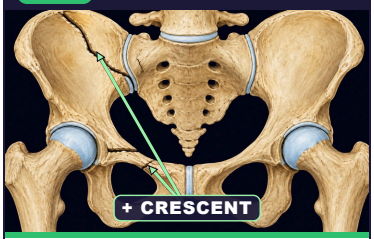
LC I SIDE IMPACT



Rami break across; sacral ala buckles.

TREAT Stable: nonop, early weight bearing.[4]

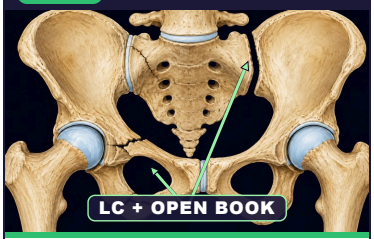
LC II CRESCENT



LC I plus an iliac wing (crescent) fracture.

TREAT Rotationally unstable: fix.[4]

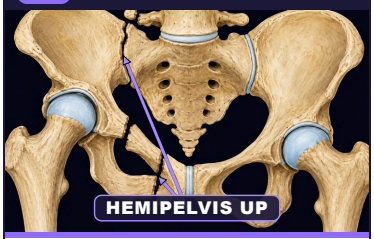
LC III WINDSWEPT



LC one side, open book the other.

TREAT Surgical fixation.[4]

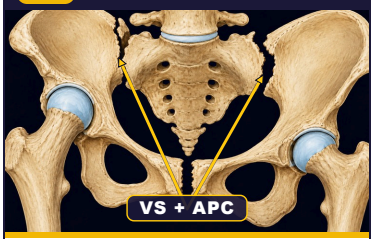
VS VERTICAL SHEAR



Hemipelvis driven up; SI and rami fail.

TREAT Traction can reduce it;[1] surgical fixation.[4]

CM COMBINED



Two different vectors; here VS + APC.

TREAT Surgical fixation.[4]

4 Things to worry about

- **Don't miss: bleeding**: APC averaged 14.8 units and 20% died.[2]
- **Binder too high**: half sat off the trochanters; gap 2.8× wider.[5]
- **Hidden instability**: APC3 hides in 39% on EUA;[1] binder, CT understate it.[6]
- **Open fracture**: up to 50% mortality; vaginal and rectal exams find it.[6]

5 Pearls and tidbits

- LC deaths: head injury + shock; APC: shock, sepsis, ARDS.[7]
- The **2.5 cm** APC I/II cutoff comes from Tile.[1]
- A **binder** beats a sheet for bleeding control.[4]
- **VS** has the highest shock risk (63%).[6]

6 On call tonight

BLEEDING
Massive transfusion protocol.[4]

BIND
Binder at the **greater trochanters**.[4]

FILMS
AP, inlet, outlet;[6] contrast CT once stable.[4]

EXAM
Rectal and vaginal exam for open fracture or rectal injury.[4,6]

STILL BLEEDING
Angioembolization or packing.[4]

CALL YOUR ATTENDING NOW Unstable blood pressure, or APC III, LC III, VS or CM.[4]

[1] Alton TB, Gee AO. Young-Burgess. CORR 2014;472:2338-42.
[2] Burgess AR. Pelvic ring disruptions. J Trauma 1990;30:848-56.
[3] Manson T. Mortality, transfusion. JOT 2010;24:603-9.
[4] Coccolini F. WSES pelvic trauma. WJES 2017;12:5.
[5] Bonner TJ. Pelvic binder placement. JBJS Br 2011;93:1524-8.
[6] Orthobullets. Pelvic Ring Fractures. orthobullets.com, accessed Nov 2026.
[7] Dalal SA. Pelvic fracture. J Trauma 1989;29:981-1000.

Illustrations: Page Ortho original art (pelvis from the front, intact and one broken version per type). Overlays are labels and arrows only.

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ELBOW · RADIAL HEAD

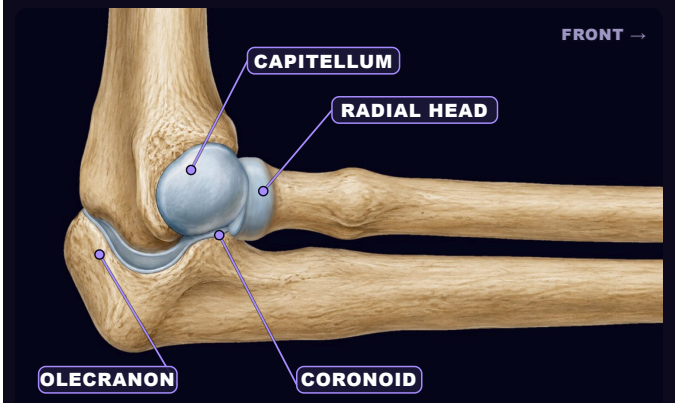
MASON CLASSIFICATION

Radial head fractures, sorted by **displacement and comminution**; type IV adds an elbow dislocation.

AUTHOR Mason, Br J Surg 1954[1]; IV: Johnston 1962[2]
GRADED ON AP and lateral elbow
COUNTS Displacement, pieces, dislocation

1 Anatomy

Right elbow from the lateral side



The **posterior interosseous nerve** lies close to the radial neck and is at risk in surgery.[3]

HOW TO GRADE

Ask three questions on the AP and lateral: is a piece **displaced** (step over 2 mm or tilted), is the whole head **broken up**, and is the elbow **dislocated**? Hotchkiss grades by what you can do: **I** under 2 mm, **II** displaced but fixable, **III** too comminuted to rebuild.[2]

2 The numbers

how common, and how ORIF did

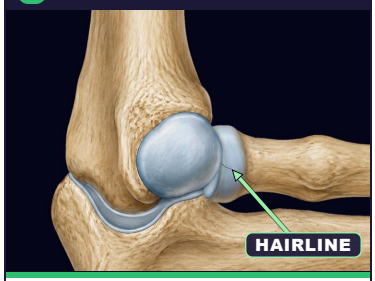
	TYPE I	TYPE II	TYPE III	TYPE IV
Share of fractures[4] 201 head and neck fractures, 1 yr	51% 103	41% 82	5% 11	2% 5
Unsatisfactory after ORIF[5] II comminuted; III with over 3 pieces	not reported	27% 4/15	93% 13/14	not reported

- **Simple pieces do well:** all 15 isolated, non-comminuted type II fractures had a good result after ORIF; ORIF is best kept for **3 or fewer** pieces.[5]
- **Nonoperative type II** (2–5 mm, ≥30% of the surface): 40 of 49 had no complaints at 19 yr; 6 needed a late head excision.[6]
- 93% of all patients reached a good or excellent Mayo score at 1 yr.[4]

3 The types

same elbow, our illustration, broken for each type

I NONDISPLACED

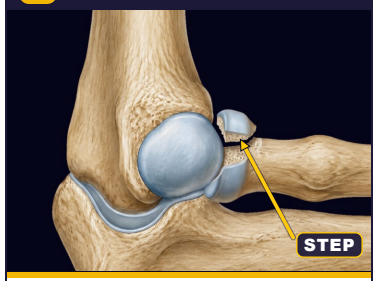


Crack or marginal fracture, step under 2 mm.

PATTERN Head shape kept; motion not blocked.

TREAT Short splint, early motion; 95% good or excellent.[2]

II DISPLACED PIECE

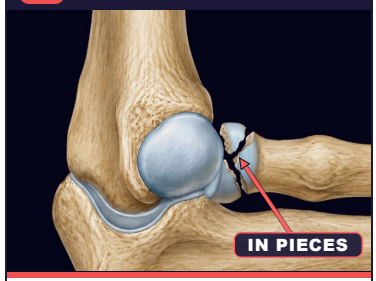


One marginal piece displaced, sunk or tilted.

PATTERN Part of the head stays on the neck.

TREAT No block: nonop did well.[6] Simple pieces: ORIF did well.[5]

III COMMINUTED

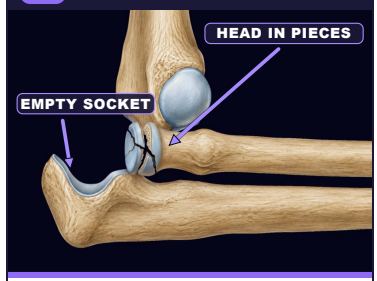


The whole head broken into displaced pieces.

PATTERN No part of the head left on the neck.

TREAT ORIF if 3 or fewer pieces;[5] otherwise excision or replacement.[2]

IV WITH DISLOCATION



Any head fracture plus an elbow dislocation.[2]

PATTERN Johnston added this type in 1962.[2]

TREAT Expect ligament injury.[7]

4 Things to worry about

- **Don't miss:** a **block to rotation**: it makes a displaced fracture type II.[2]
- **Ligaments**: on MRI the LUCL was torn in 18/24 and the MCL in 13/24.[7]
- **Essex-Lopresti**: DRUJ or interosseous membrane injury; check the forearm and wrist.[8]
- **PIN**: protect it when the proximal radius is exposed.[3]
- **Capitellum**: bone bruise in 23/24, cartilage defect in 7/24.[7]

5 Pearls and tidbits

- **Common**: 2.8 per 10,000 a year, mean age 48; another bone injured in 12%.[9]
- Mason kept type II nonop if under ¼ of the head and not blocking motion.[2]
- Readers agree only moderately: κ 0.43–0.56.[2]
- A **fat pad sign** can mean an occult, minimally displaced fracture.[8]
- In the Edinburgh series, nonop and operative type III–IV results did not differ (small groups).[4]

6 On call tonight

LOOK
PIN function (thumb and finger extension): the nerve sits close to the radial neck.[3]

GRADE
Step under or over 2 mm? Any block to rotation? Dislocated?[2]

FILMS
AP and lateral elbow, plus forearm and wrist; CT if comminuted.[8]

TYPE I
Sling or posterior long-arm splint 3-7 days, then early motion.[8]

CALL YOUR ATTENDING NOW A block to rotation, or a dislocation with the fracture (type IV).[2]

[1] Mason ML. Some observations on fractures of the head of the radius. Br J Surg 1954;42:123-32.
[2] Iannuzzi NP, Leopold SS. In brief: the Mason classification. Clin Orthop 2012;470:1799-802.
[3] Calfee RP et al. Posterior interosseous nerve anatomy with proximal forearm trauma. JBJS Am 2011;93:81-90.
[4] Duckworth AD et al. Radial head and neck fractures: functional results. J Trauma 2011;71:643-8.
[5] Ring D, Quintero J, Jupiter JB. ORIF of radial head fractures. JBJS Am 2002;84:1811-5.
[6] Akesson T et al. Nonoperative care of displaced two-part radial head fractures. JBJS Am 2006;88:1909-14.
[7] Itamura J et al. Radial head fractures: MRI of associated injuries. J Shoulder Elbow Surg 2005;14:421-4.
[8] Orthobullets. Radial Head Fractures. orthobullets.com, accessed Nov 2026.
[9] Kaas L et al. The epidemiology of radial head fractures. J Shoulder Elbow Surg 2010;19:520-3.

Illustrations: Page Ortho original art (right elbow from the lateral side, intact and one injured version per type). Overlays are labels and arrows only.

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SPINE · C2 DENS

ANDERSON-D'ALONZO ODONTOID

Fractures of the dens, sorted by **where the line crosses**: the tip, the base, or down into the C2 body.

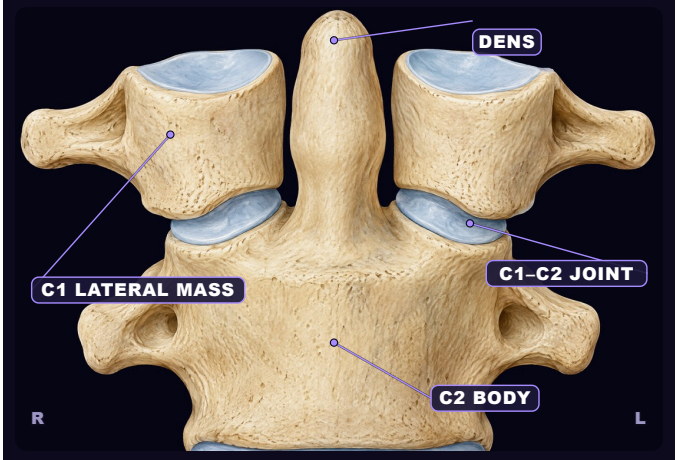
AUTHORS **L.D. Anderson, R.T. D'Alonzo**, JBJS Am **1974**

GRADED ON **Open-mouth AP + lateral**; CT

THE HARD ONE **Type II**: the base, above the C2 body

1 Anatomy

C1–C2 from the front, front arch of C1 removed



The C1–C2 joints are the dividing line: a break that reaches them is III, one above them is II.[1]

HOW TO GRADE

A line through the **tip** only = I. A line across the **base of the dens**, staying above the body = II. A line that runs **down into the C2 body** and its upper facets = III.[1,2,3] Grauer split II by line direction, displacement and comminution.[1]

2 The numbers

mostly type II, mostly older patients

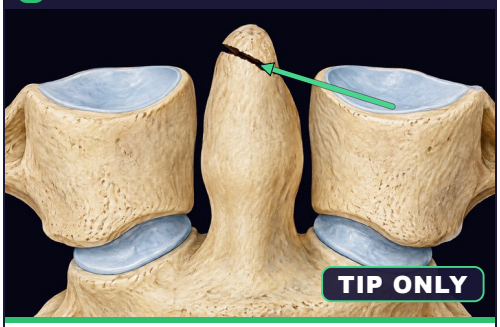
	RESULT
Halo fusion, type II[4] average across the literature	**about 70%**
Halo failure if 50 or older[4] 33 isolated type II, case-control	**21× the odds**
Over 65: fusion, surgery vs nonop[5] 46 studies, 2,822 patients	**74% vs 40%**
Over 65: death, surgery vs nonop[5] surgical patients were younger	**13% vs 19%**

- **Readers agree moderately** on Grauer's version: kappa 0.48 (52 fractures, 7 readers).[1]

3 The types

same C1–C2, our illustration, broken for each type

I TIP

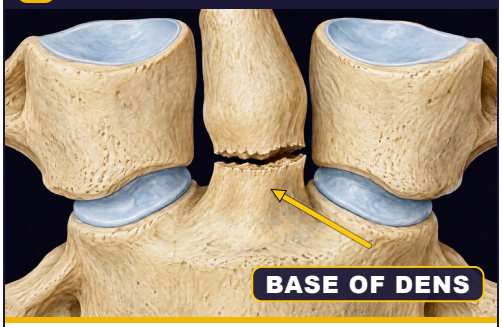


Oblique break of the tip, above the base.

PATTERN The least common type.[3]

TREAT More stable than II; often external immobilization.[3]

II BASE



Across the base of the dens, above the C2 body.

PATTERN The common one in older fallers; high nonunion.[4,5]

TREAT Over 65: surgery fuses more (74% vs 40%).[5] Grauer: IIA immobilize, IIB screw, IIC posterior fusion.[3]

III BODY



Runs down into the C2 body and its facets.

PATTERN Runs into the lateral masses of C2.[3]

TREAT More stable than II; often external immobilization.[3]

4 Things to worry about

- **Don't miss:** an odontoid after a **simple fall**: commonest neck fracture over 65.[5,6]
- **Age 50 or older:** halo treatment failed 21 times as often.[4]
- **II or a shallow III?** If the line reaches the C1–C2 facets, it is III.[1]
- **Surgery costs something:** complications 26% vs 18.5% over 65.[5]

5 Pearls and tidbits

- **Stable nonunion is a fair goal** when frail: under 5% needed surgery.[5]
- **Type II is where the decisions are.** Types I and III are more stable.[3]
- **Poor blood supply:** the watershed base is why type II heals badly.[7]
- **Collar vs halo:** no difference in mortality or complications over 60.[6]

6 On call tonight

LOOK
Neuro deficit is rare. Dysphagia: retropharyngeal hematoma.[7]

FILMS
AP, lateral, open-mouth; CT for stability; MRI if neuro signs.[7]

GRADE
Is the line at the base (II) or does it reach the C1–C2 facets (III)?[1]

WEIGH IT
Over 65: fuses more, but complications 26% vs 18.5%.[5]

COLLAR OR HALO
Over 60: no difference in mortality or complications.[6]

CALL YOUR ATTENDING NOW A displaced type II (Grauer IIB or IIC), the subtypes where surgery is considered.[3]

[1] Grauer JN et al. A modified, treatment-oriented classification of odontoid fractures. Spine J 2005;5:123-9.
[2] Anderson LD, D'Alonzo RT. Fractures of the odontoid process of the axis. JBJS Am 1974;56:1663-74.
[3] Mathkour M et al. Classifications of odontoid process fractures: a systematic review. Cureus 2022;14:e32520.
[4] Lennarson PJ et al. Management of type II dens fractures: a case-control study. Spine 2000;25:1234-7.
[5] Avila MJ et al. Nonoperative vs operative type II odontoid fracture in older adults: meta-analysis. J Neurosurg Spine 2024;40:45-53.
[6] Schroeder GD et al. Treatment of geriatric type II odontoid fractures: systematic review. Neurosurgery 2015;77 Suppl 4:S6-14.
[7] Orthobullets. Odontoid Fractures. orthobullets.com, accessed Nov 2026.

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The full book

PAGE ORTHO

Every classification, in this format. Coming soon. Follow **@page_ortho** on Instagram.