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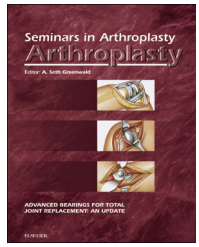

The gap balanced total knee arthroplasty

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ABSTRACT

The goals of knee arthroplasty (TKA) are to restore a neutral mechanical axis to the leg, and to create symmetric collateral ligament tension throughout the arc of knee motion. What technique best achieves this remains controversial. The two most commonly used techniques for performing TKA are measured resection and gap balancing. Measured resection relies on identification of bony landmarks to set the rotation of the femoral component. The gap balancing technique sets the rotation of the femoral component parallel to the cut tibial surface with symmetric tension on the collateral ligaments.

1. Introduction

Successful outcome after total knee arthroplasty (TKA) relies on symmetric tension on collateral ligaments and balanced flexion and extension gaps. The two most common techniques to determine femoral component rotation are the measured resection technique and the gap balancing technique. The fundamental difference between the two techniques lies in the determination of femoral component rotation. The symmetry of the flexion gap is determined by rotation of the femoral component [1]. Malrotation of the femoral component using either technique may lead to patellar tracking issues, flexion instability, and arthrofibrosis [2,3]. In the measured resection technique, femoral component rotation is determined using bony landmarks, whereas in the gap balancing technique femoral component rotation is based on soft tissue tension of the collateral ligaments with the knee in flexion.

The philosophy behind the measured resection technique in TKA is the amount of bone removed from the uninvolved condyle of the femur and tibia should equal the amount of bone being replaced by the prosthesis. The femoral component rotation is based on bony landmarks; typically the transepicondylar axis, the posterior condylar axis, Whiteside's line, or a combination of these. Soft tissue balancing is performed once trials are in place, after all bony cuts have been made as bone cuts are made independent of soft tissue tension. Advantages of the measured resection technique for TKA include maintaining the joint line position, minimizing mid-flexion instability, and for most surgeons the surgical technique is intuitively easier to perform. Disadvantages of the measured resection technique include unpredictable femoral component rotation, patellar maltracking, an asymmetric flexion gap, which can [4] predispose to lateral laxity and condylar liftoff [4].

The gap balancing technique in TKA is based on creating equal and symmetric flexion and extension gaps with bony cuts and ligament balancing during the initial part of the procedure. The flexion space is created by rotating the femoral component to create a symmetric flexion gap irrespective of bony landmarks. Advantages of the gap balancing technique in TKA include creating an equal and symmetric flexion and extension gap with equal tension of the collateral ligaments, proper patellar tracking, and a decreased risk of flexion instability and condylar liftoff. Disadvantages of the gap balancing technique are dependence on an accurate tibial cut to determine proper rotation of the femoral component, and a risk of mid-flexion instability because the technique may be insensitive to joint line restoration.

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This review describes our preferred method of performing a gap balanced total knee arthroplasty, and discusses relevant literature.

2. Surgical technique for gap balancing

After standard exposure of the knee joint, the patella is subluxed or everted. Osteophytes are removed from the distal femur and proximal tibia. The distal femoral canal is entered with a drill, and an intramedullary cutting guide is placed (Fig. 1). The angle of resection is set according to the preoperative template radiograph and generally ranges from 3° to 7° of valgus. The template is performed on a long-leg standing radiograph with the angle between the mechanical and anatomic axes of the femur measured. The depth of resection is set according the surgeon's implant choice and the presence of a flexion contracture or recurvatum deformity. The proximal tibia is then exposed. An extramedullary cutting guide is used to make the proximal tibia cut in line with the mechanical axis of the tibia and tibial slope according the surgeon's implant choice and patient anatomy (Fig. 2). Cuts are examined to ensure restoration of neutral limb alignment. The knee is then brought in to full extension and the extension gap is placed under tension either with lamina spreaders or a spacer block to assess both the size (bone resection) and symmetry of the collateral ligaments (Fig. 3). Tight structures on the medial (varus) or lateral (valgus) side of the knee are examined. The extension gap is then balanced with medial and lateral soft tissue releases as needed. The sequence for soft tissue releases in extension for varus and valgus knees are listed in Table 1. In general it is the posterior structures of the knee that are tight in extension. One important caveat to extension gap balancing is the presence of large posterior femoral osteophytes (Figs. 4 and 5). If present, these large posterior osteophytes can tent the posterior capsule and create tightness in extension. Prior to performing ligament releasing in extension, these osteophytes should be removed.

To create the flexion gap, an articulating tensioner is placed on the distal femur with the knee flexed to 90°. Using a lamina spreader, the collateral ligaments are placed under tension and the rotation of the femoral cutting block is determined to ensure a rectangular gap (Fig. 6). The appropriate size 4 in 1 femoral cutting block is then placed and the symmetry of the flexion gap is then checked prior to bony resection (Fig. 7). The same size spacer block from the extension gap measurement is placed in the flexion gap to ensure the gaps are equal and symmetric (Fig. 8). It remains controversial and debated as to the position of the extensor

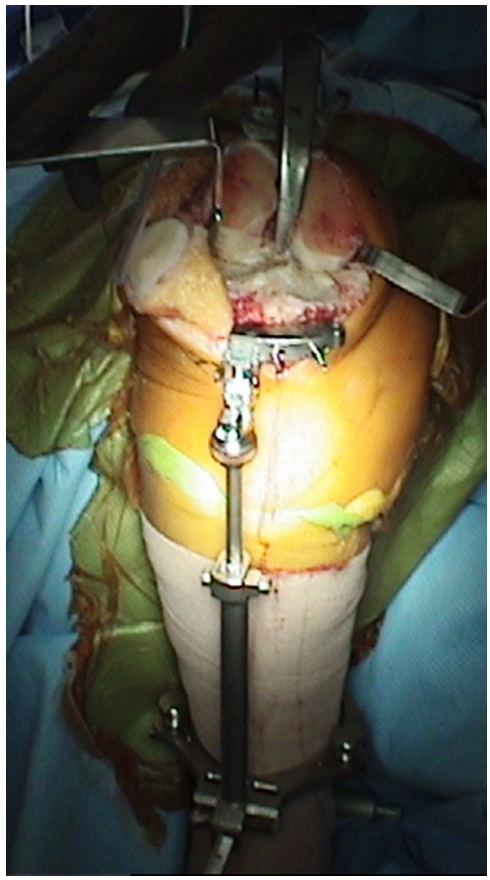

Figure 2 – Proximal tibial cut is performed perpendicular to the mechanical axis of the tibia.

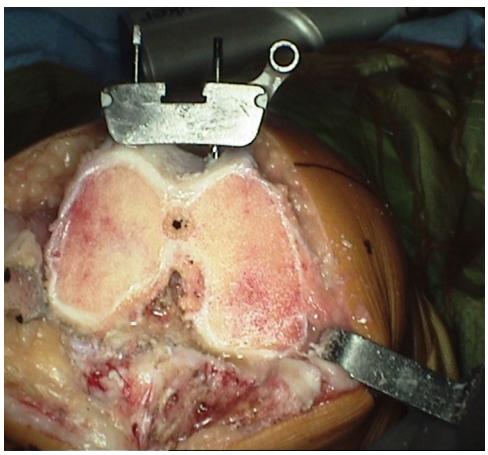

Figure 1 – Distal femoral cut is performed perpendicular to the mechanical axis of the femur.

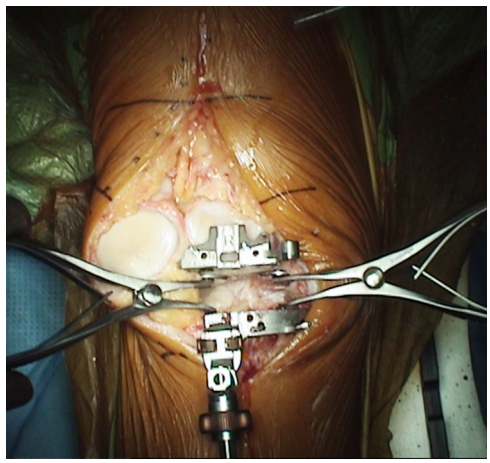

Figure 3 – Lamina spreaders can be used to assess the symmetry of the extension gap.