

AO Pediatric Comprehensive Classification of Long-Bone Fractures (PCCF)

Introduction to the classification of long-bone fractures in children



“Research into the healing patterns of pediatric fractures assumes a common language that must be the prerequisite for comprehensive documentation as the basis for treatment and research.”

Theddy Slongo, 2007

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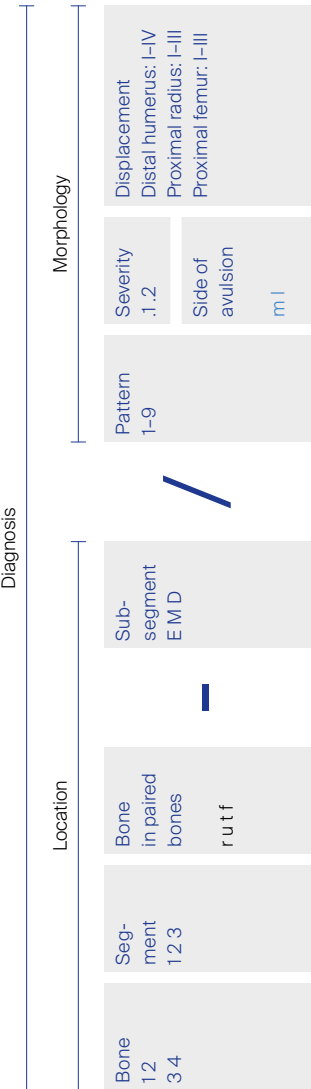
Acknowledgements

References

Classification system

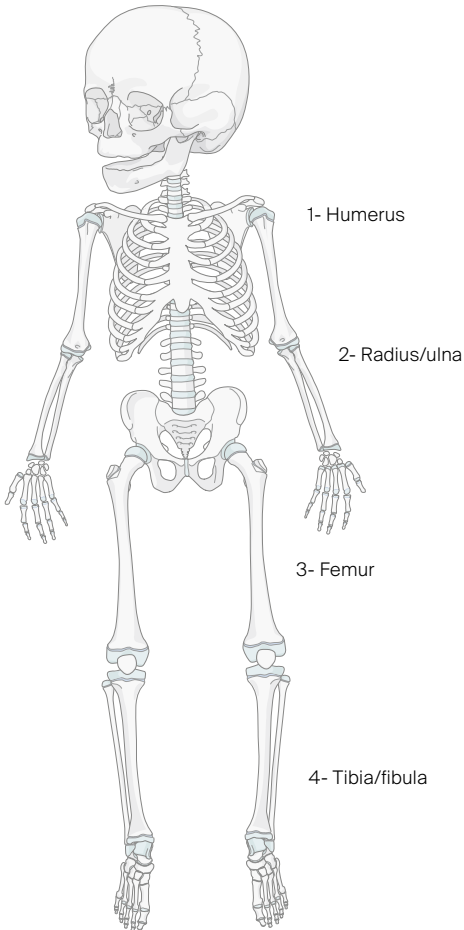
Overview

The overall structure of the classification system is based on fracture location and morphology. The fracture location comprises the different long bones and their respective segments and subsegments. The morphology of the fracture is documented by a specific child code that stands for the fracture pattern, a severity code, and an additional code that is used in certain types of displaced supracondylar humeral, displaced radial head and neck, and femoral neck fractures.



Classification according to location

Code for bones and segments



The numbering of bones (1–4) and segments (proximal = 1, diaphyseal = 2, distal = 3) is similar to that in the Müller AO Classification of Fractures—Long Bones, one difference being that malleolar fractures are coded as distal tibial/fibular fractures. Also, the definition of the three bone segments is different to that in adults (see code for subsegments). The letters "r", "u", "t", "f" stand for radius, ulna, tibia and fibula and are added to the segment code, in paired bones, when only one bone is fractured or both bones are fractured with a different pattern.

Code for subsegments

Segment 1 and 3 are each divided into two subsegments, the epiphysis (E) and the metaphysis (M). Segment 2 is identical with the diaphyseal subsegment (D).

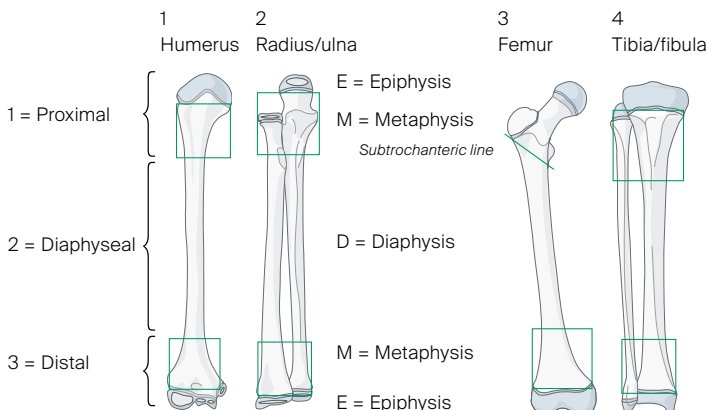
Proximal segment (1): subsegments epiphysis (E) and metaphysis (M)

Diaphyseal segment (2): subsegment diaphysis (D)

Distal segment (3): subsegments metaphysis (M) and epiphysis (E)

The metaphysis is determined by a square the sides of which have the same length as the widest part of the growth plate. In paired bones such as radius/ulna and tibia/fibula, both bones must be included in the square. The proximal femur is an exception. Its metaphysis is not defined by a square but located between the growth plate and the subtrochanteric line.

If the center of the fracture lines is located within the above mentioned square, it is a metaphyseal fracture. If the epiphysis and respective growth plate (physis) is involved, it is an epiphyseal fracture. Fractures of the apophysis are considered as metaphyseal. Transitional fractures with or without metaphyseal wedge are classified as epiphyseal. Intraarticular and extraarticular ligament avulsion fractures are epiphyseal or metaphyseal injuries, respectively.



Classification according to morphology

Code for the fracture pattern (child code)

There are a number of important fracture patterns in children that are described by the so-called "child code". These fracture patterns are specific to the subsegment they are located in and therefore grouped accordingly as E, M, or D. This code also takes into account internationally accepted fracture patterns in children.

E = Epiphysis

E/1



Salter-Harris (SH)
type I

E/4



Salter-Harris (SH) type IV

E/7



Avulsion

E/2



Salter-Harris (SH)
type II

E/5



Tillaux (two-plane)

E/8



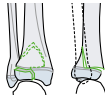
Flake

E/3



Salter-Harris (SH) type III

E/6



Tri-plane

E/9

Other fractures

M = Metaphysis

M/2



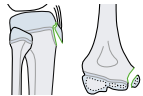
Incomplete: torus/
buckle or greenstick

M/3



Complete

M/7



Avulsion

M/9

Other fractures

Classification system

D = Diaphysis

D/1



Bowling

D/4

Complete transverse
 $\leq 30^\circ$

D/6



Monteggia

D/2

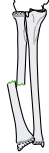


Greenstick

D/5

Complete oblique/
spiral $> 30^\circ$

D/7



Galeazzi

D/3



Toddler

The code D/8 that would describe a flake fracture does not apply to diaphyseal fractures.

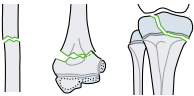
D/9

Other fractures

Severity code

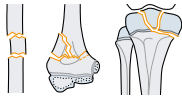
This code distinguishes between two grades of fracture severity: simple (.1), and multifragmentary (.2).

.1 Simple



Only two main fragments

.2 Multifragmentary



Two main fragments and at least one intermediate fragment

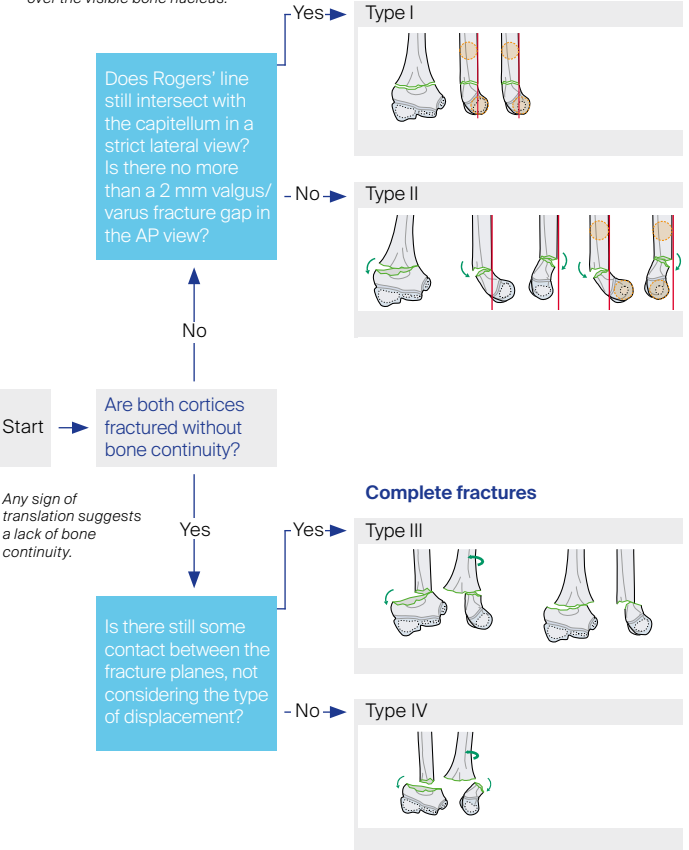
Code for the side of avulsion

The letters "m" and "l" stand for medial and lateral to indicate the side of ligament avulsion.

Code for displaced supracondylar humeral fractures

Supracondylar humeral fractures, which are all coded as 13-M/3, are described by an additional code that takes into account the grade of displacement (level I to IV). The proposed algorithm is recommended. Example: 13-M/3.1 II.

 To identify the real size of the capitellum in young children in the lateral view, a circle with a diameter equal to that of the bone shaft should be placed over the visible bone nucleus.



Code for fractures in paired bones

When both of the paired bones (radius/ulna, tibia/fibula) are fractured with the same fracture pattern (see child code), these two fractures should be documented by only one classification code. In such a case, the severity code will be that of the bone which is more severely fractured.

When only one of the paired bones is fractured, a small letter designates this bone (ie, "r", "u", "t" or "f") and should be added to the segment code. Example: 22u describes an isolated diaphyseal fracture of the ulna.

When both of the paired bones are fractured with different fracture patterns, each fracture must be coded separately and the corresponding small letter must be included in the code. Example: A complete, spiral fracture of the radius and a bowing fracture of the ulna are coded 22r-D/5.1 and 22u-D/1.1. Some of the most frequent fracture combinations can be found at the end of this brochure.

Code for displaced radial head and neck fractures

Radial head (21r-E/1 or /2) and neck fractures (21r-M/2 or /3) are described by an additional code (I-III) that takes into account the axial deviation and level of displacement. Example: 21r-M/3.1 III.

Type I



No angulation and no displacement

Type II



Angulation with displacement of up to half of the bone diameter

Type III



Angulation with displacement of more than half of the bone diameter

Code for femoral neck fractures

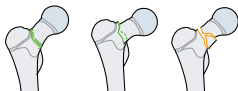
Fractures of the femoral neck are proximal metaphyseal fractures (M), the intertrochanteric line limiting the metaphysis. Such metaphyseal fractures can be further divided into three types, which are represented by an additional code (I-III) that takes into account the position of the fracture at the proximal metaphysis: midcervical, basicervical, transtrochanteric. Example: 31-M/2.1 III.

Type I



Midcervical

Type II



Basicervical

Type III



Transtrochanteric

1

Humerus

11-E Proximal epiphyseal fractures

Simple

Multifragmentary

11-E/1.1



Epiphysiolysis, SH I

Simple

Multifragmentary

11-E/4.1

11-E/4.2



Epi-/metaphyseal, SH IV

11-E/2.1

11-E/2.2



Epiphysiolysis with metaphyseal wedge, SH II

11-E/8.1

11-E/8.2



Intraarticular flake

11-E/3.1

11-E/3.2



Epiphyseal, SH III

11-M Proximal metaphyseal fractures

Simple

Multifragmentary

11-M/2.1



Torus/buckle

11-M/3.1

11-M/3.2



Complete

12-D Diaphyseal fractures

Simple

Multifragmentary

12-D/4.1

12-D/4.2



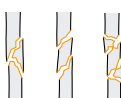
Complete transverse ($\leq 30^\circ$)

Simple

Multifragmentary

12-D/5.1

12-D/5.2



Complete oblique or spiral ($> 30^\circ$)

13-M Distal metaphyseal fractures

Simple

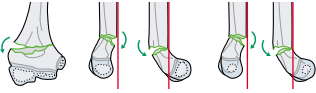
Multifragmentary

13-M/3.1 I



Incomplete, nondisplaced

13-M/3.1 II



Incomplete, displaced

13-M/3.2 II

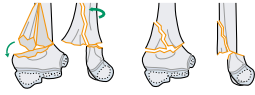


13-M/3.1 III



Complete with contact between fracture planes

13-M/3.2 III



13-M/3.1 IV



Complete without contact between fracture planes

13-M/3.2 IV



13-M/7m

Avulsion of the epicondyle
(extraarticular)

13-E Distal epiphyseal fractures

Simple

Multifragmentary

13-E/1.1



Epiphysiolysis, SH I

13-E/2.1



Epiphysiolysis with metaphyseal wedge, SH II

13-E/3.1



Epiphyseal, SH III

13-E/3.2



Simple

Multifragmentary

13-E/4.1



Epi-/metaphyseal, SH IV

13-E/4.2



13-E/7



Avulsion of/by the collateral ligament

13-E/8.1



Intraarticular flake

13-E/8.2



2 Radius/ulna

21-E Proximal epiphyseal fractures

Simple

Multifragmentary

Simple

Multifragmentary

Isolated fractures of the radius

21r-E/1.1 I*



Epiphysiolysis, SH I, no angulation and no displacement

21r-E/2.1 I*



21r-E/2.2 I*



Epiphysiolysis with metaphyseal wedge, SH II, no angulation and no displacement

21r-E/1.1 II*



Epiphysiolysis, SH I, angulation with displacement of up to half of the bone diameter

21r-E/2.1 II*



21r-E/2.2 II*



Epiphysiolysis with metaphyseal wedge, SH II, angulation with displacement of up to half of the bone diameter

21r-E/1.1 III*



Epiphysiolysis, SH I, angulation with displacement of more than half of the bone diameter

21r-E/2.1 III*



21r-E/2.2 III*



Epiphysiolysis with metaphyseal wedge, SH II, angulation with displacement of more than half of the bone diameter

21r-E/3.1

21r-E/3.2



Epiphysiolysis, SH III

*Qualifications for displaced radial head and neck fractures:

Type I No angulation and no displacement

Type II Angulation with displacement of up to half of the bone diameter

Type III Angulation with displacement of more than half of the bone diameter

21r-E/4.1

21r-E/4.2



Epiphysiolysis, SH IV

21-M Proximal metaphyseal fractures

Simple

Multifragmentary

Simple

Multifragmentary

Isolated fractures of the radius

21r-M/2.1



Torus/buckle

21r-M/3.1 II



21r-M/3.2 II



Complete, angulation with displacement of up to half of the bone diameter

21r-M/3.1 I



21r-M/3.2 I



Complete, no angulation and no displacement

21r-M/3.1 III



21r-M/3.2 III



Complete, angulation with displacement of more than half of the bone diameter

Isolated fractures of the ulna

21u-M/2.1



Torus/buckle

21u-M/6.1



Greenstick, dorsal radial head dislocation (Bado II)

Greenstick, lateral radial head dislocation (Bado III)

21u-M/3.1



21u-M/3.2



Complete

21u-M/7



Avulsion of the apophysis

22-D Diaphyseal fractures

Simple

Multifragmentary

Simple

Multifragmentary

Fractures of both bones

22-D/1.1



Bowling

22-D/4.1



22-D/4.2

Complete transverse ($\leq 30^\circ$)

22-D/2.1



Greenstick

22-D/5.1



22-D/5.2

Complete oblique or spiral
($> 30^\circ$)

Isolated fractures of the radius

22r-D/1.1



Bowling

22r-D/4.1



22r-D/4.2

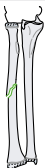
Complete transverse ($\leq 30^\circ$)

22r-D/2.1

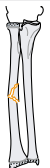


Greenstick

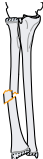
22r-D/5.1

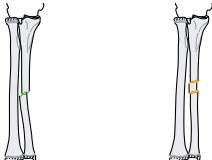
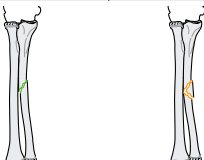


22r-D/5.2

Complete oblique or spiral
($> 30^\circ$)

Classification of specific fractures

Simple		Multifragmentary	
22r-D/7.1		22r-D/7.2	
			
Galeazzi			

Isolated fractures of the ulna			
22u-D/1.1		22u-D/4.1 22u-D/4.2	
			
Bowing		Complete transverse ($\leq 30^\circ$)	
22u-D/2.1		22u-D/5.1 22u-D/5.2	
			
Greenstick		Complete oblique or spiral ($> 30^\circ$)	
22u-D/6.1		22u-D/6.2	
			
Monteggia			

23-M Distal metaphyseal fractures

Simple

Multifragmentary

Simple

Multifragmentary

Fractures of both bones

23-M/2.1



Torus/buckle

23-M/3.1



Complete

23-M/3.2



Isolated fractures of the radius

23r-M/2.1



Torus/buckle

23r-M/3.1



Complete

23r-M/3.2



Isolated fractures of the ulna

23u-M/2.1



Torus/buckle

23u-M/3.1



Complete

23u-M/3.2



23-E Distal epiphyseal fractures

Simple

Multifragmentary

Simple

Multifragmentary

Fractures of both bones

23-E/1.1



Epiphysiolysis, SH I

23-E/4.1



Epi-/metaphyseal, SH IV

23-E/2.1

23-E/2.2



Epiphysiolysis with metaphyseal wedges, SH II



23-E/7



Avulsion of the styloid

23-E/3.1



Epiphyseal, SH III

Isolated fractures of the radius

23r-E/1



Epiphysiolysis, SH I

23r-E/4.1

23r-E/4.2



Epi-/metaphyseal, SH IV



23r-E/2.1

23r-E/2.2



Epiphysiolysis with metaphyseal wedges, SH II



23r-E/7



Avulsion of the styloid

23r-E/3



Epiphyseal, SH III

Simple

Multifragmentary

Simple

Multifragmentary

Isolated fractures of the ulna

23u-E/1.1



Epiphyseolysis, SH I

23u-E/4.1



Epi-/metaphyseal, SH IV

23u-E/4.2



23u-E/2.1

23u-E/2.2



Epiphyseolysis with metaphyseal wedge, SH II

23u-E/7



Avulsion of the styloid

23u-E/3



Epiphyseal, SH III

3 Femur

31-E Proximal epiphyseal fractures

Simple

Multifragmentary

31-E/1.1



Epiphysiolysis (SUFE/SCFE), SH I

31-E/2.1



Epiphysiolysis (SUFE/SCFE) with metaphyseal wedge, SH II

Simple

Multifragmentary

31-E/7



Avulsion of/by the ligament of the head of the femur

31-E/8.1

31-E/8.2



Intraarticular flake

31-M Proximal metaphyseal fractures

Simple

Multifragmentary

31-M/2.1 I*



Incomplete midcervical

31-M/2.1 II*



Incomplete basicervical

31-M/2.1 III*



Incomplete transtrochanteric

Simple

Multifragmentary

31-M/3.1 I*

31-M/3.2 I



Complete midcervical

31-M/3.1 II*

31-M/3.2 II*



Complete basicervical

31-M/3.1 III*

31-M/3.2 III*



Complete transtrochanteric

*Qualifications for femoral neck fractures:

Type I Midcervical

Type II Basicervical

Type III Transtrochanteric

31-M/7



Avulsion of the greater or lesser trochanter

32-D Diaphyseal fractures

Simple

Multifragmentary

32-D/4.1

32-D/4.2

Complete transverse ($\leq 30^\circ$)

Simple

Multifragmentary

32-D/5.1

32-D/5.2

Complete oblique or spiral ($> 30^\circ$)

33-M Distal metaphyseal fractures

Simple

Multifragmentary

33-M/2.1



Torus/buckle

33-M/7



Bilateral avulsion

33-M/3.1

33-M/3.2



Complete



33-M/7m



Medial avulsion

33-M/7l



Lateral avulsion

33-E Distal epiphyseal fractures

Simple

Multifragmentary

33-E/1.1



Epiphysiolysis, SH I

Simple

Multifragmentary

33-E/4.1



Epi-/metaphyseal, SH IV

33-E/4.2



33-E/2.1

33-E/2.2



Epiphysiolysis with metaphyseal wedge, SH II



33-E/8.1

33-E/8.2



Intraarticular flake



33-E/3.1

33-E/3.2



Epiphyseal, SH III



4 Tibia/fibula

41-E Proximal epiphyseal fractures

Simple

Multifragmentary

Simple

Multifragmentary

Isolated fractures of the tibia

41t-E/1.1



Epiphysiolysis, SH I

41t-E/4.1



41t-E/4.2



Epi-/metaphyseal, SH IV

41t-E/2.1



41t-E/2.2



Epiphysiolysis, with metaphyseal wedge, SH II

41t-E/7



Avulsion of the tibial spine

41t-E/3.1



41t-E/3.2



Epiphysiolysis, SH III

41t-E/8.1



41t-E/8.2



Intraarticular flake

41-M Proximal metaphyseal fractures

Simple

Multifragmentary

Simple

Multifragmentary

Fractures of both bones

41-M/2.1



Torus/buckle

41-M/3.1

41-M/3.2



Complete



Isolated fractures of the tibia

41t-M/2.1



Torus/buckle

41t-M/3.1

41t-M/3.2



Complete



41t-M/7



Avulsion of the apophysis

Isolated fractures of the fibula

41f-M/2.1



Torus/buckle

41f-M/3.1

41f-M/3.2



Complete



42-D Diaphyseal fractures

Simple

Multifragmentary

Simple

Multifragmentary

Fractures of both bones

42-D/1.1



Bowling

42-D/4.1

Complete transverse ($\leq 30^\circ$)

42-D/4.2



42-D/2.1

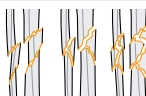


Greenstick

42-D/5.1

Complete oblique or spiral ($> 30^\circ$)

42-D/5.2



Isolated fractures of the tibia

42t-D/1.1



Bowling

42t-D/4.1

Complete transverse ($\leq 30^\circ$)

42t-D/4.2



42t-D/2.1

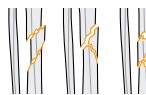


Greenstick

42t-D/5.1

Complete oblique or spiral ($> 30^\circ$)

42t-D/5.2



42t-D/3.1



Toddler

Classification of specific fractures

Simple

Multifragmentary

Simple

Multifragmentary

Isolated fractures of the fibula

42f-D/1.1



Bowling

42f-D/4.1

Complete transverse ($\leq 30^\circ$)

42f-D/4.2



42f-D/2.1

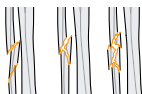


Greenstick

42f-D/5.1

Complete oblique or spiral ($> 30^\circ$)

42f-D/5.2



43-M Distal metaphyseal fractures

Simple

Multifragmentary

Simple

Multifragmentary

Fractures of both bones

43-M/2.1



Torus/buckle

43-M/3.1



Complete

43-M/3.2



Isolated fractures of the tibia

43t-M/2.1



Torus/buckle

43t-M/3.1



Complete

43t-M/3.2



Isolated fractures of the fibula

43f-M/2.1



Torus/buckle

43f-M/3.1



Complete

43f-M/3.2



43-E Distal epiphyseal fractures

Simple

Multifragmentary

Simple

Multifragmentary

Fractures of both bones

43-E/1.1



Epiphysiolysis, SH I

43-E/4.1



Epi-/metaphyseal, SH IV

43-E/2.1



Epiphysiolysis with metaphyseal wedge, SH II

43-E/8.1



Intraarticular flake

43-E/3.1



Epiphysiolysis, SH III

Isolated fracture of the tibia

43t-E/1.1



Epiphysiolysis, SH I

43t-E/4.1



Epi-/metaphyseal, SH IV

43t-E/4.2



43t-E/2.1



Epiphysiolysis with metaphyseal wedge, SH II

43t-E/2.2



43t-E/5.1



Tillaux (two-plane), SH III

43t-E/3.1



Epiphysiolysis, SH III

43t-E/6.1



Tri-plane, SH IV

Classification of specific fractures

Simple	Multifragmentary	Simple	Multifragmentary
43t-E/8.1			
			
Intraarticular flake			
Isolated fractures of the fibula			
43f-E/1.1		43f-E/4.1	
			
Epiphysiolysis, SH I		Epi-/metaphyseal, SH IV	
43f-E/2.1		43f-E/7	
			
Epiphysiolysis with metaphyseal wedge, SH II		Avulsion	
43f-E/3.1		43f-E/8.1	
			
Epiphysiolysis, SH III		Intraarticular flake	

Frequent fracture combinations

Radius/ulna

21r-M/3.1 III, 21u-M/3.1



Complete radial neck fracture type III and olecranon fracture

23r-E/2.1, 23u-E/7



Radial SH II and avulsion of the ulnar styloid

22r-D/5.1, 22u-D/1.1



Simple oblique or spiral complete radial fracture and bowing ulnar fracture

23r-M/2.1, 23u-M/3.1



Torus/buckle fracture of the radius and complete metaphyseal ulnar fracture

23r-M/2.1, 23u-E/7



Torus/buckle fracture of the radius and avulsion of the ulnar styloid

Tibia/fibula

41t-E/2.1, 41f-M/3.1



Proximal: SH II tibial fracture and complete metaphyseal fibular fracture

43t-E/4.1, 43f-E/1.1



SH III tibial and SH I fibular fracture

42t-D/4.1, 42f-D/1.1



Complete transverse ($\leq 30^\circ$) tibial fracture and bowing fibular fracture

43t-E/2.2, 43f-E/1.1



Multifragmentary epiphyseal fracture tibia SH II and SH I fibula

42t-D/5.2, 42f-D/2.1



Multifragmentary oblique or spiral ($> 30^\circ$) tibial fracture and fibular greenstick fracture

43t-E/2.1, 43f-M/3.1



Distal SH II tibial fracture and complete metaphyseal fibular fracture

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