INTRODUCTION
In the early 1970s the total condylar knee arthroplasty was designed at the Hospital for Special Surgery and emphasized the concepts of ligament balance and knee alignment. After the introduction of polymethylmethacrylate, there was a rapid increase in design work because the major obstacle of fixation was relieved. Although the knee implant designs continued to undergo refinement, instrumentation lagged significantly behind the design technology. This dichotomy occurred because the emphasis was given to the development of better anatomic and biomechanical prostheses that could take advantage of the new fixation and improve upon the early loosening and increase the range of motion. The technique for the implantation of the knee was not a central issue. Thus, instruments were designed after the prostheses had been developed and often times were not even available for the initial surgical procedures.

In the 1980s the knee designs became more sophisticated and the concept of a cementless prosthesis was introduced. The cementless components required more accurate bone cuts in order to increase the surface area of contact between the prosthesis and the bone. This placed a much greater demand upon the instrumentation and required a parallel technology to complete the prosthesis and the instruments as one unified system. It became evident that the results of the new implants were dependent both upon the design rationale of the prosthesis and the surgical technique. It was no longer acceptable to rely upon the “surgeon’s eye” to establish proper positioning of the implant. Implant design and instrument design became equally important.

PRINCIPALS OF INSTRUMENTATION

Tibiofemoral Alignment
The overall alignment of the knee must be in 5 to 10 degrees of anatomic valgus. The alignment is determined by the position of
both the femoral and tibial components in the coronal plane of the joint. There are two basic schools of thought concerning the position of the knee joint.\textsuperscript{3,4} The most popular school references the \textit{mechanical axis} of the lower leg. The tibial cut is made perpendicular to the tibial shaft and the femoral cut is made parallel to the mechanical axis of the femur (i.e., the line drawn from the femoral head through the middle of the tibia and through the middle of the ankle). The \textit{anatomic alignment} references the mechanical axis of the lower leg but allows for the fact that the proximal tibial plateau is actually in a few degrees of varus. In this system the tibial cut is set anatomically (i.e., in 2 to 3 degrees of varus) and the femoral cut is made parallel to the mechanical axis with the addition of the 2 or 3 degrees. Hungerford and Krackow popularized this concept hoping to improve knee arthroplasty with greater anatomic precision (Fig. 2.1).

\textbf{The Femoral Component}

The preceding discussion has only considered the angular relationship of the femur and the tibia in the coronal plane. The instruments must align \textit{each component} in the sagittal, coronal, and horizontal planes. The femoral component should include a valgus angle of 4 to 6 degrees, should be centered on the end of the femoral shaft with respect to the anteroposterior plane, should not be significantly flexed or extended, and should include external rotation of 3 to 4 degrees.

The femoral valgus angle can be referenced with respect to the femoral shaft. The anterior to posterior position and the external rotation can be verified with respect to the posterior condylar axis, the anterior cortex of the shaft of the femur, the intramedullary canal, the epicondyles, and the flexion gap. Each of the references has an individual variability. The posterior femoral condyles are easily defined. However, as the varus or valgus deformity of the knee increases the posterior aspect of the medial condyle (in varus) and the lateral condyle (in valgus) can become deficient. With this atrophy, the anterior to posterior thickness will be underestimated and the femoral cuts will be internally rotated in the valgus deformity and externally rotated in the varus deformity if the posterior condylar axis is the primary reference (Fig. 2.2). The anterior cortex of the femur is readily available for referencing.\textsuperscript{5} Because the lateral femoral condyle rises higher than the medial condyle in the femoral sulcus area, the surgeon must choose between the high lateral referencing or the low medial referencing. If the anterior cut is elevated, the forces in the patellofemoral joint will be increased because of the increased distance of the patella from the center of