CHAPTER 10
Meniscal-Bearing Total Knee Arthroplasty

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INTRODUCTION

Human knee joint replacements have been developed with specific bioengineering requirements to provide near-normal kinematics, maintain fixation, and minimize wear. A mechanical solution to the bearing overload problem that causes excessive wear has been to use more congruent meniscal-bearing surfaces\(^1,2,3,4\) to lower the contact stresses below 10 MPa,\(^5\) which is reported as the maximum permissible compressive stress limit of ultrahigh-molecular-weight (UHMW) polyethylene. Lowering contact stresses to within the reported medical load limit of 5 MPa\(^6\) while allowing kinematically acceptable motion provides a meniscal-bearing surface that is resistant to fatigue wear and demonstrates normal abrasive wear behavior over a 10-year period as seen in both simulator and retrieval studies.\(^2,7,8,9,10\) (Figs. 10.1 and 10.2).

The first complete systems approach to total knee replacement using menisal bearings was developed at the New Jersey Medical School in 1977 and first reported in 1986.\(^1\) Unicompartmental, bicompartental, and tricompartmental disease were managed with a variety of primary and revision components that allowed retention of both cruciates, the posterior cruciate ligament (PCL) only, or no cruciate ligaments. Additionally, the first metal-backed, rotating-bearing patella replacement was developed in 1977 to provide mobility with congruence in patellofemoral articulation. This New Jersey Low-Contact-Stress (LCS) total knee system (DePuy, Warsaw, Ind), initially used with cement in 1977, was expanded to noncemented use in 1981 with the availability of sintered-bead porous coating\(^11\) and remains the only knee system in the United States to have undergone formal Food and Drug Administration (FDA)-Investigational Device Exemption (IDE) clinical trials in both cemented and cementless applications before being released for general clinical use\(^12,13,14,15\) (Fig. 10.3).

SURGICAL TECHNIQUE

Preparation

Preoperatively, obtain a standing AP X ray of both femora and tibia centered on the knee joint. On the X ray, draw a line through the center of each femoral canal to the center of the knee joint (anatomic axis). Draw a line through the center of each femoral head to the center of the knee joint (mechanical axis). The angle between these two lines is the “valgus angle” (Fig. 10.4). Measure the valgus angle of both knees. The normal angle varies from 3 to 8 degrees and should be individualized for each patient in the distal femoral resection. It is recommended by this author that the following valgus angles be used based on the patient’s height:

- Height < 5’11” 5 degrees
- Height from 5’11” to 6’1” 4 degrees
- Height > 6’1” 3 degrees

Incision and Exposure

With the knee slightly flexed, make a straight midline incision from 8 cm above the patella, over the patella, and ending at the tibial tubercle (Fig. 10.5a). With neutral alignment or a varus deformity, make a median parapatellar incision through the retinaculum, capsule, and synovium (Fig. 10.5b). If significant valgus deformity exists, a lateral parapatellar deep incision as part of a lateral release may be preferred (Fig. 10.5c).\(^16,17\)

Following a median parapatellar incision, reflect the patella laterally to expose the entire tibiofemoral joint.
Should tension prevent adequate lateral displacement of the patella, detach the medial one-fourth to one-third of the patellar tendon from the tibial tubercle. To further mobilize the extensor mechanism, continue the sharp incision of the medial portion of the quadriceps tendon proximally or, while proximal, perform a “quadriceps snip” across the quadriceps tendon at a 45-degree angle.

Following a lateral parapatellar incision in the valgus knee, incise the anterior compartment fascia longitudinally one centimeter from the tibial tubercle. Elevate the tibial tubercle with an osteoperiosteal flap if necessary or use a reverse “quadriceps snip.” Reflect the patella and periosteal attachments medially.

Excise hypertrophic synovium and a portion of the infrapatellar fat pad to allow access to the medial, lateral, and intercondylar spaces. Excise redundant synovium to prevent possible impingement or postoperative overgrowth. Evaluate the condition of the cruciate ligaments to determine the appropriate tibial component to use.

**Ligament Balancing**

Remove femoral and tibial osteophytes, especially any deep to the collateral ligaments. Lateral soft tissue release and, occasionally, osteotomy and removal of the fibular head will enable correction of valgus contracture (Fig. 10.7a). Medial sleeve release may be necessary for a fixed varus deformity (Fig. 10.7b). An extensive medial tibial subperiosteal sleeve may be necessary in severe varus angulation.

Nine basic steps are then performed using precision instruments to gain a perpendicular tibial component orientation in the frontal plane, anatomically sloped posteriorly in the lateral plane; balanced flexion-extension gaps; and reasonable mechanical axis positioning. These steps are as shown in Figure 10.8.

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**Figure 10.1.** Meniscal-bearing simulator specimen after 10 million cycles under loads of 2,200 NS.

**Figure 10.2.** (A) Ten-year postmortem retrieval of an asymptomatic rotating platform prosthesis demonstrating continued rotation of the tibial bearing. (B) The same retrieval specimen demonstrating continued axial rotation of the rotating patella bearing.