Why Knees Fail

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Total knee replacements (TKR) fail due to reasons common to all procedures regardless of experience, case volume, technical expertise, or type of prosthesis. These failure modes comprise the general complications of surgery and anesthesia (eg, pulmonary and cardiac complications), wound healing problems, deep venous thrombosis, and infection.

Other failure modes are primarily influenced by surgical technique and are therefore under the control and are the responsibility of the operating surgeon. Although some of these parameters may be influenced by prosthetic choices, they are relatively independent of the particular prosthesis. These include aseptic loosening, ligament instability, polyethylene wear (and consequent osteolysis), and limitation of motion. Malalignment is the common denominator for all of these complications.

**What is Alignment?**

Alignment encompasses the orientation of each of the three components of the prosthetic construct in the x, y, and z axes, both around and along these axes (Figure 1). The common terms for these positions are flexion–extension (x axis), internal–external rotation (y axis), and varus–valgus (z axis) for the malalignments around the three axes, and medial–lateral displacement (x axis), proximal–distal displacement (y axis), and anteroposterior displacement (z axis) for malalignments along the axes.

A correct alignment and a pair of incorrect alignments (one in either direction from the goal, eg, varus-valgus) exist for each parameter. Because 6° of freedom are allowed for the spatial relationship of each component (ie, 12 separate malalignments) and there are 3 components in a TKR, 36 possible malalignments can occur for each TKR. Therefore, any individual component can have up to 6 possible malalignments at the same time. It would not be possible to have both malalignments simultaneously for the same degree of freedom (ie, both varus and valgus), but it is possible to have one from each degree of freedom simultaneously.

**Consequences of Malalignment**

**Aseptic Loosening**

Aseptic loosening is significantly impacted by the asymmetric loading that malalignment imposes. In fact, malalignment increases prosthesis/cement interface stress in much the same way as increased prosthetic constraint. In the well-aligned knee, the interfaces are loaded mainly in compression, which is ideal for the cemented interface. With malalignment, an overload situation is created or the interfacial forces are converted to shear or distraction. It is rare for the well-aligned TKR with good cement technique to undergo aseptic loosening.

**Ligament Instability**

Figure 2 shows a dislocated total condylar knee. The femoral component is anteriorly displaced. This creates instability in flexion, creating the conditions for dislocation and is independent of the intrinsic constraint of the prosthesis.

**Wear**

Wear has involved plastic that is too thin, poorly sterilized, of poor quality, or “enhanced” in a way that degraded the wear characteristics. However, when the knee...
is malaligned, the plastic is loaded asymmetrically and the mechanical tolerances may be exceeded.

**Poor Flexion**

Figure 3 shows a prosthesis with the tibial component implanted in anterior slope rather than the posterior slope that the design calls for. This means that the posterior aspect of the tibia is under-resected. As the knee flexes, the ligaments tighten and eventually block further flexion. Malalignment trumps prosthetic design in limiting flexion.

**UNDERSTANDING MALALIGNMENT**

The surgeon should understand alignment and malalignment in all its complexity for four reasons: 1) awareness leads to avoidance, 2) understanding the findings of trial reduction, 3) understanding the reason for a poor result, and 4) planning for revision.

**Awareness**

Not all alignments are equally common. This is because most knees are exposed through a medial parapatellar incision. The extensor mechanism retracted laterally can make visualization of the lateral half of the knee more difficult than the medial part. In cases where exposure is difficult (eg, obesity, prior surgery with limitation of motion, etc), the soft tissues may impinge on instruments, causing them to lead the surgeon astray. For this reason, varus malalignment is more common than valgus, internal rotation of the femoral and tibial components is more common than external rotation, and medial displacement is more common than lateral displacement.

**Findings of Trial Reduction**

At trial reduction, the patella dislocates laterally. Nine potential reasons exist for this finding: medial displacement of the femoral (1) or tibial (2) component, internal rotation of the femoral (3) or tibial (4) component, lateral displacement of the patellar component (5), valgus malalignment of the femoral component (6) (1-6 all have the effect of shifting the tracking of the patella medially, increasing the quadriceps angle, which leads to subluxation), oversizing of the femoral component (7), under-resection of the patella (8), (7 and 8 increase lateral retinacular tightness above its preoperative state), and a lateral retinaculum that is too tight (9). The last may be created by a malalignment, but in the absence of malalignment should only be present if it was too tight preoperatively and therefore associated with patellar subluxation/dislocation prior to TKR. If the knee jerk response to the finding at trial reduction of patellar subluxation is to perform a lateral release, the opportunity to correct a malalignment prior to closure will be missed.

**Understanding a Poor Result**

Figure 4 shows the lateral radiograph of a patient with poor postoperative flexion. The components are perfectly aligned. Revision is unlikely to lead to improved flexion. On the other hand, Figure 5 shows a radiograph of a patient with an over-sized femoral component. The soft tissues are significantly tightened in flexion. Improvement in flexion was achieved by femoral component down sizing.

**Planning for Revision**

Failure of TKR due to aseptic loosening, wear, and poor motion is frequently caused by inadequate technique, mostly malalignment. This is particularly true for polyethylene wear. If the knee has survived >10 years and the wear is symmetrical, changing only the polyethylene insert can be successful. However, if accelerated wear has been caused by malalignment, failure to correct the fault results in only short-term success, since conditions leading to failure are not addressed.

**REFERENCE**