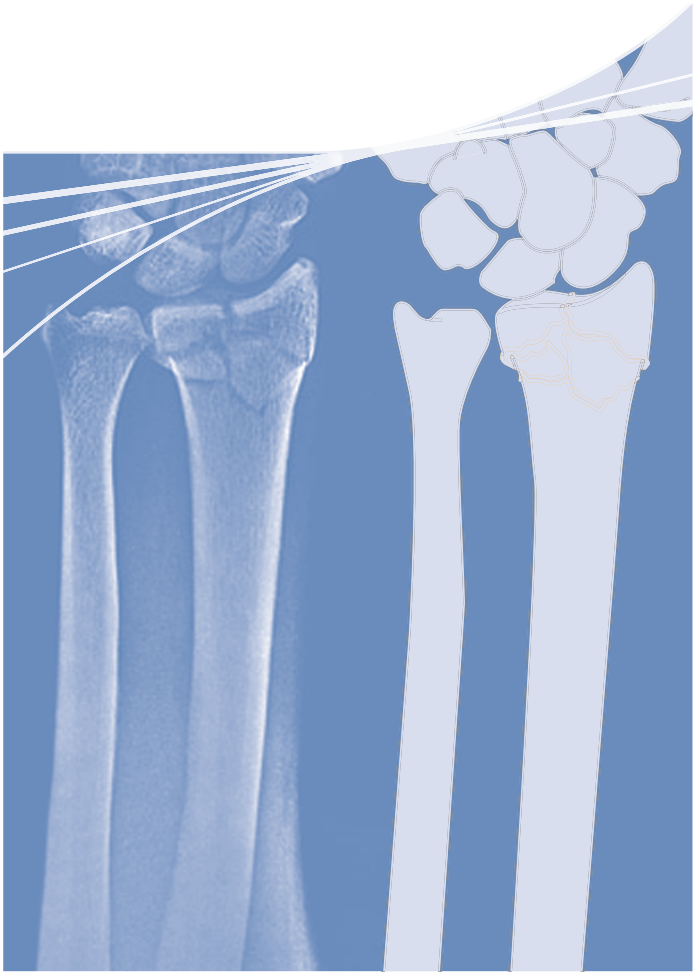
AOTRAUMA

Müller AO Classification of Fractures—Long Bones

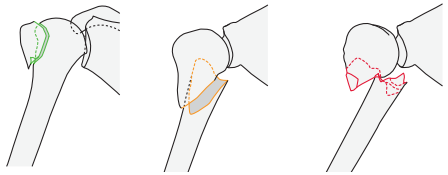
This leaflet is designed to provide an introduction to the classification of long-bone fractures.



1 Humerus

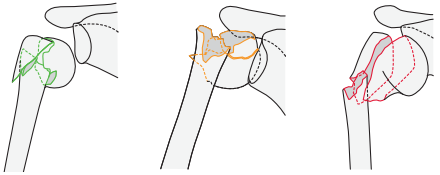
11 proximal (types according to topography and extent of bone lesion)

11-A1 | 11-A2 | 11-A3



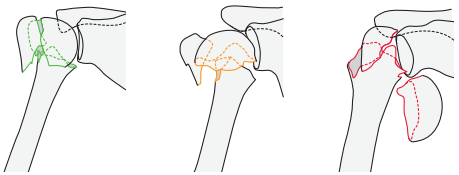
11-A extraarticular unifocal fracture
11-A1 tuberosity
11-A2 impacted metaphyseal
11-A3 nonimpacted metaphyseal

11-B1 | 11-B2 | 11-B3



11-B extraarticular bifocal fracture
11-B1 with metaphyseal impaction
11-B2 without metaphyseal impaction
11-B3 with glenohumeral dislocation

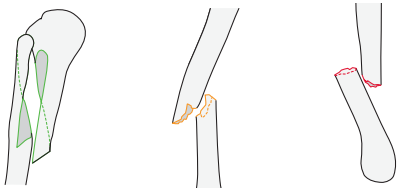
11-C1 | 11-C2 | 11-C3



11-C articular fracture
11-C1 with slight displacement
11-C2 impacted with marked displacement
11-C3 dislocated

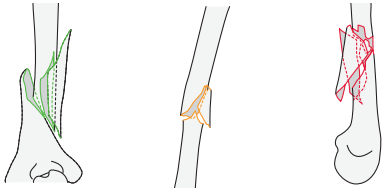
12 diaphyseal

12-A1 | 12-A2 | 12-A3



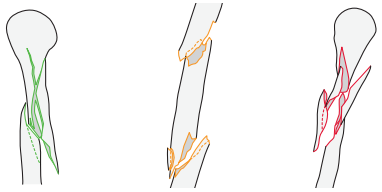
12-A simple fracture
12-A1 spiral
12-A2 oblique (≥ 30°)
12-A3 transverse (< 30°)

12-B1 | 12-B2 | 12-B3



12-B wedge fracture
12-B1 spiral wedge
12-B2 bending wedge
12-B3 fragmented wedge

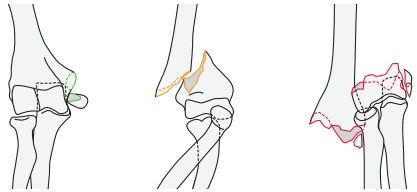
12-C1 | 12-C2 | 12-C3



12-C complex fracture
12-C1 spiral
12-C2 segmental
12-C3 irregular

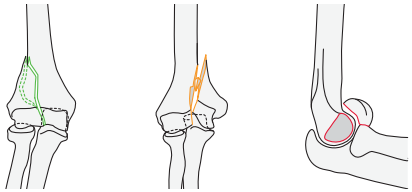
13 distal

13-A1 | 13-A2 | 13-A3



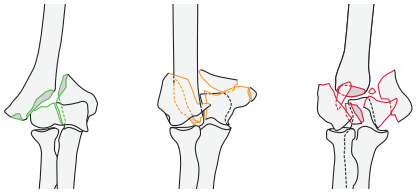
13-A extraarticular fracture
13-A1 apophyseal avulsion
13-A2 metaphyseal simple
13-A3 metaphyseal multifragmentary

13-B1 | 13-B2 | 13-B3



13-B partial articular fracture
13-B1 sagittal lateral condyle
13-B2 sagittal medial condyle
13-B3 coronal

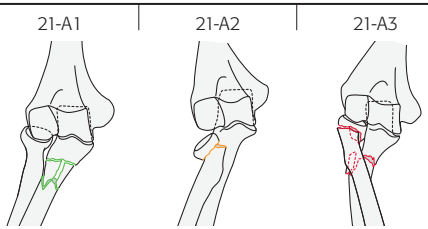
13-C1 | 13-C2 | 13-C3



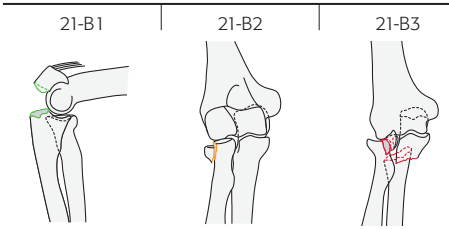
13-C complete articular fracture
13-C1 articular simple, metaphyseal simple
13-C2 articular simple, metaphyseal multifragmentary
13-C3 articular multifragmentary

2 Radius/ulna

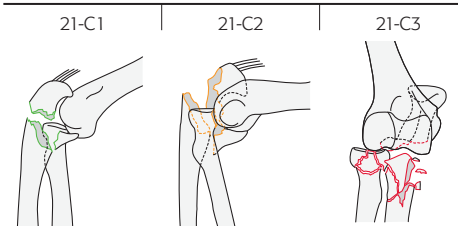
21 proximal



21-A extraarticular fracture
21-A1 ulna fractured, radius intact
21-A2 radius fractured, ulna intact
21-A3 both bones

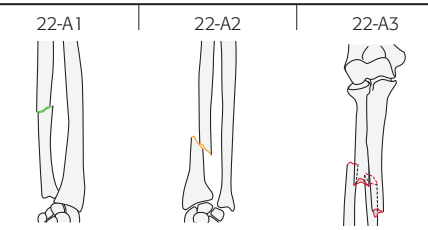


21-B articular fracture
21-B1 ulna fractured, radius intact
21-B2 radius fractured, ulna intact
21-B3 one bone articular fracture, other extraarticular

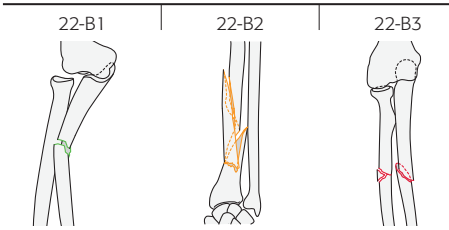


21-C articular fracture of both bones
21-C1 simple
21-C2 one artic. simple, other artic. multifragmentary
21-C3 multifragmentary

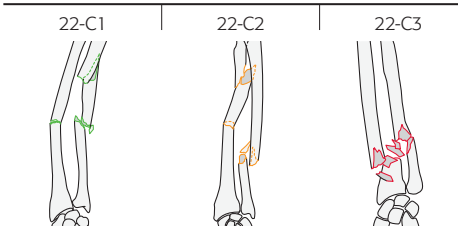
22 diaphyseal



22-A simple fracture
22-A1 ulna fractured, radius intact
22-A2 radius fractured, ulna intact
22-A3 both bones

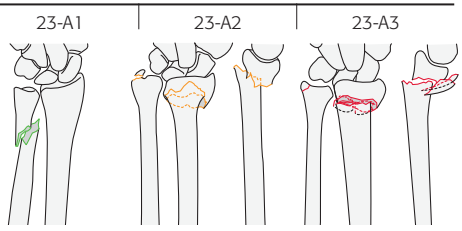


22-B wedge fracture
22-B1 ulna fractured, radius intact
22-B2 radius fractured, ulna intact
22-B3 one bone wedge, other simple or wedge

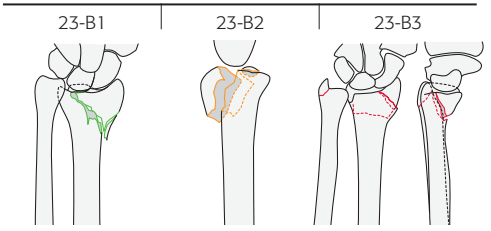


22-C complex fracture
22-C1 ulna complex, radius simple
22-C2 radius complex, ulna simple
22-C3 both bones complex

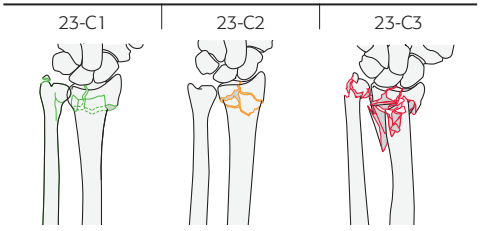
23 distal



23-A extraarticular fracture
23-A1 ulna fractured, radius intact
23-A2 radius, simple and impacted
23-A3 radius, multifragmentary



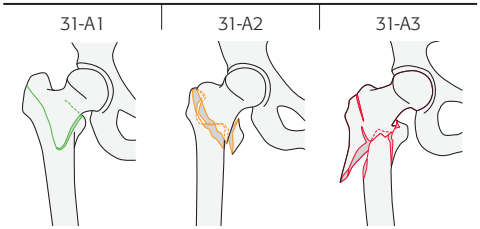
23-B partial articular fracture of radius
23-B1 sagittal
23-B2 coronal, dorsal rim
23-B3 coronal, palmar rim



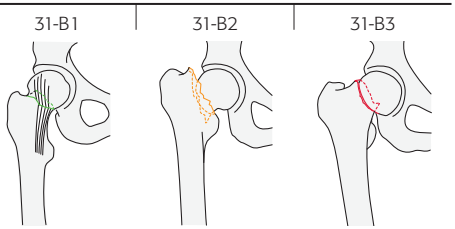
23-C complete articular fracture of radius
23-C1 articular simple, metaphyseal simple
23-C2 articular simple, metaphyseal multifragmentary
23-C3 articular multifragmentary

3 Femur

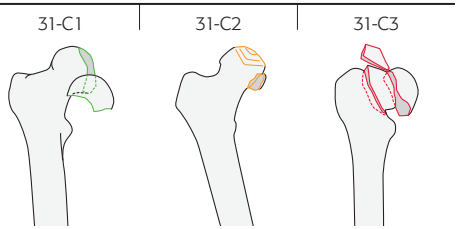
31 proximal (defined by a line passing transversely through the lower end of the lesser trochanter)



31-A extraarticular fracture, trochanteric area
31-A1 pertrochanteric simple
31-A2 pertrochanteric multifragmentary
31-A3 intertrochanteric

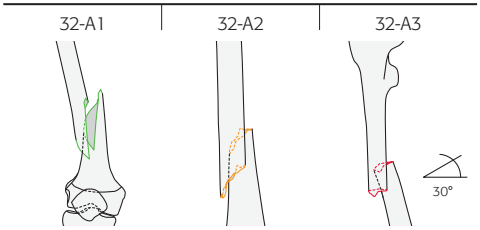


31-B extraarticular fracture, neck
31-B1 subcapital, with slight displacement
31-B2 transcervical
31-B3 subcapital, displacted, nonimpacted

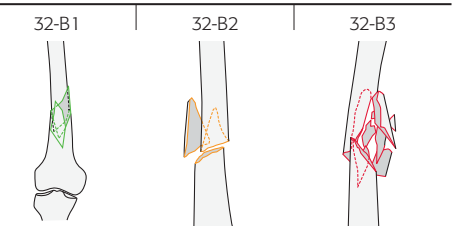


31-C articular fracture, head
31-C1 split (Pipkin)
31-C2 with depression
31-C3 with neck fracture

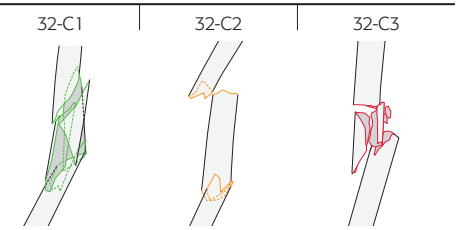
32 diaphyseal



32-A simple fracture
32-A1 spiral
32-A2 oblique (≥ 30°)
32-A3 transverse (< 30°)
32-A(1–3).1 = subtrochanteric fracture

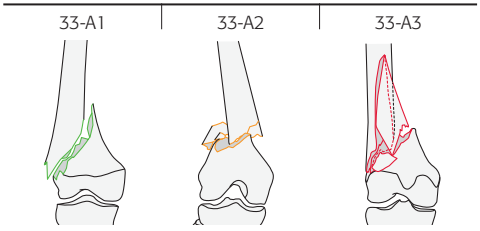


32-B wedge fracture
32-B1 spiral wedge
32-B2 bending wedge
32-B3 fragmented wedge
32-B(1–3).1 = subtrochanteric fracture

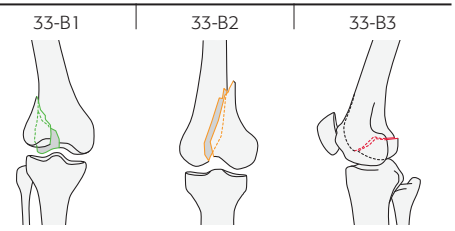


32-C complex fracture
32-C1 spiral
32-C2 segmental
32-C3 irregular
32-C(1–3).1 = subtrochanteric fracture

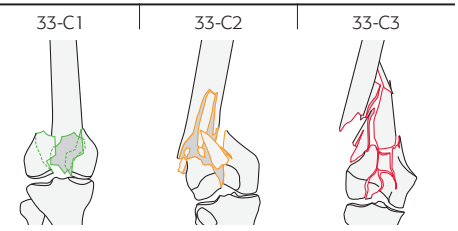
33 distal



33-A extraarticular fracture
33-A1 simple
33-A2 metaphyseal wedge and/or fragmented wedge
33-A3 metaphyseal complex



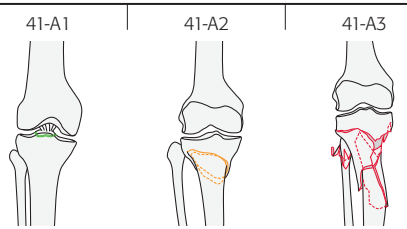
33-B partial articular fracture
33-B1 lateral condyle, sagittal
33-B2 medial condyle, sagittal
33-B3 coronal



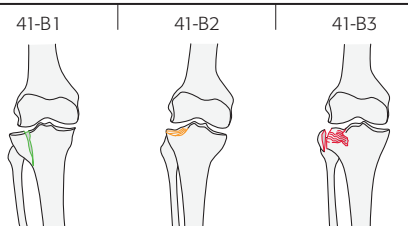
33-C complete articular fracture
33-C1 articular simple, metaphyseal simple
33-C2 articular simple, metaphyseal multifragmentary
33-C3 articular multifragmentary

4 Tibia/fibula

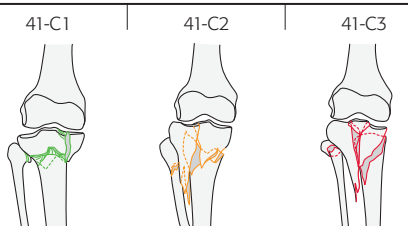
41 proximal



41-A extraarticular fracture
41-A1 avulsion
41-A2 metaphyseal simple
41-A3 metaphyseal multifragmentary

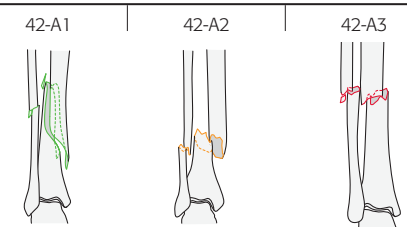


41-B partial articular fracture
41-B1 pure split
41-B2 pure depression
41-B3 split-depression

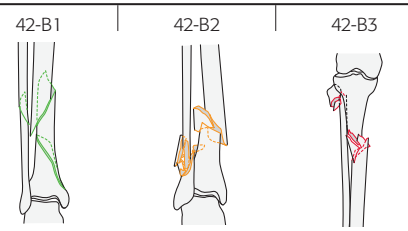


41-C complete articular fracture
41-C1 articular simple, metaphyseal simple
41-C2 articular simple, metaphyseal multifragmentary
41-C3 articular multifragmentary

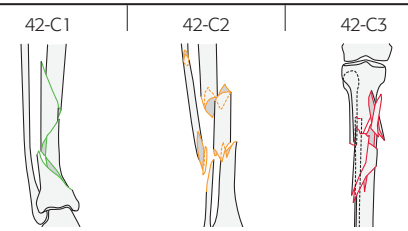
42 diaphyseal



42-A simple fracture
42-A1 spiral
42-A2 oblique (≥ 30°)
42-A3 transverse (< 30°)

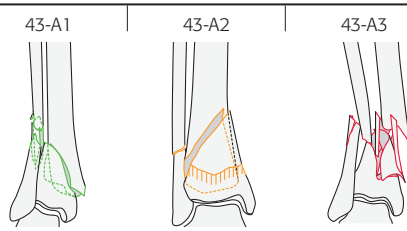


42-B wedge fracture
42-B1 spiral wedge
42-B2 bending wedge
42-B3 fragmented wedge

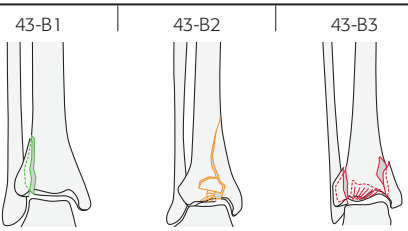


42-C complex fracture
42-C1 spiral
42-C2 segmental
42-C3 irregular

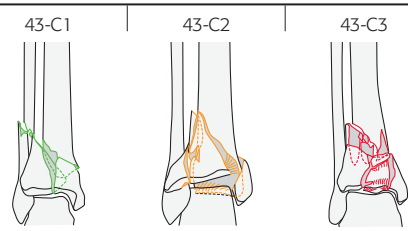
43 distal



43-A extraarticular fracture
43-A1 simple
43-A2 wedge
43-A3 complex

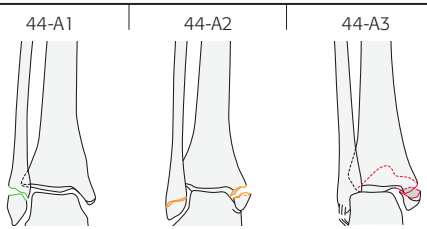


43-B partial articular fracture
43-B1 pure split
43-B2 split-depression
43-B3 multifragmentary depression

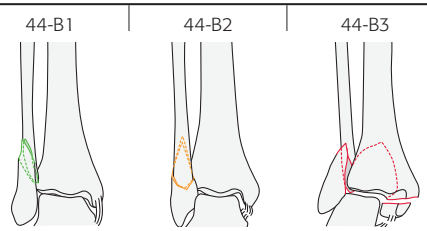


43-C complete articular fracture
43-C1 articular simple, metaphyseal simple
43-C2 articular simple, metaphyseal multifragmentary
43-C3 articular multifragmentary

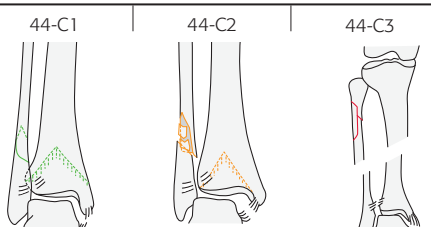
44 malleolar



44-A infrasyndesmotic lesion
44-A1 isolated
44-A2 with fractured medial malleolus
44-A3 with posteromedial fracture

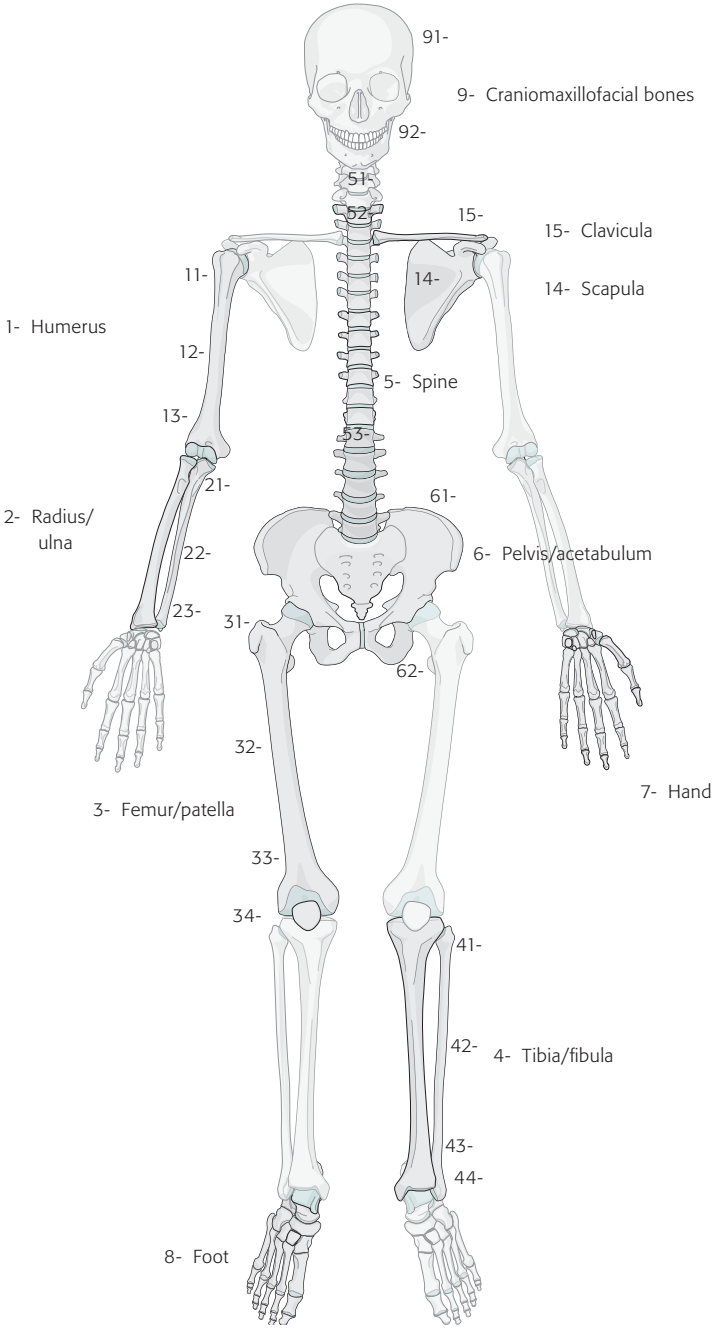


44-B transsyndesmotic fibular fracture
44-B1 isolated
44-B2 with medial lesion
44-B3 with medial lesion and Volkmann's fracture



44-C suprasyndesmotic lesion
44-C1 fibular diaphyseal fracture, simple
44-C2 fibular diaphyseal fracture, multifragmentary
44-C3 proximal fibular lesion

AO/OTA system for numbering the anatomical location of a fracture in three bone segments (proximal = 1, diaphyseal = 2, distal = 3)



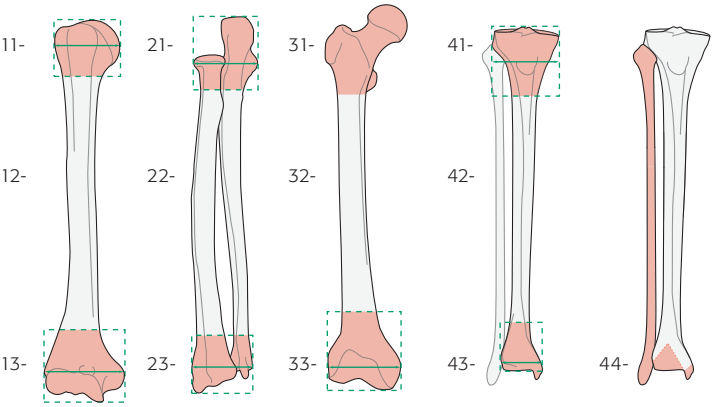
Alphanumeric structure of the Müller AO Classification of Fractures—Long Bones for adults

Diagnosis = "essence" of the fracture

Localization			Morphology		
Bone 1 2 3 4	Segment 1 2 3 (4)	—	Type A B C	Group 1 2 3	Subgroup .1 .2 .3
4 long bones	3 or 4 segments		3 types	3 groups	3 subgroups

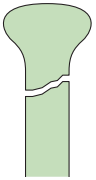
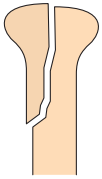
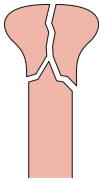
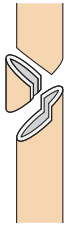
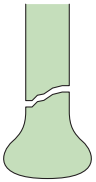
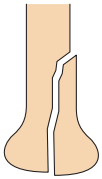
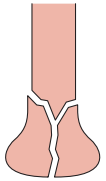
Example 32-B2

3 femur	2 diaphyseal	—	B wedge fracture	2 bending wedge



Anatomical location of the fracture. Anatomical location is designated by two numbers: one for the bone and one for its segment (ulna and radius as well as tibia and fibula are regarded as one bone). The malleolar segment (44-) is an exception. The proximal and distal segments of long bones are defined by a square the sides of which have the same length as the widest part of the epiphysis (exceptions 31- and 44-).

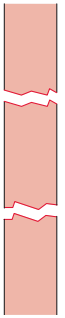
Definitions of fracture types for long-bone fractures in adults
Exception to this are fractures of the proximal humerus (11-), proximal femur (31-), malleoli (44-), subtrochanteric fractures (32-)

Segment	Type		
	A	B	C
1 Proximal			
	Extraarticular No involvement of displaced fractures that extend into the articular surface	**Partial articular** Part of the articular component is involved, leaving the other part attached to the meta-/diaphysis	**Complete articular** Articular surface involved, metaphyseal fracture completely separates the articular component from the diaphysis
2 Diaphyseal			
	Simple One fracture line, cortical contact between fragments exceeds 90% after reduction	**Wedge** Three or more fragments, main fragments have contact after reduction	**Complex** Three or more fragments, main fragments have no contact after reduction
3 Distal			
	Extraarticular No involvement of displaced fractures that extend into the articular surface	**Partial articular** Part of the articular component is involved, leaving the other part attached to the meta-/diaphysis	**Complete articular** Articular surface involved, metaphyseal fracture completely separates the articular component from the diaphysis

Steps in identifying diaphyseal fractures

Diaphyseal fracture		
Step	Question	Answer
1	Which bone?	Specific bone (X)
2	Is the fracture at the end or in the middle segment of the bone?	Middle segment (X2)
3	Type: Is the fracture a simple or multifragmentary one (does it have >2 parts)?	Simple (X2-A)
		If it is multifragmentary, go to step 3a
3a	Is there contact between both fracture ends or not?	If there is contact, it is a wedge (X2-B)
		If there is no contact, it is complex (X2-C)
4	Group: Is the fracture pattern caused by a twisting (spiral) or bending force?	Spiral or twisting forces will result in a simple spiral (X2-A1), a spiral wedge (X2-B1), or a spiral fragmented complex fracture (X2-C1)
		Bending forces produce simple oblique (X2-A2), simple transverse (X2-A3), bending wedge (X2-B2), fragmented wedge (X2- B3), or complex (X2-C3) fractures
		C2 fractures are segmental by definition

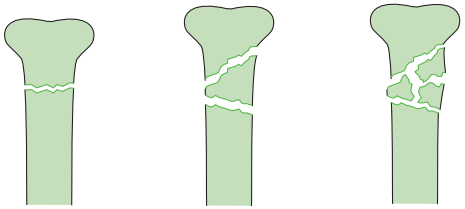
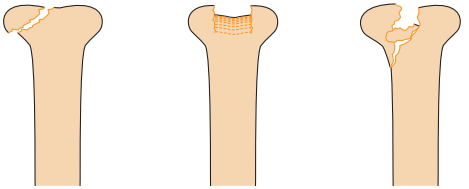
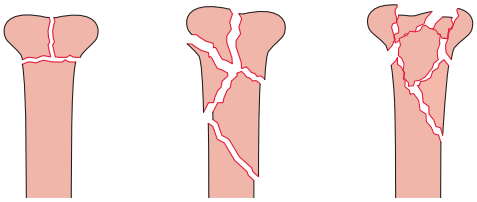
Classification of fractures of the diaphysis into the three fracture groups

Type	Group 1	Group 2	Group 3
A Simple	 **Spiral**	 **Oblique**	 **Transverse**
B Wedge	 **Spiral**	 **Bending**	 **Multifragmentary**
C Complex	 **Spiral**	 **Segmental**	 **Irregular**

Steps in identifying end segment fractures

End segment fracture		
Step	Question	Answer
1	Which bone?	Specific bone (X)
2	Is the fracture at the end or in the middle segment of the bone?	End segment
3	Is the fracture through the proximal or distal end segment?	Proximal (X1)
		Distal (X3)
4a	Type: Does the fracture enter the articular surface?	If it does not enter, it is extraarticular (XX-A), go to step 6
		If it enters, it is articular, go to step 4b
4b	Type: Is it partial or total articular?	If part of the joint is still attached to the meta-/diaphysis, it is partial articular (XX-B)
		If it is not attached to the diaphysis, it is complete articular (XX-C)
5	Group: How many fracture lines cross the joint surface?	If there is one line, it is simple
		If there are >2 lines, it is multifragmentary
6	Group: How is the metaphysis fractured?	Simple: extraarticular (XX-A1), or simple articular (XX-C1)
		Wedge: extraarticular (XX-A2)
		Complex: extraarticular (XX-A3), or simple articular (XX-C2), or complex articular (XX-C3)

Classification of fractures of the end segment into the three fracture groups

Type	Group		
	1	2	3
A Extraarticular			
	Simple	**Wedge**	**Complex**
B Partial articular			
	Split	**Depression**	**Split-depression**
C Articular			
	Simple articular, simple metaphyseal	**Simple articular, complex metaphyseal**	**Complex articular, complex metaphyseal**