Instability is a common indication for early revision after both primary and revision total knee arthroplasty (TKA), accounting for up to 20% in the literature. The number of TKAs performed annually continues to climb exponentially, thus having an effective algorithm for treatment is essential. This relies on a thorough pre- and intra-operative assessment of the patient. The underlying cause of the instability must be identified initially and subsequently, the surgeon must be able to balance the flexion and extension gaps and be comfortable using a variety of constrained implants.

This review describes the assessment of the unstable TKA, and the authors’ preferred form of treatment for these difficult cases where the source of instability is often multifactorial.

Cite this article: Bone Joint J 2016;98-B(1 Suppl A):116–19.

Instability is a common indication for early revision after both primary and revision total knee arthroplasty (TKA), accounting for up to 20% in the literature.13 It is essential when assessing a patient with a painful or malfunctioning arthroplasty to eliminate the possibility of infection. Thus, the pre-operative evaluation should include a full blood count including C-reactive protein and erythrocyte sedimentation rate (ESR), and aspiration of the joint in accordance with the American Academy of Orthopaedic Surgeons Clinical Practice Guidelines.4,5 Once infection is excluded, a thorough history, examination, and radiographic analysis will often help to identify the cause of any underlying instability.

The history should include details of previous operations on the knee, the indication for the initial replacement, comorbid conditions, such as diabetes with Charcot arthropathy, rheumatoid arthritis and Ehlers-Danlos syndrome, the type of prosthesis used, the post-operative rehabilitation and any subsequent trauma. The timing of the development of further symptoms should be recorded. If the patient is referred from elsewhere, other details of the initial surgery including any intra-operative complications and bony corrections or ligamentous releases that were required should be noted.

Physical examination should include observations of gait, which might suggest instability in the axial or coronal planes if, for instance, a varus or valgus thrust is observed. Additionally, the range of movement is recorded and stability is assessed with varus/valgus and anterior/posterior stress at 90° of flexion, 30° of flexion, and full extension, attempting to reproduce the patient’s symptoms. A posterior sag with the knee flexed to 90° is indicative of flexion instability.6 The strength of the leg, patellar tracking, and competency of the extensor mechanism are also assessed, as the latter, in particular, can cause global instability after total knee arthroplasty (TKA).7

Finally, the alignment, sizing, and rotation of the components are estimated radiologically. Full-length weight-bearing radiographs can provide excellent initial information about the mechanical and anatomical alignment and the size of the components.8,9 Attention should be given to wear, breakage, and loosening of components, as these can cause apparent rather than true instability after primary TKA, which is the main concern of this review. With lateral radiographs in both flexion and extension, the surgeon should concentrate on the posterior tibial slope, tibial subluxation, and potential recurvatum as in the patient with poliomyelitis (Fig. 1).8 CT scans can provide information about the rotation of the components.9

Following the patient interview, physical examination, and diagnostic studies, the instability can be characterised as extension, flexion, midflexion, genu recurvatum, or global. These categories are important as treatment is tailored to the specific factors rendering the TKA unstable.
Types of instability and their treatment

In order to obtain a successful outcome in these revision cases, it is necessary for the surgeon to return to the basic principles of TKA: proper alignment and rotation of the components, the correction of deficiencies of bone, equalisation of the flexion and extension gaps, restoration of the native joint line and soft-tissue balancing. One should also have experience with a variety of prosthetic designs and levels of constraint which, from least to most constrained include cruciate-retaining implants, cruciate-substituting designs, constrained condylar implants, and hinged systems.

**Extension instability.** There are two basic forms of extension or varus/valgus instability. The first is symmetrical and is secondary to an excessive distal femoral resection of bone that causes the extension gap to be larger than the flexion gap. The asymmetrical form is much more common and is caused by failure to correct the alignment in the coronal plane, resulting in ligamentous asymmetry. The asymmetry can allow ligamentous attenuation or frank rupture of the restraint on the convex side of the deformity.

For symmetrical extension instability, distal femoral augments are commonly used to lower the joint line and tighten the extension gap. A pre-operative strategy to increase the thickness of the tibial polyethylene will usually fail, as it will raise the joint line and tighten both the flexion and extension gaps.

With asymmetrical extension instability, the key issue is to treat the cause, thus correction of the deformity in order to restore alignment. Often, instability in a varus TKA is associated with a tight superficial medial collateral ligament causing attenuation of the lateral ligament. Likewise, instability in the valgus TKA is associated with a tight lateral ligament. Careful release of the contracted side can sometimes restore alignment in the coronal plane in these patients, but if stability cannot be achieved because of ligamentous insufficiency, a varus/valgus constrained condylar implant may be required (Fig. 2).

Although various ligamentous reconstructions and advancements have been described in the literature, in this scenario, at our centre, unlinked devices are chosen as they provide resistance to varus/valgus as well as anterior/posterior forces by the engagement of the tibial polyethylene post with the notch in the femoral component.

**Flexion instability.** This occurs when the flexion gap exceeds the extension gap. This can occur in a variety of ways including undersizing the femoral component, excessive posterior tibial slope, overly aggressive posterior femoral condylar cuts, posteromedial polyethylene wear, and rupture of the posterior cruciate ligament (PCL) in cruciate-retaining designs.

The surgical treatment for such instability should be tailored to the specific factor leading to it.

A patient with a cruciate-retaining TKA presenting either early or late with instability is frequently the result of PCL rupture. This may be managed by conversion to a posterior stabilised TKA, ensuring that the flexion and extension gaps are balanced.

Although it is tempting simply to exchange the tibial polyethylene for flexion instability, this does not correct the problem of gap mismatch, and therefore should only be used in specific situations such as where there is postero-medial polyethylene wear producing instability.

Flexion instability can also occur after TKA using posterior stabilised (PS) implants. Typically, this requires revision of the femoral component with posterior augmentation to fill the flexion gap. This occurs with excessive posterior femoral condylar resection or in association with an exaggerated posterior tibial slope. Careful pre-operative radiographic evaluation (particularly on the lateral radiograph) can guide decision making in this setting. Favorable results with revision for flexion instability in PS designs have been reported if the principles of gap balancing can be adhered to.
Midflexion instability. A poorly understood phenomenon, midflexion instability is associated with modification of the joint line. According to McPherson et al., midflexion instability involves rotation when the knee is flexed between 45° and 90°, and factors contributing to this pattern were thought to be the design of the femoral component in the sagittal plane, anterior medial collateral ligament attenuation, and the geometry of the tibiofemoral joint. Typically, full revision is required with careful attention to restoring the joint line and equalisation of the flexion and extension gaps with appropriate augmentation. More data are needed to guide the treating surgeon on the diagnosis and management of this difficult pattern of instability.

Genu recurvatum. This represents a rare form of instability usually presenting in patients with rheumatoid arthritis, poliomyelitis, or Charcot arthropathy. It is associated with a fixed valgus deformity and contracture of the iliotibial band. In the patient with poliomyelitis, recurvatum presents as a result of quadriceps weakness and equinus of the ankle that is compensated for by walking with the knee locked in hyperextension. These are difficult situations to treat, but moderate results have been obtained using a long stemmed PS or varus/valgus constrained implant. Rotating hinged prostheses can be used for these patients, although persistent hyperextension may lead to failure.

Global, multiply-operated instability. The multiply-operated, unstable revision TKA is distinctly unique to these prior situations, where an isolated polyethylene exchange or relying on a plastic post for ligamentous stability is likely fraught with failure secondary to attenuated tissues, large flexion/extension gap mismatch, and at times, extensor mechanism disruption. At the point of testing, these patients will have multidirectional ligamentous instability and may exhibit recurvatum gait. Often the surgical answer here is revision to a varus/valgus constrained implant, or, for severe instabilities in a salvage situation, a hinged TKA design. Instability is a frequent indication for revision TKA, and for a successful outcome, a thorough pre-operative assessment is critical. After infection has been excluded, the pursuit of the cause of instability begins with the history and physical examination, seeking to correlate the two. Furthermore, radiographic data in the form of full-length weight-bearing films and often computer tomography can provide a wealth of information about the size and alignment of the components, and the bone cuts that were used at the initial arthroplasty. Simple flexion instabilities in a cruciate-retaining TKA can often be revised using a PS implant with favourable results. Minor collateral insufficiencies causing extension instability can be managed with soft-tissue releases on the concave side of the deformity to restore alignment, but with more severe ligamentous insufficiency, a varus-valgus constrained design may be required. In more problematic cases of global instability or genu recurvatum, symmetrical and balanced flexion and extension gaps may not be obtainable, and more constrained implants including constrained condylar or hinged devices may be necessary.

Author contributions:
J. R. Petrie: background research, manuscript synthesis.
G. J. Haidukewych: manuscript synthesis and editing.

The author or one or more of the authors have received or will receive benefits for personal or professional use from a commercial party related directly or indirectly to the subject of this article.

This article was primary edited by J. Scott.

This paper is based on a study which was presented at the 31st Annual Winter 2014 Current Concepts in Joint Replacement® meeting held in Orlando, Florida, 10th-13th December.
References


