Journal of Orthopaedic Trauma
Vol. 10, Suppl. 1, pp. v–ix

Introduction

Fracture and Dislocation Compendium

Orthopaedic Trauma Association
Committee for Coding and Classification

The need for a systematic classification of fractures of the skeleton has been recognized for many years. Beginning in 1970 Professor Maurice Müller recognized that this was obtainable. The aim was to develop an unified system which would be comprehensive and adaptable to each bone of the skeleton. Using the AO/ASIF Documentation Center in Bern, Müller and numerous collaborators developed what has become known as the Comprehensive Classification of Fractures of the Long Bones.

The Orthopaedic Trauma Association recognized this need for a systematic classification of fractures in order to allow for standardization of research and communication. The Committee for Coding and Classification under the direction of Dr. Marc Swiontkowski recommended that the Long Bone Classification System be adopted by the Orthopaedic Trauma Association. The committee then classified the non-classified bones.

This combination of the Comprehensive Long Bone Classification* with the classifications of the other bones reordered into the alpha-numeric system of the comprehensive classification forms the O.T.A. classification. This classification may not be the ideal system, but unless a classification is accepted and used, subsequently modified, we as orthopaedic traumatologists will be unable to achieve our goal to communicate in a uniform, consistent fashion.

This classification system is a start to this process. It is proposed to be an evolving system. It is on a three year cycle. In the first year, the system is used and problems documented. The second year is the acceptance of comment and criticism based on documentation for change. The third year will represent change based only on appropriate clinical research documentation that the existing system does not work. This is under the direction of the Orthopaedic Trauma Association's Committee on Coding and Classification. It is hoped through this system that a flexible evolving classification system will arise which will take into account the needs of all practicing orthopaedic traumatologists both in clinical research and practice. This is a collaborative cooperative classification system. The pride of authorship is not important, but what is important is the pride of the product.

Coding And Classification Committee
Orthopaedic Trauma Association

INTRODUCTION

The decision as to what treatment, what implant, and what is the result is determined in part from the morphological features of the fracture. Through an understanding of the fracture and the soft tissue injury the surgeon is guided to the best treatment. However, in order to do this a classification must have a consistent basis. At the present, fracture terminology is vague, uncertain and in essence useless. The aim of this classification is to develop a unified terminology. The terminology has been defined through the Müller Comprehensive Long Bone Classification System. Through the use of a standard terminology, communication between orthopaedic surgeons will become simpler and more precise. This will have many benefits for teaching, research, and patient care.

Through the Long Bone Classification system's alpha-numerical coding system, localization and mor-

Based on the *Comprehensive Classification of Fractures of Long Bones*, by M.E. Müller, J. Nazarian, P. Koch and J. Schatzker, Springer–Verlag, Berlin, 1990.

The Orthopaedic Trauma Association is indebted to Professor Maurice Müller for allowing the Association to use this system.

phological characterization of a fracture is possible. It is based upon the ability to ask three questions with three possible answers. In this way a fracture is classified. Although not all fractures will fit into this system, the Orthopaedic Trauma Association fracture classification applies the rules and definitions as much as possible in order to allow for an alpha numerical coding system which is compatible with the long bone system.

THE PRINCIPLES AND DEFINITION OF FRACTURE CLASSIFICATION

Glossary

The terms and definitions in the glossary follow the meanings that have been established by Müller's Long Bone Comprehensive Classification of Fractures.

Severity

Implies anticipated difficulties of treatment, likeli hood of complications, and finally prognosis.

Location

Bone location is designated by: 1) Humerus; 2) Radius/Ulna; 3) Femur; 4) Tibia/Fibula; 5) Spine; 6) Pelvis. Bone location is also designated by: 24) Carpus; 25) Metacarpals; 26) Phalanx (Hand); 72) Talus; 73) Calcaneus; 74) Navicular; 75) Cuneiform; 76) Cuboid; 80) LisFranc; 81) Metatarsals; 82) Phalanx (Foot); 06) Clavicle; 09) Scapula; 45) Patella. See Fig. 1.

Segments

Long bone segments are: 1) proximal; 2) diaphyseal; 3) distal. For the tibia and fibula, a fourth segment (4) is added known as the malleolar segment. For the pelvis the two segments are 1) pelvic ring and 2) acetabulum.

Diaphyseal Fracture Type

Fractures are divided into 3 types based on the fracture pattern.

Simple: A single circumferential disruption of diaphysis. Diaphyseal simple fractures are: 1.) simple spiral; 2.) simple oblique where the angle between fracture plane and perpendicular to long bone is greater than 30°; 3.) simple transverse where the angle between fracture plane and perpendicular to long bone is less than 30°. Cortical fragments less than 10% are ignored.

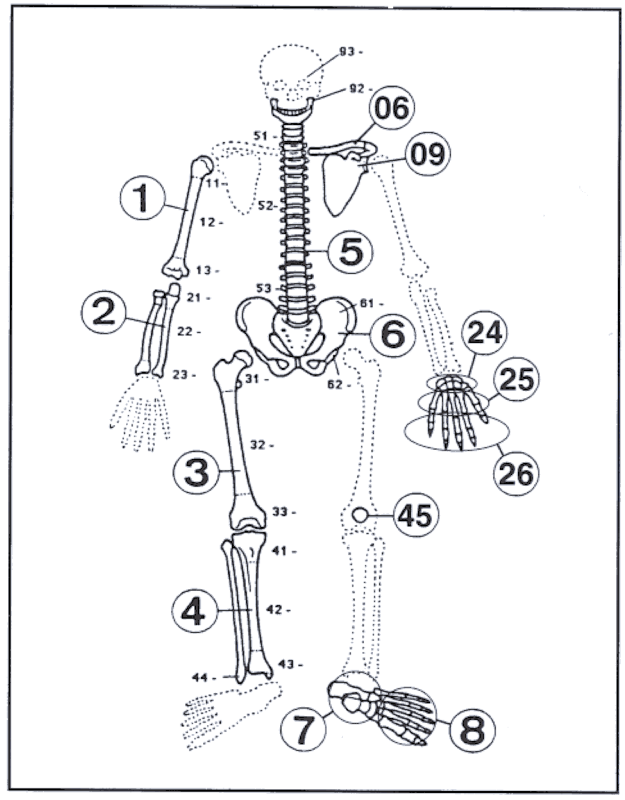

FIG. 1. Designation of bone location.

Multifragmentary: Any fracture with one or more completely separated intermediate fragments. It includes Wedge and Complex Fractures. The term wedge and complex are used for only diaphyseal and metaphyseal fractures.

Wedge: One or more intermediate fragments which after reduction, there is contact between main fragments. Wedges may be intact or fragmented: 1.) spiral wedge or so-called butterfly fragment, result of torsion; 2.) bending wedge or triangular extrusion wedge, result of bending; 3.) fragmented wedge or intermediate wedge which is fragmented by bending.

Complex: A fracture with one or more intermediate fragments in which after reduction, there is no contact between the main fragments: 1.) complex spiral, a diaphyseal fracture with multiple spiral wedge fracture fragments; 2.) complex segmental, a diaphyseal fracture at 2 levels (bifocal). After reduction the intermediate fragment makes contact with more than 50% of the circumference of each of the main fracture fragments. The intermediate fracture fragment may be associated with one or two further wedge fragments. 3.) Complex irregular, with a number of irregular intermediate fracture fragments.

Impacted

Stable simple fracture of metaphysis or epiphysis in which fragments are driven into each other.

Center of Fracture

The center of fracture is pivotal to assignment of fracture location: 1.) simple fracture center obvious; 2.) wedge fracture center at the level broadest part of wedge; 3.) complex center can be determined after reduction.

Specific Terms for Proximal and Distal Segments (Metaphysis)

Fractures of the proximal and distal segments are either extra-articular or articular.

Extra-articular: Does not involve articular surface yet may be intracapsular, includes apophyseal and metaphyseal fractures.

Articular: Articular fractures involve articular surface, divided into partial and complete. Also includes a displaced articular fracture associated with a diaphyseal fracture.

Partial Articular Fractures

Partial articular fractures involve only part of the articular surface while the rest remains attached to the diaphysis.

Types of fractures include: 1.) split, which results from shearing force, direction of split longitudinal; 2.) depression of the articular surface without split or separation, may be central or peripheral; 3.) split depression, a combination of major split and depression, with joint fragments usually separated; and 4.) multifragmentary depression, with joint depressed fragments completely separated.

Complete Articular Fractures

Articular surface is disrupted and completely separated from diaphysis, severity dependent upon location of multifragmentary component, articular and/or metaphysis.

Anatomical Terms

Humerus: Condyle of humerus is the whole distal articular surface of the humerus including the capitellum and the trochlea.

Radius/Ulna: Dorsal is posterior; volar is anterior. Dorsal rim is the partial articular fracture of distal radius in frontal plane, where the detached fragment consists of dorsal distal rim and portion of articular surface. Volar rim is the partial articular fracture of distal radius in frontal plane, where the detached fragment consists of volar distal rim with portion of articular surface.

Femur: Trochanteric area is the proximal segment that is between the intertrochanteric ridge and a transverse line through the inferior edge of the lesser trochanter. Subtrochanteric area is the proximal diaphysis delineated by a transverse line through the inferior edge of the lesser trochanter and distally to a transverse line 3 centimeters below the lesser trochanter. Distal zone of femoral diaphysis begins at the flare of the distal femoral diaphysis.

Tibia/Fibula: Intercondylar eminence is the tibial spines. Condyles are the medial and lateral portion of proximal segment each of which supports an articular surface. Anterior tubercle is the anterior lateral portion of the distal tibial metaphysis at the insertion of anterior inferior tibial-fibular ligament (tubercle of Chaput). Posterior tubercle is the posterior lateral portion of the distal tibial epiphysis at the insertion of posterior inferior tibial-fibular ligament. Syndesmosis is the distal tibial-fibular articulation maintained by anterior and posterior tibia-fibular ligaments and the interosseous membrane.

Preferred Terms: Dorsal instead of posterior, volar instead of anterior, supra instead of above, infra instead of below.

Inappropriate Terms: Comminution/fragmentation convey action and are inappropriate for description of static state.

Fracture Characterization

In order to classify a fracture, five questions are asked.

Which Bone?

This provides the first number (see Location, pg.2).

Where in the Bone is the Fracture?

This provides the specific segment. The diaphyseal segment (2) is that bone between the proximal and distal segments. The proximal (1) and distal (3) segments are defined by the anatomical region of the metaphysis and epiphysis. To better define this, the rule of squares

as proposed by Heim is used. The proximal and distal segment of a long bone is defined by a square whose sides are the same length as the widest part of the epiphysis in question. The exceptions to this are the proximal femur defined as the portion of the femur proximal to a line which passes transversely through the inferior edge of the lesser trochanter. The malleolar segment is separate. The proximal segment is labeled 1 and the distal segment 3 (Fig. 2). Segment determination is done by determining the center of the fracture. Any diaphyseal fracture associated with a displaced articular component is an articular fracture. If the articular fracture is an undisplaced fissure into the joint, the fracture is then classified as extra-articular or diaphyseal depending on its center.

Which Type?

The diaphyseal fractures are either simple or multifragmentary. Type A includes simple fractures with two fragments. Type B and C are multifragmentary fractures. Type B includes wedge fractures where after reduction, contact between main fragments exists, so length and alignment are restored. Type C includes complex fractures where no contact between main fragments occurs after reduction.

Which Group?

This further grades the fracture types into more meaningful groups. Simple fractures (type A) are grouped into spiral (1), oblique (2) and transverse (3). Wedge fractures (type B) have 3 groups: spiral wedge (1), bending wedge (2) and fragmented wedge (3). Complex fractures (type C) are fractures where there is segmentation: spiral multifragmentary wedge (1), segmental (2) and irregular (3).

With regards to the radius and ulna, the system has been modified because of the rarity of spiral fractures. Grouping here is done through fracture severity and bone involvement. Therefore, fractures in the first group are ulnar fracture (1), second group radial fracture (2) and third group are both bones (3). Type of fractures remain the same, for diaphyseal, proximal and distal fractures.

Which Subgroup?

The sub-groupings will differ from bone to bone depending upon what are the most distinguishing features with any given bone for its classification. For a diaphyseal fracture of the humerus and of the femur, the subgroups are similar being related to the level of the fracture: .1 for proximal zone, .2 for middle zone and .3 for distal zone. For definition, the middle diaphysis is the zone of uniform intramedullary canal diameter, the distal zone is the distal diaphyseal flare and the proximal zone is defined in the femur as the subtrochanteric region 3 centimeters below the inferior aspect of the

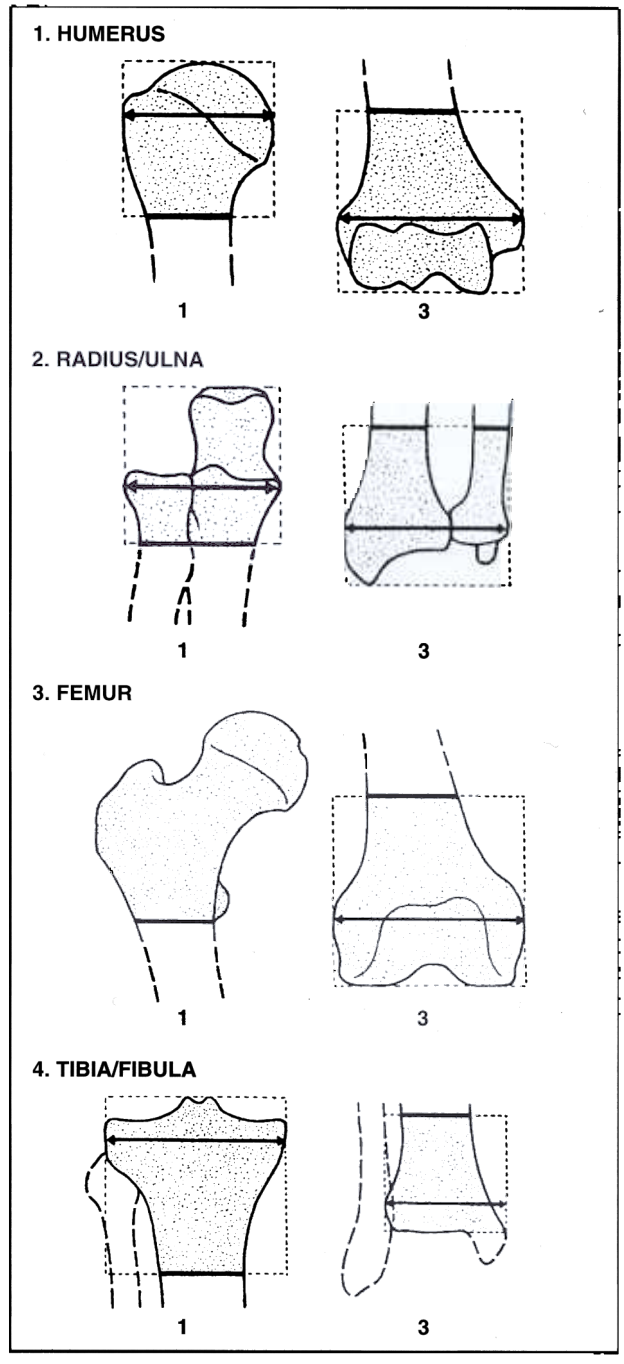

FIG. 2. Proximal and distal segments.

lesser trochanter and in the humerus as the zone with the proximal diaphyseal flare.

Subgroups in the tibia reflect the presence of a fibular fracture and its level: .1 for fibula intact, .2 for fibula fractured at another level, and .3 for fibula fractured at the same level. With regards to radius and ulna this will be further defined in the full group classification.

Subgroups within the C type represent the multifragmentary nature. With regards to C1 these are complex spiral fractures, C2 are related to the intermediate fragment and the number of wedges, and C3's are essentially shattered fracture fragments.

The use of qualifications increases the precision of the subgroup classification. In the qualifications numbered 1–6 the first code number listed is again descriptive about fracture location and extent of fracture. The additional qualifications from 7–9 are representative of descriptive terms with regards to amputation and bone loss.

Fractures of the Proximal and Distal Segments

The same questions are asked in this group. Which bone, which location that is proximal or distal segment, as previously outlined. The humeral and femoral heads because of their direct articulation with the trunk and their greater range of motion have different anatomy, and therefore require different classification schemes than the distal end of the humerus, proximal radius and ulna, distal radius and ulna, distal femur, proximal tibia, and distal tibia.

The fourth segment has been added for the ankle to account for the accepted classification of ankle injuries. Having determined which bone and at which end one then determines which type.

Type A are extra-articular fractures. The articular surface is always spared in this fracture pattern, although there may be a small undisplaced crack.

The type B represents partial articular fractures. The proximal radius and ulna is considered a functional unit, then a partial articular fracture of either the radius or ulna will occur when one or the other bone is spared or has an extra-articular fracture.

Type C fractures are complete disruptions of the articular surface from a diaphysis. The distal segments are the same.

With regards to the proximal humerus and proximal femur that is segments 1.1 and 3.1 respectively, the type A simple extra-articular fractures involve one tuberosity of metaphysis (unifocal) in the humerus. In the proximal femur, it involves the intertrochanteric region. Type B fractures of the proximal humerus are extra-articular which involve one tuberosity and the metaphysis (bifocal). The proximal femur is represented by fractures of the neck. Type C fractures of the proximal humerus represent articular fractures involving the anatomical neck of the humerus, while in the proximal femur it represents fractures of the femoral head.

Fracture type of segment 44 is dependent upon the level of the fibular fracture and the condition of the syndesmosis. Therefore, type A are fibular fractures below syndesmosis or infrasyndesmotic. Type B represents fibular fractures at the level of the syndesmosis or transsyndesmotic. Type C represents fibular fractures above the syndesmosis or suprasyndesmotic.

Groups for segments of distal humerus, proximal radius and ulna, distal radius and ulna, distal femur, proximal tibia and distal tibia are usually represented by either avulsion fractures of ligamentous or tendinous insertions or simple metaphyseal or multifragmentary metaphyseal fractures. Partial articular fractures are split, depression and split depressions. Complete articular fractures are classified based upon the morphology of the articular and metaphyseal fractures, being: group 1, simple articular and simple metaphyseal; group 2, simple articular and multifragmentary metaphyseal; and group 3, multifragmentary articular and simple or multifragmentary metaphyseal involvement.

Using these special rules then the specific fractures can be classified.