2.2 Fracture classification

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Fracture classifications have multiple purposes. They should facilitate communication among physicians and be useful for documentation and research. For clinical relevance, they should have a value to guide physicians in their planning and management of fractures. They should also inform both physicians and patients of the prognosis for the injury. The basis for all clinical activity, be it assessment and treatment, investigation and evaluation, or learning and teaching, must be sound data which is properly assembled, clearly expressed, and readily accessible. Numerous classification systems have been proposed in orthopaedics but only a small number of them are widely accepted in practice, such as the Müller AO/OTA Classification of fractures. Even fewer have stood the rigorous task of evaluation.

2.2.1 Principles of Müller AO/OTA Classification of Fractures—Long Bones

Overall structure and attributes

Any classification system should be suitable for the acquisition, storage, and retrieval of data. The Müller system presents a way not only to document fractures but also to understand them in biomechanical and biological terms. The system is based on a well-defined terminology which allows the surgeon to consistently describe the fracture in as much detail as is required for the clinical situation. The description is the key to the classification and this then forms the basis for the alphanumeric code which makes it suitable for computerization, documentation, and research. The first aim of the surgeon is to identify what Müller has referred to as the "essence of the fracture." This is the attribute that gives the fracture its particular identity and enables it to be assigned to one particular type.

Classification is an ongoing process which depends on the information available to the surgeon at any given time. This process of classification is known as the diagnostic method. To make a diagnosis, information concerning the anatomical location and morphological characteristics of the fracture is obtained. This consists of a description of the location (ie, which bone is fractured and which part of the bone is affected?), followed by a fracture type (ie, how many fragments are involved?), and finally the morphological characteristics of a fracture (ie, what does the fracture look like?). This process provides useful clinical information for the physician to determine treatment. Only when all information concerning the fracture is collected may the classification process be considered complete.

Fracture localization: bones and segments

Each major long bone (humerus, radius and ulna, femur, and tibia and fibula) is named and then numbered (Fig 2.2-1). It should be noted that the two-paired bones, that is the radius and ulna, and the tibia and fibula, are regarded as one entity or group. Each long bone consists of three segments. There are two end segments (proximal and distal) and these are joined by a middle portion known as the diaphysis or shaft. The end segment consists of the metaphysis and articular surface. The extent of the end segments is defined as a square whose sides are the same length as the widest part of the epiphysis of the segment in question. Each of the segments in the bones is also numbered (Fig 2.2-2). There is a final segment, the malleolar segment, which is an exception to the rule. The pattern of these ankle fractures is determined by the relationship between the bones of the ankle mortise and their associated ligaments. The rule of defining the end segment cannot be applied. The Weber classification is universally accepted for this segment.

To assign each fracture to a segment, the center of the fracture must be determined. For a simple fracture, where there are only two bone fragments, this is apparent. It is the midpoint of an oblique or spiral fracture, and in a transverse fracture it is obvious.

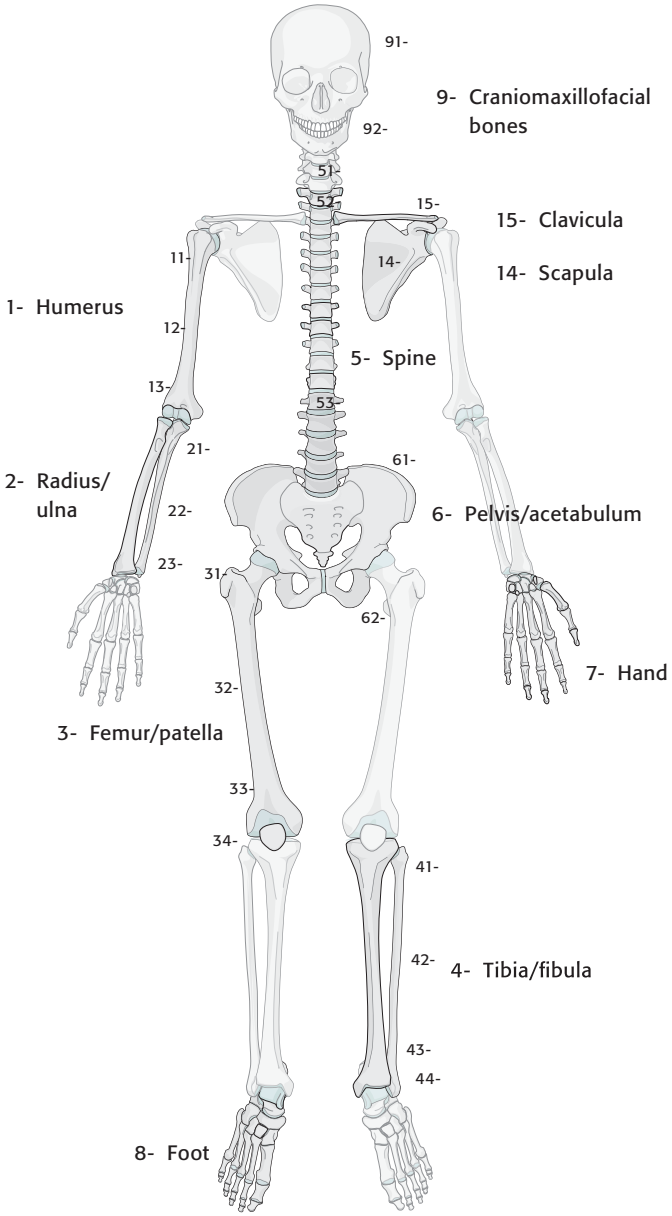


Fig 2.2-1 Müller AO/OTA Classification for numbering the anatomical location of a fracture in three bone segments (proximal = 1, diaphyseal = 2, distal = 3).

A wedge fracture has a center which is the broadest portion of the wedge or the mid portion of the fragmented area when reduced. For complex fractures, where there are many bone fragments, the center may well have to be determined after reduction when the full extent of fragmentation is determined. This may mean that the surgeon can only give a final classification after surgical treatment. A displaced articular fracture will always be classified in an end segment regardless of its diaphyseal extension, since the articular injury is the most important for treatment and prognosis.

2.2.2 Describing fracture morphology

The description of the morphology of a fracture is determined by a set of precisely defined rules. Following these rules allows the surgeon to classify a fracture according to its type, group, and subgroup. For all fractures the surgeon classifies the fracture by answering a well described set of questions. Müller and colleagues refined this process into a binary-type questioning. This means that there is either a yes/no or either/or answer. Different rules apply to fractures in the middle segments of long bones (diaphyseal) and fractures in the end segments (articular or metaphyseal)

Diaphyseal fractures

The questions are:

1. Which bone? Humerus, radius and ulna, femur or tibia (Fig 2.2-1)
2. Which segment? Proximal end segment, middle segment (diaphysis), or distal end segment (Fig 2.2-1)
3. Which type? (Fig 2.2-2)
   A. A simple fracture in which there are only two pieces of bone
   B. A wedge fracture—there are more than two pieces of bone but once reduced the main fragments will have some contact
   C. Complex—three or more fragments. No contact between main fragments after reduction
4. Which group? (Fig 2.2-3)
   1. Spiral fractures
   2. Oblique fractures
   3. Transverse fractures

End segment fractures (metaphyseal and articular)

The questions are:

1. Which bone?—Humerus, radius and ulna, femur, or tibia (Fig 2.2-1)
2. Which segment—proximal or distal end segment (Fig 2.2-1)
3. Which type? (Fig 2.2-2)
   A. Extraarticular—no involvement of articular surface
   B. Partial articular—part of the articular surface is involved leaving the other part attached to the diaphysis
   C. Complete articular—articular surface involved. Metaphyseal fracture completely separates articular component from diaphysis
4. Which group? (Fig 2.2-4)
   A. Extraarticular fractures:
      1. Simple fracture with two pieces of bone
      2. Wedge fracture
      3. Multifragmentary fracture
   B. Partial articular fractures:
      1. Split
      2. Depression
      3. Split depression
   C. Total articular fractures:
      1. Simple articular fracture with a simple metaphyseal fracture
      2. Simple articular fracture with a complex metaphyseal fracture
      3. Complex articular fracture with a complex metaphyseal fracture

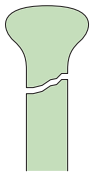
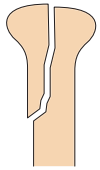
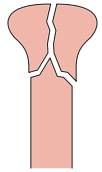
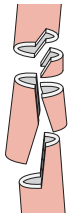
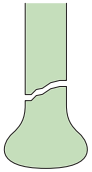
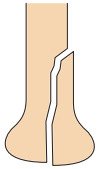
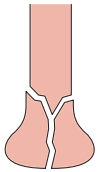
Segment	Type		
	A	B	C
1 Proximal			
	Extraarticular No involvement of displaced fractures extending into the articular surface	Partial articular Part of the articular component is involved, leaving the other part attached to the meta-/diaphysis	Complete articular Articular surface involved, metaphyseal fracture completely separates 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 extending 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 articular component from the diaphysis

Fig 2.2-2 Definitions of fracture types for long-bone fractures in adults according to Müller AO/OTA Classification.

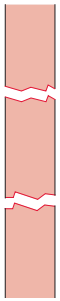
Type	Group 1	Group 2	Group 3
A Simple	 Spiral	 Oblique	 Transverse
B Wedge	 Spiral	 Bending	 Multifragmentary
C Complex	 Spiral	 Segmental	 Irregular

Fig 2.2-3 Classification of fractures of the diaphysis into the three fracture groups according to Müller AO/OTA Classification.

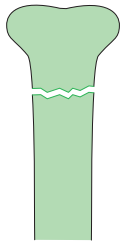
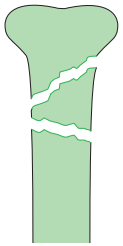
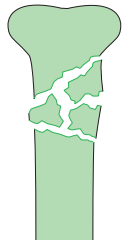
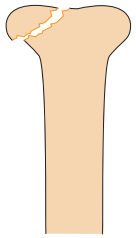
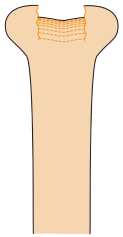
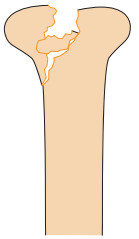
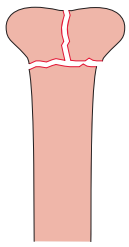
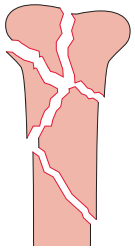
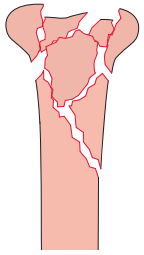
Type	Group		
	1	2	3
A **Extraarticular**	 Simple	 Wedge	 Complex
B **Partial articular**	 Split	 Depression	 Split-depression
C **Articular**	 Simple articular, simple metaphyseal	 Simple articular, complex metaphyseal	 Complex articular, complex metaphyseal

Fig 2.2-4 Classification of fractures of the diaphysis into the three fracture groups according to Müller AO/OTA Classification.

2.2.3 Conclusion

Fracture classification is the categorization of a fracture. It is used for documentation and research and gives surgeons and patients information about treatment options and prognosis. The process of obtaining this documentation is the process of diagnosis. Throughout this process, the surgeon will learn to understand the fracture, that is "the essence," and be able to determine its treatment. This system is based on a well-defined series of definitions which are an important aspect in clinical practice.

Finally, there are attempts at the present time to determine whether fracture classifications are valid. In other words, can they be used reproducibly and do they represent what is truly seen clinically so that clinical outcome research can be based on solid data.

2.2.4 Classification terminology

Articular: fractures which involve the joint surface. They are subdivided into partial articular and complete articular fractures.
Articular, partial: only part of the joint is involved while the remainder stays attached to the diaphysis.
Articular, complete: the joint surface is fractured and the entire joint surface is separated from the diaphysis.
Complex: fractures with one or more intermediate fragments in which there is no contact between the main fragments after reduction.
Extraarticular: fractures that do not involve the articular surface.
Multifragmentary: a fracture with more than one fracture line so that there are three or more pieces. It includes wedge and complex fractures.
Multifragmentary depression: a fracture in which part of the joint is depressed and the fragments are completely separated.
Depression: an articular fracture in which there is only depression of the articular surface, without a split.
Split: articular fracture in which there is a longitudinal metaphyseal and an articular fracture line, without any additional articular surface lesion.
Simple: there is a single fracture line producing two fracture fragments. Simple fractures of the diaphysis or metaphysis are spiral, oblique, or transverse.
Wedge: fracture complex with a third fragment in which, after reduction, there is some direct contact between the two main fracture fragments.

2.2.5 Further reading

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