■ SPECIALTY UPDATE

The Unified Classification System (UCS): improving our understanding of periprosthetic fractures

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Periprosthetic fractures are an increasingly common complication following joint replacement. The principles which underpin their evaluation and treatment are common across the musculoskeletal system. The Unified Classification System proposes a rational approach to treatment, regardless of the bone that is broken or the joint involved.

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Introduction

Periprosthetic fractures are an increasingly common complication of joint replacement. They are difficult to manage and may have a poor outcome. They were the third most common indication for revision surgery in the Swedish Hip Registry in 2011[1] and only slightly less common in others, such as in the United Kingdom and Australia.[2,3] It is therefore important to establish the principles of management which are most likely to provide the greatest chance of a satisfactory outcome. This requires a brief comprehensive classification system on which to base algorithms of treatment.

Various systems have been adopted, not only as they apply to different bones and joints, but in some cases, as with the patella, with multiple systems relating to only one bone.[4-7] It is important to dispense with classification systems when they have become redundant or have been replaced with another which is more relevant to clinical practice. We recently prepared an introductory chapter to a textbook on periprosthetic fractures,[8] and used that opportunity to incorporate what has been learnt over the years into a new Unified Classification System (UCS) covering the management of all periprosthetic fractures. We present here an overview of the UCS. For more detailed information and its wider application across the musculoskeletal system, the reader is directed to the original publication.[8]

Case example

A middle-aged patient presents following a substantial injury some years after total hip replacement. Radiographs show a fracture of the acetabulum with pelvic discontinuity and of the femur, loose implants and substantial bone deficiency (Fig. 1).

The types. Type A is a fracture of an apophysis or protuberance of bone, to which one or more soft-tissue structures are attached. Examples in relation to a joint replacement include the trochanters of the femur and the tuberosities of the humerus. The principles of treatment are common to all and will be outlined below.

Type B involves the bed supporting or adjacent to an implant. Examples include a fracture of the femoral shaft around a stem, or one affecting the patella which has been resurfaced. The principles of treatment are again common to all, but the fracture first requires sub-classification, so that the appropriate principles are chosen:

B1 The implant is still well fixed; B2 The implant is loose; B3 The implant is loose and the bone bed is of poor quality because of osteolysis, osteoporosis, or comminution.

This sub-classification is fundamental to the original Vancouver Classification System.[9]

Type C involves a fracture which is in the bone containing the implant, but distant from the bed of the implant. The most common example affects the femur distal to a femoral stem. Other examples include the shaft of the tibia below a knee replacement or the hemipelvis adjacent to a hip replacement without extension into the acetabulum.

Type D is a fracture affecting one bone which supports two replacements, such as the humerus following shoulder and elbow replacement, or the tibia following knee and ankle replacement. This type is increasing in prevalence. The most common example involves the femur after hip and knee replacement.

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Fig. 1

Anteroposterior radiograph of the left hip and proximal femur following significant injury some years after total hip replacement. (Copyright by AO Foundation, Switzerland[8] reproduced with permission).

Fig. 2a

Fig. 2b

a) Anteroposterior and b) lateral radiographs of the hip, femur and knee after injury some time following a hip hemiarthroplasty and knee replacement. They illustrate a UCS Type D fracture: dividing a single bone which supports two arthroplasties. Block-out analysis reveals it is a Type C for each joint.

Type E involves two bones supporting one replacement. The most common example involves the acetabulum and femur after hip replacement (Fig. 1). Other examples include the femur and tibia after knee replacement or the humerus and ulna after elbow replacement.

Type F is an uncommon fracture involving a joint surface which is not resurfaced or replaced, but is directly articulating with an implant. The most common example of this type involves the acetabulum following hemi-arthroplasty of the hip. Other examples include the glenoid after hemiarthroplasty of the shoulder, or the patella after knee replacement in which the patella was not resurfaced. This type of fracture can, in current practice, only affect the glenoid, lateral humeral condyle, acetabulum or patella.

The principles of treatment

Type A: Two questions need to be answered:

1) How important is the attached soft tissue to the health and function of the adjacent joint replacement?

2) Is the fracture displaced?

If the attachments are unimportant, the fracture may be safely observed, even if displaced. Examples include the coracoid process and the lesser trochanter. If they are important, such as the supraspinatus to the greater tuberosity of the humerus or the quadriceps to the superior pole of the patella, especially if displaced, early intervention should be considered. Other examples in which intervention should be considered include the greater trochanter and tibial tuberosity.

Type B: Management is determined by the subtype. If it is a B1, which is the least common subtype, where sound fixation of the implant is assured, management would depend on the already documented outcomes of operative or non-operative treatment of that particular type of fracture. For example, a fracture of the femur around a well fixed proximally-coated stem would be best managed by reduction and fixation using the principles of indirect reduction and minimally invasive plate osteosynthesis (MIPO).[10,11] If B2, and the surrounding quality of bone will permit it, revision with a longer stem is a common approach. In the case of B3, a more complex reconstruction should be considered with extensive pre-operative planning.

Type C: If sufficiently distant from the bed of the implant, the implant can be ignored and the fundamental principles of management would follow those employed as if the implant was not present. But some specialised techniques may have to be used, as with the B1 subtype, if the hardware required for fixation will extend to the bed of the implant, such as cerclage cables and unicortical screws.

Type D: The term 'block out analysis' has been coined for this uncommon type. For the most common example, which involves the femur between a hip and knee replacement, block out the knee and ask 'what type of fracture is this for the hip?'. Next, block out the hip and ask the same question with reference to the knee. A rational approach can then be planned based on this analysis, which may involve revision of one, both or neither joint replacement. For instance, a fracture of the femoral shaft, between well-functioning and well-fixed hip and knee replacements (Type C for each), would employ reduction and fixation by MIPO, if feasible, without the need to disturb either replacement (Figs. 2 and 3).

Type E: In this case, a block-out analysis of each fracture should be undertaken in relation to each component of the

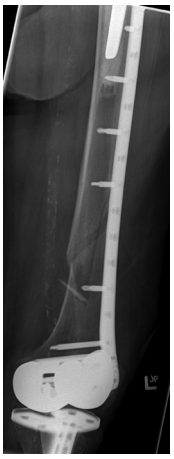

Fig. 3a

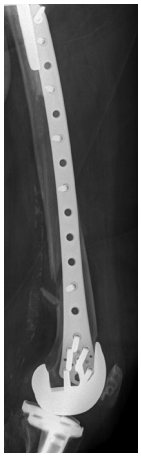

Fig. 3b

a) Anteroposterior and b) lateral radiographs of the hip, femur and knee after operation. The UCS Type D fracture was managed by indirect reduction and minimally invasive plate osteosynthesis without need to disturb the implants.

Fig. 4

Anteroposterior radiograph of the pelvis and proximal femur after a minor injury some time following a bipolar hip hemiarthroplasty for subcapital fracture. It reveals a mildly displaced UCS Type F fracture of the acetabulum. (Copyright by AO Foundation, Switzerland[8] reproduced with permission)

Fig. 5

Anteroposterior radiograph of the pelvis and proximal femur, of a different patient, after an injury some time following a bipolar hemiarthroplasty for subcapital fracture. It reveals a UCS Type F fracture of the acetabulum with substantial fracture displacement and medial migration of the implant (traumatic arthrokatadysis). (Copyright by AO Foundation, Switzerland[8] reproduced with permission).

joint replacement and from that a logical treatment plan can be developed (Fig. 1).

Type F: In the case of the most common example, which is a fracture of the acetabulum after hemi-arthroplasty of the hip, where the displacement is minimal, it would be appropriate to take a non-operative approach with protected weight-bearing, using the implant as a mould (Fig. 4). A delayed and relatively straightforward conversion to total hip replacement could be considered later if there are persistent symptoms. If the initial displacement is substantial, early intervention should be considered, unless the patient is suffering from dementia and not able to co-operate, or is not walking and in a fragile state of general health (Fig. 5). Similar principles would apply to the native glenoid after hemi-arthroplasty of the shoulder or an unresurfaced patella, even if only slightly displaced, or a lateral humeral condyle articulating with a radial head implant.

The UCS mnemonic

In order to assist with recall, this simple guide is offered.

Type A, Apophyseal; Type B, Bed of the implant; Type C, Clear of the implant; Type D, Dividing one bone which supports two joint replacements; Type E, Each of two bones supporting one joint replacement; and Type F, Facing or articulating with an implant.

Applying the classification to the case example. Figure 1 demonstrates a UCS Type E periprosthetic fracture following hip replacement. Both bones supporting one joint replacement are involved. Block-out analysis indicates that this is a Type B3 of the acetabulum (bed of the implant, loose component and substantial bone loss) and a Type B2 of the femur (bed of the implant, loose component, but adequate bone to support a non-complex revision). The broad principles of treatment would involve a complex reconstruction of the acetabulum and a long stem revision of the femur, along with stabilisation of the fractures and bone grafting.

The specifics of how this would be achieved would be dependent on an individual surgical team's experience and available facilities and, not surprisingly, would provoke healthy debate among experts. That is how it should be; otherwise our knowledge in this complicated area will not be advanced. The management of periprosthetic fractures will change with the passage of time, in order to keep pace with evolving knowledge, surgical techniques and technology, and also should be modified in response to the results of outcome studies. In contrast, the guiding

principles, fundamental to the development of a rational treatment plan, are unlikely to change.

It is hoped that the UCS will find a place in the algorithms of patient care, as well as allowing consistency in the reporting of periprosthetic fractures in registries, and that it will serve a useful purpose in research into the management and outcome of these complicated fractures.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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