alignment rationale

THE P.C.A.® UNIVERSAL™ TOTAL KNEE INSTRUMENT SYSTEM is designed to seat the femoral and tibial components parallel to the anatomic transverse axis of the knee. Since this axis is parallel to the ground and perpendicular to the vertical in single-leg stance, this positioning achieves: (1) uniform stress distribution at fixation interfaces, (2) optimal alignment, and (3) physiological ligamentous balance of the knee. Since the ankles remain closer to the midline vertical axis of the body than either the knees or hips throughout normal gait, these alignment features must be preserved or reconstituted to achieve the goals of total knee arthroplasty.

The P.C.A.® Universal™ Total Knee Instrument System uses the femoral shaft axis (S), the center of the knee (K), the center of the ankle joint (A), and the transverse axis of the knee (T) as alignment references (Figure 1). The mechanical axis of the lower limb runs from the center of the hip (H) through the center of the knee (K) to the center of the ankle (A). This forms an angle of 3 degrees with the vertical (V), because the hips are wider apart than the ankles in both normal stance and gait (Figure 1).

Since the femoral head and neck overhang the shaft, the axis of the femoral shaft does not coincide with the mechanical axis, but forms with it a valgus angle of 6 degrees (SKH, Figure 1). In total, the femoral shaft axis averages 9 degrees of valgus with the vertical. The valgus angle of the femur varies with body build. The specific femoral valgus angle for a given individual can be determined by measuring angle HKS (Figure 1) on a long x-ray which includes both the hip and the knee and adding 3 degrees (the angle between the mechanical axis and the vertical with the leg in the position of single-leg stance). This method is valid for reconstituting a mechanical axis of 3 degrees, regardless of the degree of preoperative axial deformity at the knee.

For tibial alignment, the center of the knee and the center of the ankle are used as reference points. Instruments which rely on the proximal tibial shaft as their key alignment reference tend to be inaccurate due to the frequent occurrence of tibial bowing. Since the center of the

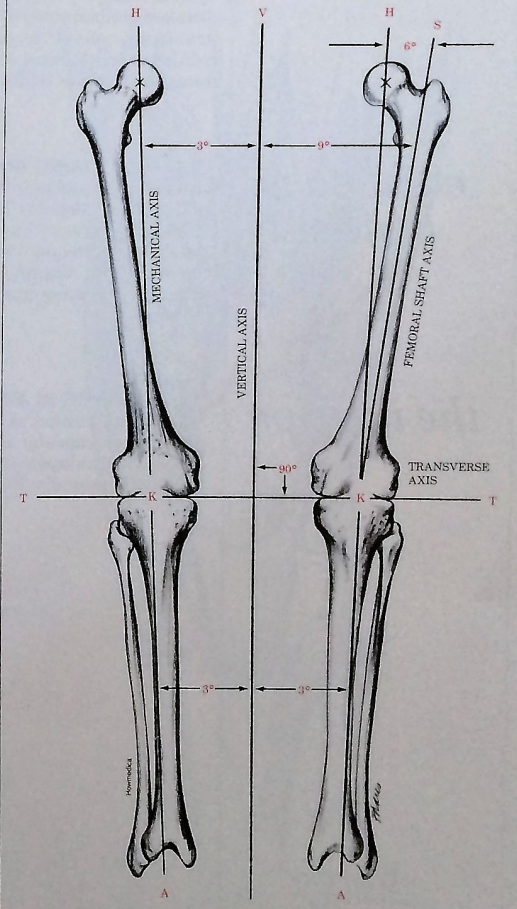

FIGURE 1
Anatomical references for the P.C.A.® Universal™ Total Knee Instrument System:

V = Vertical axis
T = Transverse axis
H = Center of femoral head
S = Axis of femoral shaft
K = Center of knee joint
A = Center of ankle

Sample Copy and Spread

femoral alignment and cuts

ORIENTATION OF THE CENTRAL DRILL HOLE

The intercondylar drill guide is designed to assure that the intercondylar hole is aligned with the axis of the femur and within the medullary canal. The posterior pin of the drill guide is positioned anteriorly to the femoral posterior cruciate attachment, centered in the intercondylar groove and firmly tapped into position. Any intercondylar osteophytes are first debrided visualizing the femoral attachment of the posterior cruciate and the anterior margin of the intercondylar groove. The anterior projection of the intercondylar drill guide contains a series of holes through which the long alignment pin is passed. The hole that is chosen allows minimal clearance of the alignment pin in the trochlear groove. This alignment pin is passed along the femoral shaft underneath the quadriceps mechanism to facilitate alignment of the intercondylar drill hole with the femoral intramedullary axis. Centering the pin on the shaft from the front assures that the drill guide is correctly aligned for varus/valgus. When viewed from the side, the pin should align with the long axis of the shaft, assuring flexion/extension alignment of the drill guide (Figure 4). The 5/16 inch (8mm) intercondylar drill is passed through the guide into the medullary canal. The drill and drill guide are then removed. *A synovial rongeur or small curette is used to create a relief channel in the anterior margin of the intercondylar drill hole. This will allow fat and air to escape when the intramedullary rod is inserted.*

TECHNICAL HINT: After completing the intercondylar drill hole, place the intramedullary rod gently into the femur to be certain that it passes up the shaft. This maneuver verifies alignment with the femoral shaft and facilitates subsequent steps with jig I-A.

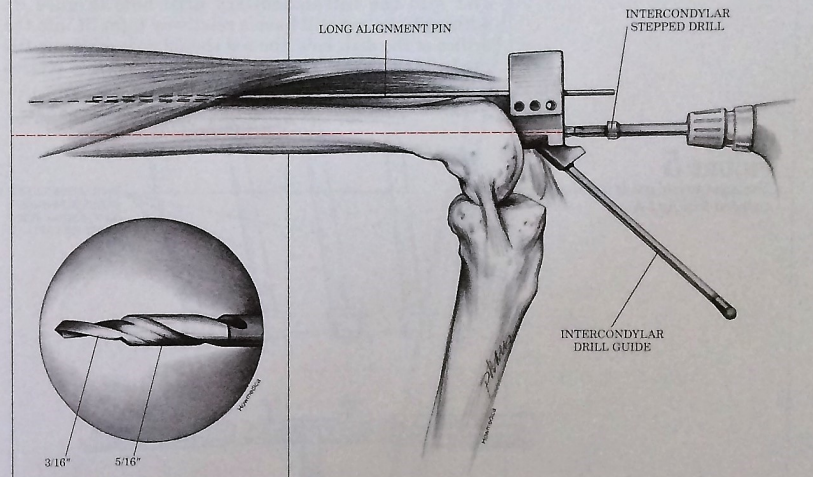

FIGURE 4
Initial intercondylar drill hole is made in distal femur for jig I-A and intramedullary rod.

tibial alignment and cuts

CHECKING SOFT TISSUE BALANCE AND TIBIAL ALIGNMENT

If the preoperative deformity is mild or moderate and fully passively correctable, the following step is optional. With more severe deformity, the following step will lead to the appropriate soft tissue release which will allow correction of the deformity with minimal bone removal.

Jig IV is inserted into the drill holes in the distal femoral condyles and the leg is extended. *A folded towel or sheet is placed behind the knee to prevent inadvertent hyperextension at this stage of the procedure.* The alignment guide and pin are placed into position on jig IV (Figure 25). With traction on the foot, the center of the ankle is brought under the tip of the alignment pin (Figure 26). If this cannot be accomplished, only that degree of soft tissue release which is necessary to allow correction of the deformity is carried out. For varus deformity, this will include all of the fibers of the deep medial collateral ligament. For valgus deformities, release of the iliotibial tract is usually sufficient.

For flexion contractures, recheck to be sure that all posterior osteophytes have been removed. The posterior capsule can also be divided under direct vision. If there is a severe deformity that cannot be corrected with the spacer/tensor (jig IV) in place, it is still possible to proceed to cutting the proximal tibia prior to addressing the problem of ligamentous imbalance. However, the ligamentous imbalance will have to be addressed at the time of trial reduction using one of the special techniques which are addressed in *The P.C.A.® Primary Total Knee System Surgical Technique.*

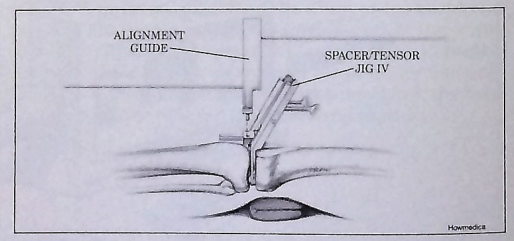

FIGURE 25
The long axial alignment guide is assembled with the spacer/tensor jig IV (optional).

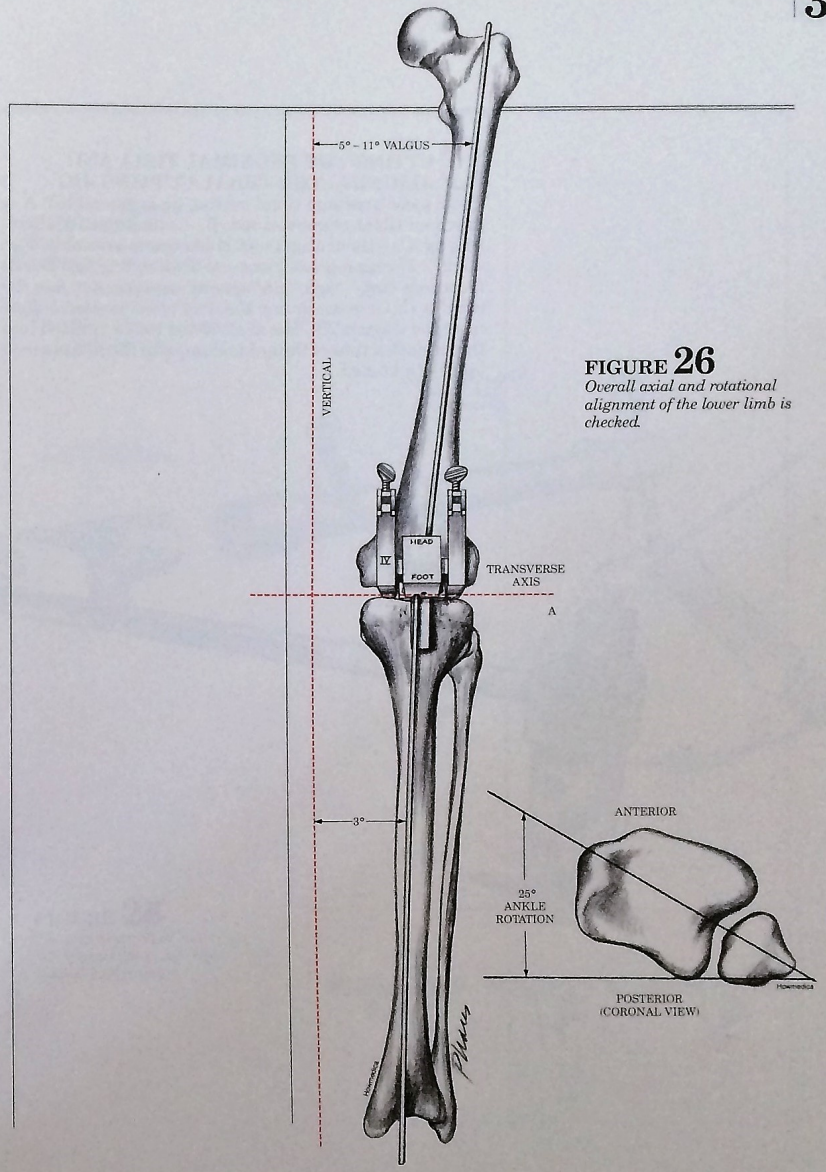

FIGURE 26
Overall axial and rotational alignment of the lower limb is checked.

TIBIAL FIXATION (RESURFACING OR STEMMED)

A tibial drill guide is set onto the anterior surface of jig VII.

When the resurfacing tibial baseplate is used, two 5/16 inch medial/lateral peg fixation holes are fashioned with the stepped drill. The drill is inclined 30 degrees to the horizontal (Figure 50).

When the stemmed tibial prosthesis is being used, a 3/16 inch pilot hole is drilled through the center of the drill guide bushing (Figure 51). The pilot hole will accept the tip of the stem chisel. The cutting fins of the chisel orient the cruciform cutout in jig VII, and ensure proper orientation of the stemmed component (Figure 52). The chisel is impacted until it is flush with the body of jig VII, and removed.

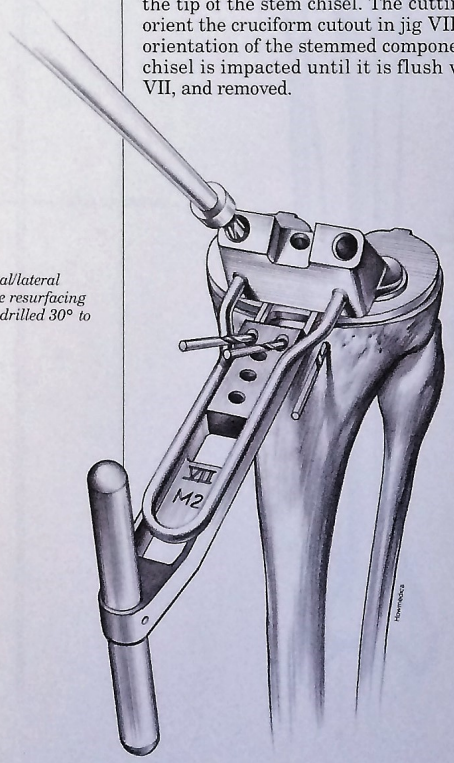

FIGURE 50
The 5/16 inch medial/lateral fixation holes for the resurfacing tibial baseplate are drilled 30° to the horizontal.

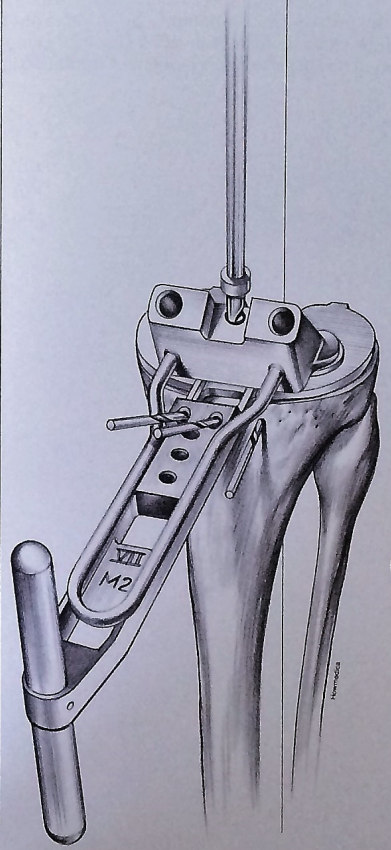

FIGURE 51
The 3/16 inch pilot hole for the stemmed tibial baseplate is drilled through the center of the drill guide bushing.

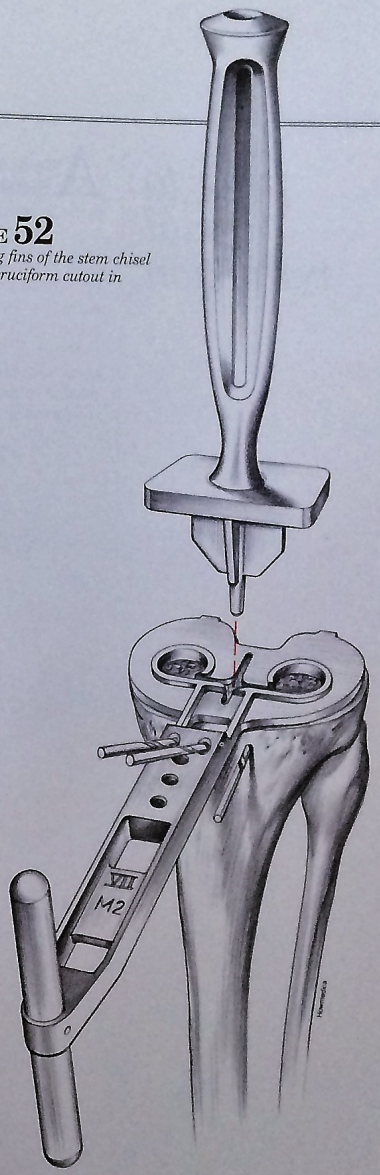

FIGURE 52
The cutting fins of the stem chisel orient the cruciform cutout in jig VII.

Sample Copy and Spread