

Fracture and Dislocation Classification Compendium for Children

The AO Pediatric Comprehensive Classification of Long Bone Fractures (PCCF)¹

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on behalf of the AO Pediatric Classification Group‡*

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

Th. Slongo, 2007

¹ Original publications

Audigé L, Hunter J, Weinberg A, Magidson J, Slongo T. Development and Evaluation Process of a Paediatric Long-Bone Fracture Classification Proposal. *European Journal of Trauma*. 2004;30:248–254.

Slongo T, Audigé L, Schlickewei W, Clavert J-M, Hunter J. Development and Validation of the AO Pediatric Comprehensive Classification of Long Bone Fractures by the Pediatric Expert Group of the AO Foundation in Collaboration With AO Clinical Investigation and Documentation and the International Association for Pediatric Traumatology. *Journal of Pediatric Orthopaedics*. 2006;26:43–49.

Slongo T, Audigé L, Clavert J-M, Nicolas L, Frick S, Hunter J. The AO Comprehensive Classification of Pediatric Long-bone Fractures: A Web-based Multicenter Agreement Study. *Journal of Pediatric Orthopaedics*. 2007;27:171–180.

Slongo T, Audigé L, Lutz N, Frick S, Schmittenbecher P, Hunter J, Clavert J-M. Documentation of Fracture Severity with the AO Classification of Pediatric Long-bone Fractures. *Acta Orthopaedica*. 2007;78:247–253.

Summary: The AO Pediatric Expert Group and the AO Pediatric Classification Group, in cooperation with the AO Investigation and Documentation Group introduce and present the first comprehensive classification of pediatric long bone fractures. The anatomy is related to the 4 long bones and their 3 segments defined as proximal (1), shaft (2) and distal (3). It is further described by the fracture subsegment recorded as epiphyseal (E), metaphyseal (M) and diaphyseal (D), whereby proximal and distal fractures are classified as E or M and shaft fractures are always D. The distinction between metaphyseal and diaphyseal fractures is achieved by localizing the center of fracture lines with regard to a square drawn over the respective growth plates. The morphology of the fracture is documented by a subsegment-specific child pattern code, a severity code as well as an additional code for displacement of specific fractures such as supracondylar fractures and radial heads. The classification process requires trained observers to read standard radiographic images.

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INTRODUCTION

The need to compile a classification of pediatric fractures arises, on the one hand, from an obligation to perform quality control and, on the other hand, from a desire to pursue basic research in the form of prospective and retrospective studies.

In contrast to adult fractures, the primary difficulty with regard to pediatric fractures is not their complexity or severity, but rather the phenomenon of growth. This is driven by mechanisms, still not fully understood, that may alter the course of healing depending on the fracture pattern and the age of the patient. Among these mechanisms, the epiphyseal cartilage is considered most distinctive.

Any classification or documentation must do justice to the two phenomena of injury pattern and growth. The well-known classifications of children's fractures in the literature take into account only particular aspects of the bones, eg, the Salter–Harris classification for epiphyseal fractures,¹ Baumann,² Gartland³ and L.v. Laer⁴ for supracondylar fractures or Judet's classification for radial neck/head fractures,⁵ while other classifications have attempted to include all fracture patterns by simplifications.⁶ However, none of these classifications have been scientifically validated.⁷ In addition, no classification system is available for diaphyseal long bone fractures.

To perform appropriate clinical data auditing (quality control) and well-documented studies, there is an inescapable need for a comprehensive classification of pediatric fractures. A documentation system for fractures in childhood based on the AO classification for adults,⁸ has been implemented during the past decade.⁹ This experience has shown that an adaptation of the classification of pediatric fractures including all well-known and currently applied systems, is necessary.

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The need for clinical relevance dictates that a system different from those for adults must be developed, and that already known pediatric classifications must be considered.^{1,4–6} However, the structures of both adult and pediatric classifications of similar bones should remain similar to facilitate their application in the clinical setting. In addition, the classification process (ie, the fracture diagnosis) should be reliable and valid,^{7,10,11} underscoring the need to start early with such evaluation in the development process.¹² Audigé et al¹¹ have recommended that 3 research phases should be completed before a classification can be considered as validated. The first development phase involves clinical experts who develop a first proposal for the classification system and define the classification process. This phase has delineated a common language with which surgeons should be able to view and describe fractures similarly. Successive pilot studies are conducted to ensure agreement among clinical experts. The second phase involves a multicenter study to ensure agreement among future users. This phase establishes the basis for a classification tool to be used for documentation and evaluation of treatment options. Only after these first two phases are completed can recommendations for patient care based on the classification be developed in a third phase, after the implementation of a prospective clinical study.

To meet these needs, the AO Pediatric Expert Group (PAEG) and the AO Pediatric Classification Group, in cooperation with the AO Investigation and Documentation (AOCID) Group introduce and present the first comprehensive classification of pediatric long bone fractures.^{13–15}

PEDIATRIC LONG BONE CLASSIFICATION

Glossary

The terms and definitions in the glossary of the classification of pediatric fractures follow the meanings that have been established by Müllers's Long Bone Comprehensive Classification of Fractures. The glossary therefore comprises an extension of this internationally accepted classification of adult fractures, which has proven its worth over a period of more than 30 years.

Description of the Classification Definition

The current classification proposal is based on the Müller AO classification for adults⁸ and considers child-specific relevant fracture features. The original unifying principle of the CCF, valid for all fractures, is an anatomic and morphologic organization divided mostly into triads. The anatomy is related to the four long bones and their three segments. It is further described by the fracture subsegment recorded as E, M, or D (see below). The morphology of the fracture is documented by a location-specific child code, a severity code, and an additional code for displacement of specific fractures.

Location

Bone

Following the Müller AO classification for adults, the bones are similarly coded: 1 = Humerus, 2 = Radius/Ulna, 3 = Femur, 4 = Tibia/Fibula (Figure 1). Except for the known Monteggia and Galeazzi lesions, when the paired bones Radius/Ulna or Tibia/Fibula are fractured with the same pediatric pattern (see below), a single classification code should

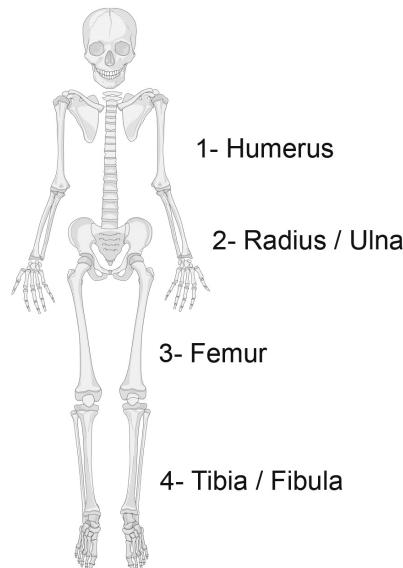


FIGURE 1. Designation of bone location

Code	Fracture	
23r – E/2.1		Salter-Harris II fracture of the distal radius
23u – E/2.1		Salter-Harris II fracture of the distal ulna

FIGURE 2. Coding of same fracture but different bone in paired bones.

be used, with the severity code referring to the more badly fractured of the two bones. When a single bone is fractured, a small letter describing that bone (ie, "r," "u," "t," or "f") should be added after the segment code (eg, the code "22u" identifies an isolated diaphyseal fracture of the ulna).

When the paired bones Radius/Ulna or Tibia/Fibula are fractured with different pediatric patterns (eg, a complete fracture of the radius and a bowing fracture of the ulna), each bone must be coded separately including the corresponding small letter (Figure 2). This will allow a detailed documentation of combined fractures of the radius and ulna, or those of the tibia and fibula, in clinical studies so that their relative influence on treatment outcomes can be properly evaluated. A list of the most common combinations of paired fractures is presented at the end of this article.

Segments

The segments within the bones also follow a similar coding scheme, ie, 1 = proximal, 2 = diaphyseal, 3 = distal, but their identification differs from that in adults. For the latter, the proximal and distal metaphyseal fragments are identified via a square "whose sides are the same length as the widest part of the epiphysis".⁸ However, we know that the metaphysis in pediatric fractures extends much further into the shaft, as can be observed with the typical pediatric metaphyseal fractures (eg,

buckle and torus fractures). Furthermore, the width of the growth plate is almost visible in younger children, whereas the epiphysis itself cannot be used because of the different age-dependent ossification stages. This makes the same use of squares in children clinically inappropriate. For pediatric long bone fractures, the metaphysis is identified by a square whose side has the same length as the widest part of the physis in question (Figure 3). For the pairs of bones radius/ulna and tibia/fibula, both bones must be included in the square. Consequently, the three segments can be defined as follows:

- Segment 1: Proximal, including subsegments epiphysis (E) and metaphysis (M)
- Segment 2: Shaft/Diaphysis (D)
- Segment 3: Distal, including subsegments metaphysis (M) and epiphysis (E)

Malleolar fractures in adults are classified with a specific code 44 because they have a very special pattern.⁸ However, such fractures are not so common in children and their characteristics do not justify a specific coding. Therefore, they are simply coded as distal tibia fractures (for example the fracture of the medial malleolus is a typical Salter-Harris III or IV fracture of the distal tibia coded, as 43).

Subsegment

The original severity coding A-B-C used in adults is replaced by a classification of fractures according to diaphysis (D), metaphysis (M) and epiphysis (E) (Figure 3). This terminology is known and accepted worldwide and is relevant to pediatric fractures. The most common fracture subsegments in children are the shaft fractures (segment 2), and the epimetaphyseal subsegment (segments 1 and 3). Use of the E-M-D coding identifies intra-articular and extra-articular fractures without ambiguity because epiphyseal fractures are intra-articular fractures by definition. The metaphyseal fractures are identified through the position of the square (the center of the fracture lines must be located in the square) with one side over the physis (Figures 3 and 4). For easier and more accurate application of the squares and, consequently, more reliable classification, a series of pre-drawn squares are copied

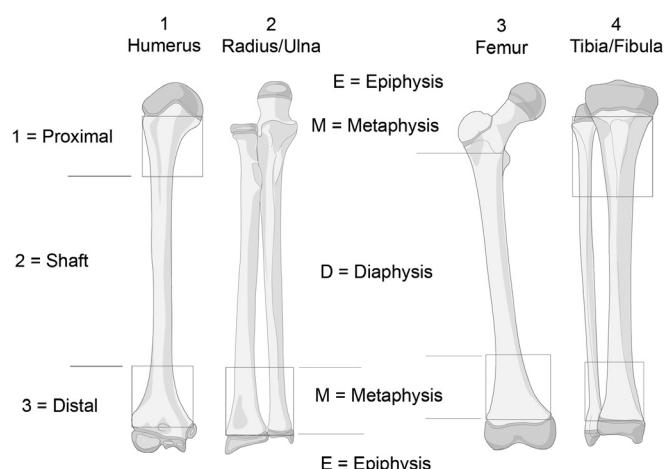


FIGURE 3. Definition of bone segments and subsegments; For children, the square must be placed over the larger part of the physis.

on a transparency and applied to the anteroposterior (AP) radiographic view (Figure 4). For the pairs of bones radius/ulna and tibia/fibula, both bones must be included in the square. This square definition is not applicable to the proximal femur where metaphyseal fractures are located between the physis of the head and the intertrochanteric line (see below).

In applying the square definition, surgeons should be aware that if this view is not strictly on the AP plane, eg, if the plane is slightly rotated the applied square will be smaller than expected, leading to risk of misclassification. In such cases, the classification process should be checked after fracture reduction. When a metaphyseal fragment is severely angulated in the frontal plane, the square will be correctly chosen, but the length of the fragment will appear smaller than it really is. In this situation, the same square should be used on the lateral radiographic view to assess the length of the metaphyseal fragment.

Morphology

Child Code

Specific pediatric features (also called “child patterns”) are transformed into a “child code.” For easier recognition, this code is preceded by a forward slash “/” throughout the entire classification code (Figure 5). Relevant child patterns are specific to one of the fracture subsegments E, M, or D and hence are grouped accordingly. Regardless of fracture type,

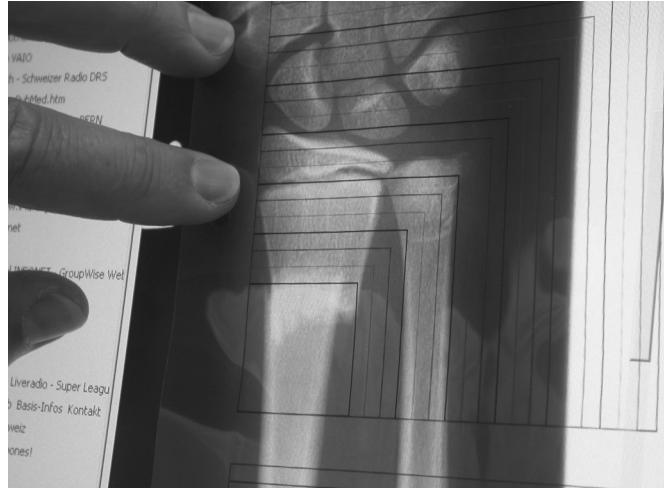
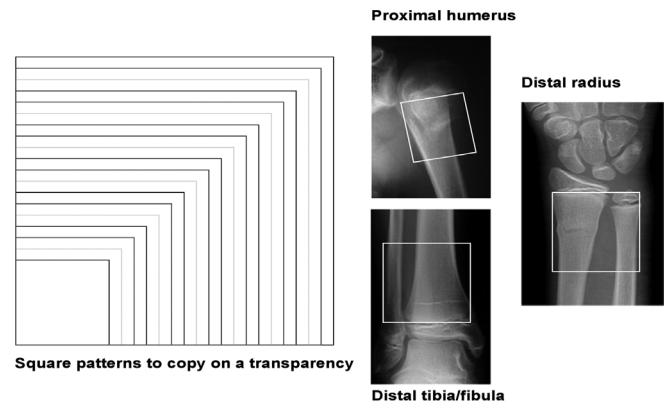


FIGURE 4. Use of the square patterns to classify a fracture as epiphysial (E), metaphysial (M) or diaphysial (D).

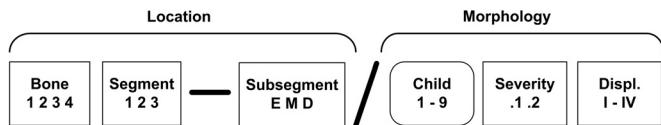


FIGURE 5. Overall structure of the paediatric fracture classification.

child patterns having a similar morphology are given the same child code for simplification and consistency.

Internationally known and accepted child patterns are considered. Patterns of epiphyseal fractures include the known epiphyseal injuries I to IV according to Salter and Harris¹ using the child codes E/1 to E/4. These codes resulted from intensive discussion within the AO Pediatric Expert Group and among other surgeons about whether Salter-Harris I and II fractures should be classified as metaphyseal fractures (M), since they have very similar characteristics to these fractures.⁶ However, surgeons worldwide traditionally recognize these fractures as epiphyseal fractures (E) (Figure 6). Other child codes E/5 to E/9 are used to identify Tillaux (two plane) fractures (E/5), tri-plane fractures (E/6), ligament avulsions (E/7), and flake fractures (E/8).

Three child patterns are identified for metaphyseal fractures, ie, the buckle or torus greenstick fractures (M/2), complete fracture (M/3) and osteo-ligamentous, musculo-ligamentous avulsion or only avulsion injuries (M/7) (Figure 7).

Child patterns within segment 2 (diaphyseal fractures) are presented in Figure 8. They include bowing fractures (D/1), greenstick fractures (D/2), complete transverse fracture (angle <30°, D/4), complete oblique/spiral fracture (angle >30°, D/5), Monteggia lesions (D/6) and Galeazzi lesions (D/7).

Similar to adult fractures, oblique fractures are identified when the angle between the fracture line and the line transverse to the bone axis is above 30°. A 30° angle should be drawn on the transparency sheet mentioned above and should be applied to the radiographs for more reliable classification. The angle should be measured according to the longitudinal axis of the main fragment and on the radiographic view showing the most severe angle (lateral or AP view)

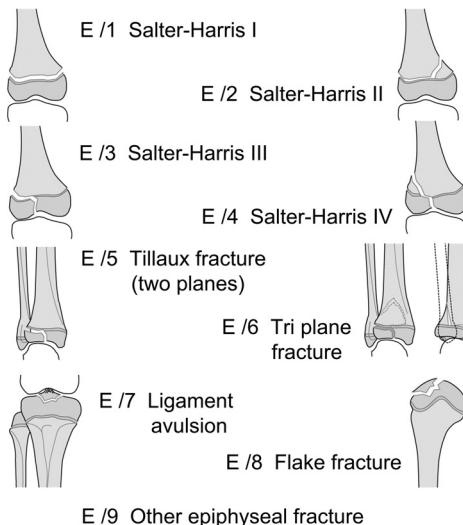


FIGURE 6. Definition of child patterns for epiphyseal fractures.

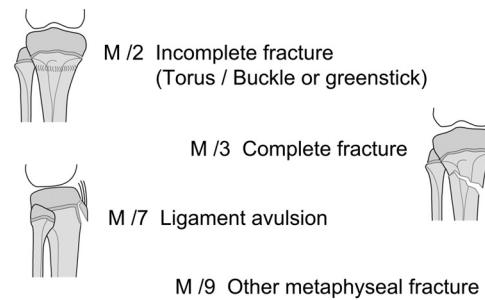


FIGURE 7. Definition of child patterns for metaphyseal fractures.

(Figure 9). Similarly the code /9 should be used for fractures that may not belong to well-defined categories.

Severity Code

A grade of fracture severity is considered, not so much because of its influence on healing, as in adults, but because of the need to investigate the indications for various methods of osteosynthesis.

This code distinguishes between simple (.1), wedge (partially unstable fracture with 3 fragments including a fully separated fragment) and complex (totally unstable fracture with more than 3 fragments) (.2), as shown in Figure 10.

Exceptions and Additional Codes

As for adult fractures, not all pediatric fractures can simply be classified according to the above scheme, and a few more definitions and rules were agreed on:

- Fractures of the apophysis are recognized as metaphyseal injuries.
- Transitional fractures with or without metaphyseal wedge are classified as epiphyseal fractures.
- Intra- and extra-articular ligament avulsions are epiphyseal and metaphyseal injuries, respectively.

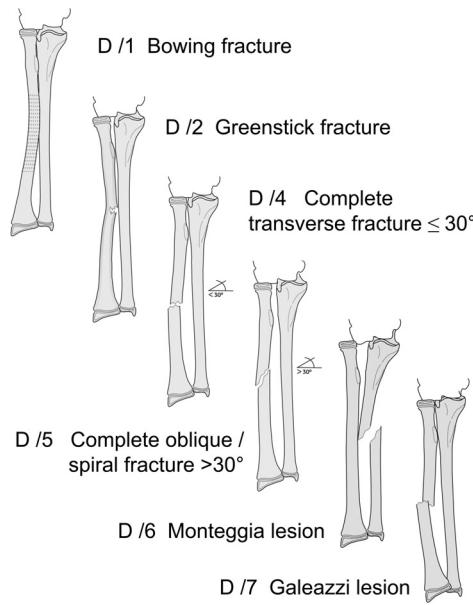


FIGURE 8. Definition of child patterns for diaphyseal fractures.

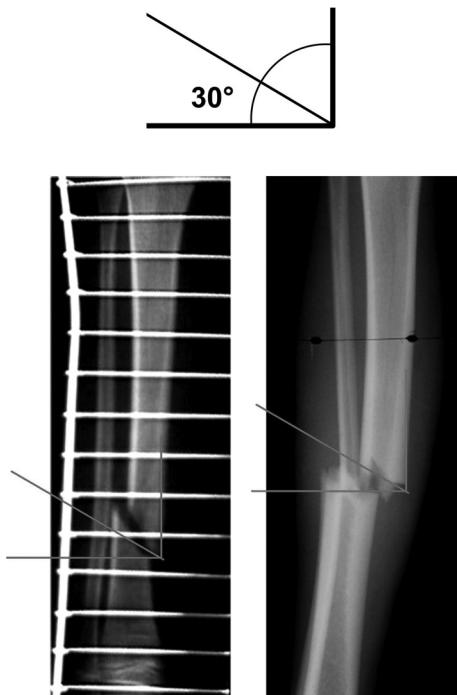


FIGURE 9. Measurement of the fracture angle.

- Supracondylar humerus fractures (code 13 – M/3) are given an additional code regarding the grade of displacement at 4 levels (I to IV) (*see supracondylar fractures*).
- Radial head (21-E/1 or /2) and neck fractures (21-M/2 or M/3) are given an additional code (I –III) regarding the axial deviation and level of displacement (*see radial neck fractures*).
- Femoral neck fractures. Epiphysiolysis and epiphysiolysis with a metaphyseal wedge are coded as normal Type E epiphyseal SH I and II fractures E/1 and E/2. Fractures of the femoral neck are coded as normal type M metaphyseal fractures code I to III (*see femoral neck fractures*). The intertrochanteric line limits the metaphysis.
- The side of ligament avulsion fractures of the distal humerus and distal femur is indicated by the small letter “u” (ulnar/medial) or “r” (radial/lateral) for the humerus and by “t” (tibial/medial) or “f” (fibular/lateral) for the femur.

The full classification code therefore includes 5 or 6 fracture entities depending on the use of an exception code. Two typical classification examples are presented in Figure 11.

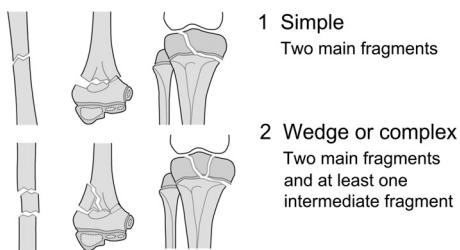


FIGURE 10. Severity implies anticipated difficulties and method of treatment, not the prognosis.

Supracondylar Fractures

Supracondylar humerus fractures (code 13 – M/3) are given an additional code regarding the grade of displacement at 4 levels (I to IV) as defined below and presented in an algorithm (Figure 12).

Type I

Incomplete fracture. In a strict lateral view, the Rogers’ line still intersects the capitellum. In the AP view there is no more than a 2mm valgus/varus fracture gap.

Type II

Incomplete fracture: Antecurvature or recurvature with continuity of the posterior (extension fracture) or anterior cortex (flexion fracture). The Rogers’ line does not intersect the capitellum.

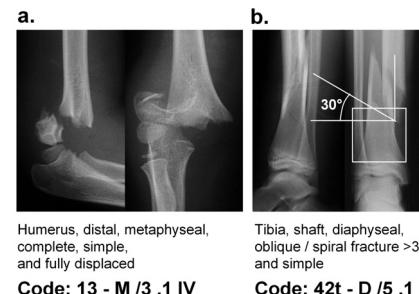


FIGURE 11. Example of a supracondylar fracture (a) and a tibia shaft fracture (b).

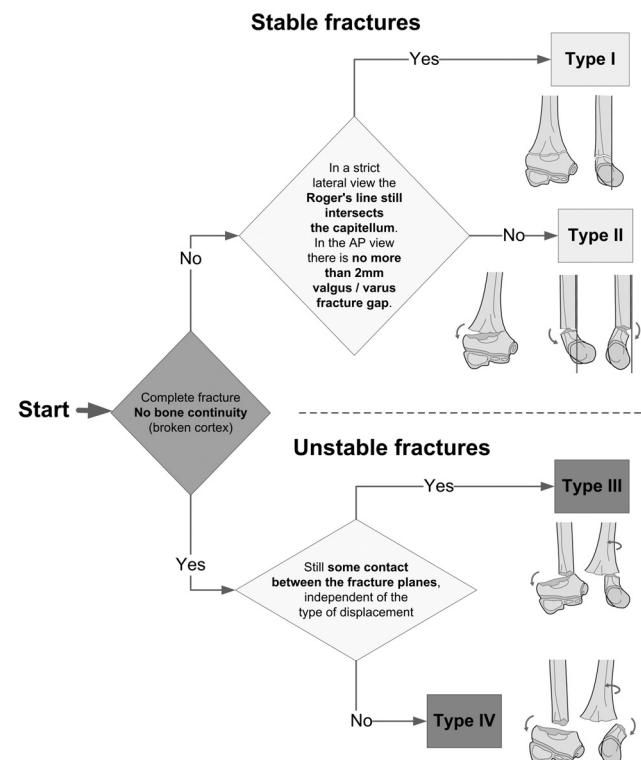


FIGURE 12. Algorithm for supracondylar fracture classification.

Type III

Complete fracture: No bone continuity (broken cortex), but still some contact between the fracture planes, independent of the type of displacement.

Type IV

Complete fracture: No bone continuity (broken cortex), and no contact between the fracture planes, independent of the type of displacement.

Radial Neck (Head) Fractures

Radial head (21-E/1 or /2) and neck fractures (21-M2 or M/3) are given an additional code regarding the axial deviation and level of displacement: no angulation and no displacement (I), angulation with displacement up to half of the bone diameter (II) and angulation with displacement more than half of the bone diameter (III) as shown in Figure 13.

Femoral Neck Fractures

Femoral neck fractures. Epiphysiolysis and epiphysioly sis with a metaphyseal wedge are coded as subsegment E epiphyseal SH I and II fractures E/1 and E/2. Fractures of the femoral neck are coded as subsegment M metaphyseal fractures: midcervical (I), basocervical (II), and transtrochanteric (III). The intertrochanteric line limits the methaphysis (Figure 14).

Detailed Presentation and Definitions

In the following sections, only the most common pediatric fractures are described, illustrated and coded.

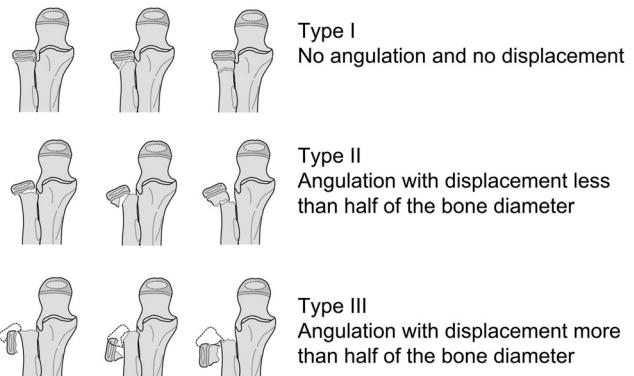


FIGURE 13. Classification of radial neck (head) fractures.

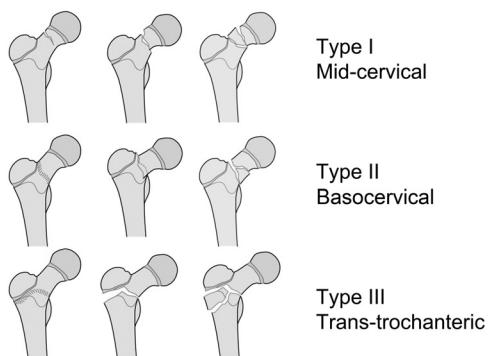


FIGURE 14. Classification of femoral neck fractures.

HUMERUS (1)

Proximal epiphyseal fractures (11-E)

Simple fractures			Wedge/complex fractures		
Code	Figure	Description	Code	Figure	Description
11 – E/1.1		Simple epiphysiolysis			
11 – E/2.1		Simple epiphysiolysis with metaphyseal wedge	11 – E/2.2		Epiphysiolysis with multifragmentary metaphyseal wedge
11 – E/3.1		Simple epiphyseal fracture SH III	11 – E/3.2		Multifragmentary epiphyseal fracture SH III
11 – E/4.1		Simple epi-metaphyseal fracture SH IV	11 – E/4.2		Multifragmentary epimetaphyseal fracture SH IV
11 – E/8.1		Single intraarticular flake fracture	11 – E/8.2		Multiple intraarticular flake

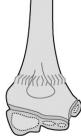
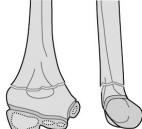
Proximal metaphyseal fractures (11-M)

Simple fractures			Wedge/complex fractures		
Code	Figure	Description	Code	Figure	Description
11 – M/2.1		Metaphyseal torus / buckle fracture			
11 – M/3.1		Complete, simple metaphyseal	11 – M/3.2		Complete, multifragmentary metaphyseal

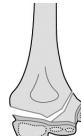
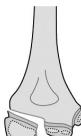
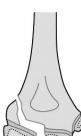
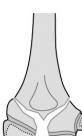
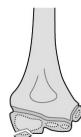
Diaphyseal fractures (12-D)

Simple fractures			Wedge/complex fractures		
Code	Figure	Description	Code	Figure	Description
12 – D/4.1		Simple, transverse (>30°) diaphyseal	12 – D/4.2		Multifragmentary, transverse (>30°) diaphyseal
12 – D/5.1		Simple, oblique or spiral (< 30°) diaphyseal	12 – D/5.2		Multifragmentary oblique or spiral (< 30°) diaphyseal

Distal metaphyseal fractures (13-M)

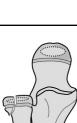
Simple fractures			Wedge/complex fractures		
Code	Figure	Description	Code	Figure	Description
13 – M/2.1		Torus, buckle metaphyseal, supracondylar fracture			
13 – M/3.1		Incomplete supracondylar fracture	13 – M/3.2		Multifragmentary complete fracture
13u – M/7.1		Avulsion of the ulnar epicondyle (extra-articular)			

Distal epiphyseal fractures (13-E)

Simple fractures			Wedge/complex fractures		
Code	Figure	Description	Code	Figure	Description
13 – E/1.1		Simple epiphysiolysis SH I			
13 – E/2.1		Simple epiphysiolysis with metaphyseal wedge SH II			
13 – E/3.1		Simple epiphyseal fracture SH III			
13r – E/4.1		Simple epiphyseal fracture with metaphyseal wedge SH IV	13 – E/4.2		Complex epi-metaphyseal (Y or T fracture)
13r – E/7.1		Avulsion of the radial collateral ligament			
13r – E/8.1		Simple flake fracture of the radial condyle	13r – E/8.2		Multifragmentary flake fracture of the radial condyle

Radius/Ulna (2)

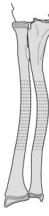
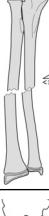
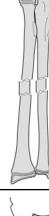
Proximal epiphyseal fractures/radial head (21-E)

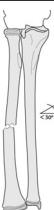
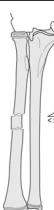
Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
21r – E/1.1 I		Simple epiphysiolysis radial head SH I no displacement			
21r – E/1.1 II		Simple epiphysiolysis radial head SH I angulation and displacement $\leq \frac{1}{2}$ shaft			
21r – E/1.1 III		Simple epiphysiolysis radial head SH I displacement $> \frac{1}{2}$ shaft or complete			
21r – E/2.1 I		epiphysiolysis radial head with simple metaphyseal wedge SH II no displacement	21r – E/2.2 I		epiphysiolysis radial head with multifragmentary metaphyseal wedge SH II no displacement
21r – E/2.1 II		epiphysiolysis radial head with simple metaphyseal wedge SH II angulation and displacement $\leq \frac{1}{2}$ shaft	21r – E/2.2 II		epiphysiolysis radial head with multifragmentary metaphyseal wedge SH II angulation and displacement $\leq \frac{1}{2}$ shaft
21r – E/2.1 III		epiphysiolysis radial head with simple metaphyseal wedge SH II displacement $> \frac{1}{2}$ shaft or complete	21r – E/2.2 III		epiphysiolysis radial head with multifragmentary metaphyseal wedge SH II displacement $> \frac{1}{2}$ shaft or complete
21r – E/3.1		Simple epiphyseal radial head fracture SH III	21r – E/3.2		multifragmentary epiphyseal radial head fracture SH III
21r – E/4.1		Simple epi- metaphyseal radial head fracture SH IV	21r – E/4.2		multifragmentary epimetaphyseal radial head fracture SH IV

Proximal metaphyseal fractures radius/ulna (21-M)

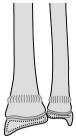
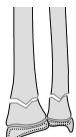
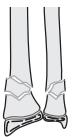
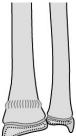
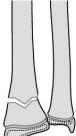
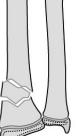
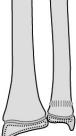
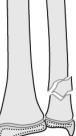
Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
21r - M/2.1		Metaphyseal torus/buckle fracture radial neck			
21r - M/3.1 I		Complete, simple metaphyseal radial neck no displacement	21r - M/3.2 I		Complete, multifragmentary metaphyseal radial neck no displacement
21r - M/3.1 II		Complete, simple metaphyseal radial neck angulation and displacement $\leq \frac{1}{2}$ shaft	21r - M/3.2 II		Complete, multifragmentary metaphyseal radial neck angulation and displacement $\leq \frac{1}{2}$ shaft
21r - M/3.1 III		Complete, simple metaphyseal radial neck displacement $> \frac{1}{2}$ shaft or complete	21r - M/3.2 III		Complete, multifragmentary metaphyseal radial neck displacement $> \frac{1}{2}$ shaft or complete
21u - M/2.1		Metaphyseal torus / buckle olecranon			
21u - M/3.1		Complete, simple metaphyseal olecranon	21u - M/3.2		Complete, multifragmentary metaphyseal olecranon
21u - M/7.1		Avulsion of the olecranon apophysis			

Diaphyseal fractures radius/ulna (22-D)

Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
22 - D/1.1		Bowing diaphyseal			
22 - D/2.1		Greenstick diaphyseal			
22 - D/4.1		Complete simple forearm transverse	22 - D/4.2		Complete multifragmentary forearm transverse
22 - D/5.1		Complete simple forearm oblique or spiral	22 - D/5.2		Complete multifragmentary forearm oblique or spiral
22 - D/6.1		Monteggia lesion, ulna simple	22 - D/6.2		Monteggia lesion, ulna multifragmentary
22 - D/7.1		Galeazzi lesion, radius simple	22 - D/7.2		Galeazzi lesion, radius multifragmentary
22r - D/1.1		Bowing radius			

Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
22r – D/2.1		Greenstick radius			
22r – D/4.1		Radius complete, single transverse	22r – D/4.2		Radius complete, multifragmentary, transverse
22r – D/5.1		Radius complete, single oblique or spiral	22r – D/5.2		Radius complete, multifragmentary oblique or spiral
22u – D/1.1		Bowing ulna			
22u – D/2.1		Greenstick ulna			
22u – D/4.1		Ulna complete, single transverse	22u – D/4.2		Ulna complete, multifragmentary transverse
22u – D/5.1		Ulna complete, single oblique or spiral	22u – D/5.2		Ulna complete, multifragmentary oblique or spiral

Distal metaphyseal fractures radius/ulna (23-M)

Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
23 – M/2.1		Torus, buckle metaphyseal, distal radius/ulna			
23 – M/3.1		Complete simple distal radius/ulna	23 – M/3.2		Complete multifragmentary distal radius/ulna
23r – M/2.1		Torus/buckle distal radius			
23r – M/3.1		Complete simple distal radius	23r – M/3.2		Complete multifragmentary distal radius
23u – M/2.1		Torus/buckle distal ulna			
23u – M/3.1		Complete simple distal ulna	23u – M/3.2		Complete multifragmentary distal ulna

Distal epiphyseal fractures radius/ulna (23-E)

Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
23 – E/1.1		Simple epiphysiolysis SH I			
23 – E/2.1		Simple epiphysiolysis with metaphyseal wedges SH II	23 – E/2.2		Epiphysiolysis with multifragmentary metaphyseal wedges SH II
23 – E/3.1		Simple epiphyseal fracture SH III			
23 – E/4.1		Simple epimetaphyseal fracture SH IV			
23 – E/7.1		Radioulnar ligament avulsion			
23r – E/1.1		Simple epiphysiolysis SH I radius			
23r – E/2.1		Simple epiphysiolysis with metaphyseal wedge SH II radius	23r – E/2.2		Multifragmentary epiphysiolysis radius SH II
23r – E/3.1		Simple epiphyseal fracture SH III radius			
23r – E/4.1		Simple epiphyseal fracture with metaphyseal wedge SH IV radius	23r – E/4.2		Multifragmentary epiphyseal fracture with metaphyseal wedge SH IV radius

Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
23u – E/1.1		Simple epiphysiolysis SH I ulna			
23u – E/2.1		Simple epiphysiolysis with metaphyseal wedge SH II ulna	23u – E/2.2		multifragmentary epiphysiolysis with metaphyseal wedge SH II ulna
23u – E/3.1		Simple epiphyseal fracture SH III ulna			
23u – E/4.1		Simple epi- metaphyseal fracture SH IV ulna	23u – E/4.2		multifragmentary epimetaphyseal fracture SH IV ulna
23u – E/7.1		Ligament avulsion ulnar styloid process			

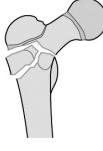
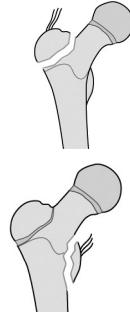
Femur (3)

Proximal epiphyseal fractures (31-E)

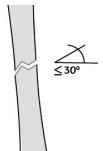
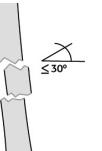
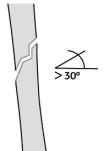
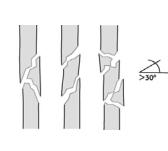
Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
31 – E/1.1		Epiphysiolysis (SUEF/SCFE) SH I			
31 – E/2.1		Epiphysiolysis (SUEF/SCFE) with metaphyseal wedge SH I			
31 – E/7.1		Ligament avulsion (ligam. capituli femoris)			
31 – E/8.1		Single flake fracture	31 – E/8.2		Multiple flake fracture

Proximal metaphyseal fracture/femoral neck (31-M)

Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
Exception femoral neck fractures			Exception femoral neck fractures		
31 – M/2.1 I		Incomplete midcervical			
31 – M/3.1 I		Simple complete midcervical	31 – M/3.2 I		Multifragmentary midcervical
31 – M/2.1 II		Incomplete basocervical			

Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
Exception femoral neck fractures					
31 – M/3.1 II		Simple complete basocervical	31 – M/3.2 II		Multifragmentary basocervical
31 – M/2.1 III		Incomplete transtrochanteric			
31 – M/3.1 III		Simple complete transtrochanteric	31 – M/3.2 III		Multifragmentary transtrochanteric
31 – M/7.1		Ligament avulsion of greater OR lesser trochanter			

Diaphyseal fractures femur (32-D)

Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
32 – D/4.1		Simple complete transverse ($\leq 30^\circ$)	32 – D/4.2		Multifragmentary transverse ($\leq 30^\circ$)
32 – D/5.1		Simple complete oblique or spiral ($> 30^\circ$)	32 – D/5.2		Multifragmentary oblique or spiral ($> 30^\circ$)

Distal metaphyseal fractures femur (33-M)

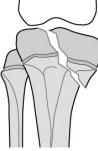
Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
33 - M/2.1		Torus/buckle metaphyseal distal femur			
33 - M/3.1		Simple complete distal femur	33 - M/3.2		Multifragmentary distal femur
33 - M/7.1		Ligament avulsion bilateral			
33t - M/7.1		t = tibial/medial			
33f - M/7.1		f = fibular/lateral			

Distal epiphyseal fractures femur (33-E)

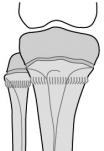
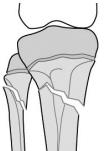
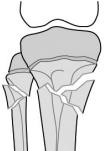
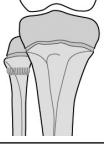
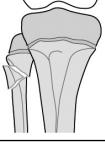
Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
33 - E/1.1		Simple epiphysiolysis			
33 - E/2.1		Simple epiphysiolysis with metaphyseal wedge SH II	33 - E/2.2		Epiphysiolysis with multifragmentary metaphyseal wedge SH II
33 - E/3.1		Simple epiphyseal fracture SH III	33 - E/3.2		Multifragmentary epiphyseal fracture SH III
33 - E/4.1		Simple epimetaphyseal fracture SH IV	33 - E/4.2		Multifragmentary epimetaphyseal fracture SH IV
33 - E/8.1		Single intraarticular flake fracture	33 - E/8.2		Multiple intraarticular flake fracture

Tibia/Fibula (4)

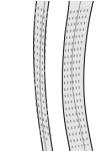
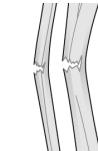
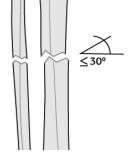
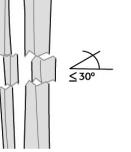
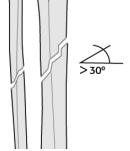
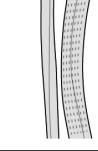
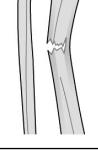
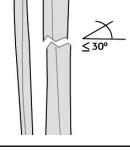
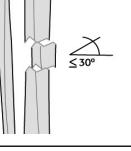
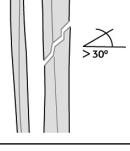
Proximal epiphyseal fractures tibia/fibula (41-E)

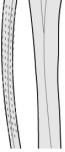
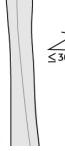
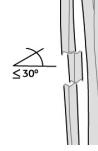
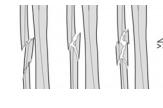
Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
Only tibia					
41t - E/1.1		Simple epiphysiolysis tibia SH I			
41t - E/2.1		Simple tibial epiphysiolysis, simple metaphyseal wedge SH II	41t - E/2.2		Tibial epiphysiolysis, multifragmentary metaphyseal wedges SH II
41t - E/3.1		Simple tibial epiphyseal fracture SH III	41t - E/3.2		Multifragmentary tibial epiphyseal fracture SH III
41t - E/4.1		Simple tibial epi-metaphyseal fracture SH IV	41t - E/4.2		Multifragmentary tibial epi-metaphyseal fracture SH IV
41t - E/7.1		Tibial spine fracture			
41t - E/8.1		Flake fracture tibial plateau			

Proximal metaphyseal fractures tibia/fibula (41-M)

Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
41 - M/2.1		Torus/buckle fracture tibia/fibula			
41 - M/3.1		Simple complete tibia and fibula	41 - M/3.2		Multifragmentary tibia and fibula
Only tibia					
41t - M/2.1		Torus/buckle fracture tibia			
41t - M/3.1		Tibia simple complete	41t - M/3.2		Tibia multifragmentary
41t - M/7.1		Fracture of the tibial apophysis			
Only fibula					
41f - M/2.1		Torus/buckle fibula			
41f - M/3.1		Fibula simple complete	41f - M/3.2		Fibula multifragmentary

Disphyseal fractures tibia/fibula (42-D)

Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
42 - D/1.1		Bowing tibia and fibula			
42 - D/2.1		Greenstick tibia and fibula			
42 - D/4.1		Transverse simple tibia and fibula ($\leq 30^\circ$)	42 - D/4.2		Transverse multifragmentary tibia and fibula ($\leq 30^\circ$)
42 - D/5.1		Simple oblique or spiral tibia and fibula ($> 30^\circ$)	42 - D/5.2		Multifragmentary oblique or spiral tibia and fibula ($> 30^\circ$)
Only tibia					
42t - D/1.1		Bowing tibia			
42t - D/2.1		Greenstick tibia			
42t - D/4.1		Transverse simple tibia ($\leq 30^\circ$)	42t - D/4.2		Transverse multifragmentary tibia ($\leq 30^\circ$)
42t - D/5.1		Oblique or spiral tibia ($> 30^\circ$)	42t - D/5.2		Oblique or spiral multifragmentary tibia ($> 30^\circ$)

Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
Only fibula					
42f – D/1.1		Bowing fibula			
42f – D/2.1		Greenstick fibula			
42f – D/4.1		Transverse simple fibula ($\leq 30^\circ$)	42f – D/4.2		Transverse multifragmentary fibula ($\leq 30^\circ$)
42f – D/5.1		Oblique or spiral simple fibula ($> 30^\circ$)	42f – D/5.2		Oblique or spiral multifragmentary fibula ($> 30^\circ$)

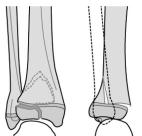
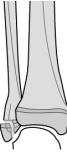
Distal metaphyseal fractures tibia/fibula (43-M)

Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
43 – M/2.1		Torus/buckle tibia and fibula			
43 – M/3.1		Complete simple tibia and fibula	43 – M/3.2		Multifragmentary tibia and fibula
Only tibia					
43t – M/2.1		Torus/buckle tibia			
43t – M/3.1		Complete simple tibia	43t – M/3.2		Multifragmentary tibia

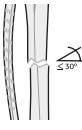
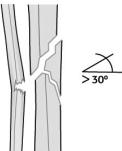
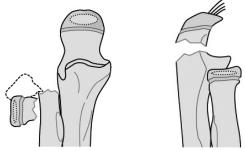
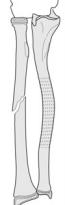
Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
Only fibula					
43f – M/2.1		Torus/buckle fibula			
43f – M/3.1			43f – M/3.2		Multifragmentary fibula

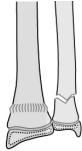
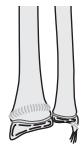
Distal epiphyseal fractures tibia/fibula (43-E)

Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
43 – E/1.1		Simple epiphysiolysis tibia and fibula			
Only tibia					
43t – E/1.1		Simple epiphysiolysis tibia SH I			
43t – E/2.1		Simple epi-metaphyseal fracture tibia SH II	43t – E/2.2		Multifragmentary epimetaphyseal fracture tibia SH II
43t – E/3.1		Simple metaphyseal fracture tibia SH III			
43t – E/4.1		Simple epi-metaphyseal fracture tibia SH IV	43t – E/4.2		Multifragmentary epimetaphyseal fracture tibia SH IV
43t – E/5.1		Tillaux (two plane) fracture tibia SH III			

Simple fractures			Wedge/multifragmentary fractures		
Code	Figure	Description	Code	Figure	Description
43t – E/6.1		Tri-plane fracture SH IV			
43t – E/8.1		Intra-articular flake tibia			
Only fibula					
43f – E/1.1		Simple epiphysiolysis fibula SH I			
43f – E/2.1		Simple epiphysiolysis with metaphyseal wedge fibula SH II			
43f – E/3.1		Simple epiphyseal fracture fibula SH III			
43f – E/4.1		Simple epimetaphyseal fracture fibula SH IV			
43f – E/7.1		Osteoligament avulsion fibula			
43f – E/8.1		Intra-articular flake fibula			

Frequent fracture combinations in paired bones

Codes	Combinations	Description
	Tibia/fibula	
41t – E/2.1 41f – M/3.1		Proximal lower leg SH II tibia and complete metaphyseal fibula
42t – D/4.1 42f – D/1.1		Complete diaphyseal tibia and bowing of the fibula
42t – D/5.2 42f – D/2.1		Multifragmentary diaphyseal tibia and greenstick fibula
43t – E/4.1 43f – E/1.1		Combined fracture: SH III tibia and SH I fibula
43t – E/4.2 43f – E/1.1		Multifragmentary epiphyseal fracture tibia SH III and SH I fibula
43t – E/2.1 43f – M/3.1		Distal lower leg SH II tibia and complete metaphyseal fibula
	Radius/Ulna	
21r – M/3.1 III 21u – M/3.1		Complete radial neck Type III and olecranon fracture
22r – D/5.1 22u – D/1.1		Simple oblique or spiral complete radius and bowing of the ulna
23r – E/2.1 23u – E/7.1		Radial SH II and fracture of the ulnar styloid

Codes	Combinations	Description
	Radius/Ulna	
23r – M/2.1 23u – M/3.1		Torus/buckle of the radius and complete metaphyseal ulna
23r – M/2.1 23u – E/7.1		Torus/buckle of the radius and fracture of the ulnar styloid

APPENDIX

The AO Pediatric Classification Group consists of: T. Slongo, L. Audigé, P. Schmittenbecher, N. Lutz, J-M. Clavert, S. Frick, J. Hunter, and W. Schlickewei.

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