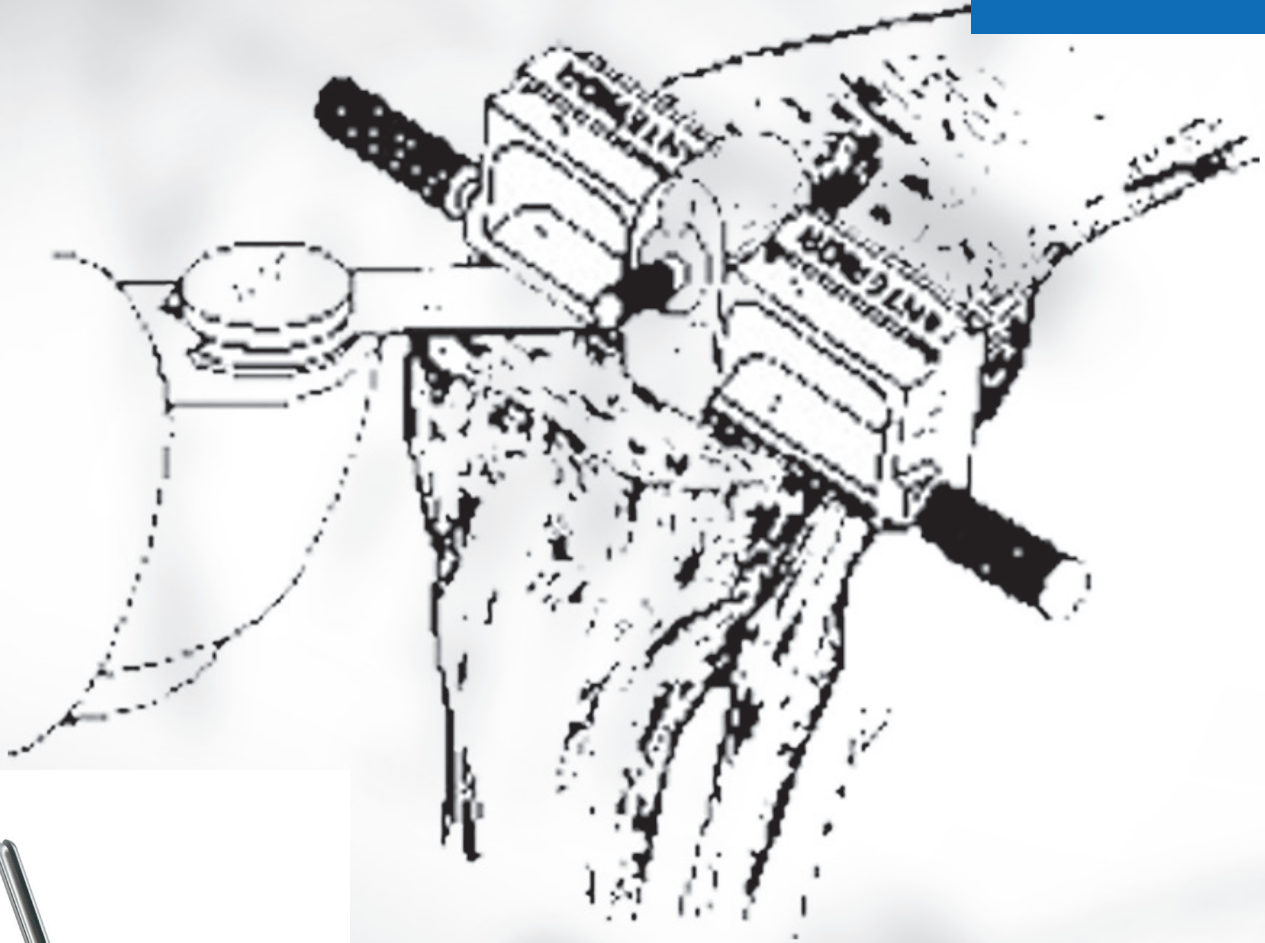# Zimmer® Natural-Knee® II Revision System

Surgical Technique

**Zimmer®
Natural-Knee® II
Revision System
Surgical Technique**

Table of Contents

Introduction

The *Natural-Knee®* II Revision system has been used successfully in patients to meet the need for a more anatomic knee replacement. The system was designed to provide maximum range of motion, restore the limb to normal alignment and provide improved fixation of the components. Early clinical results have confirmed that the *Natural-Knee* II System's design considerations have resulted in improved motion and stability, normal alignment and stable fixation of the implant.[1,2]

Material Technology
The design innovations of the *Natural-Knee* II Revision System are matched with porous coating technological advances pioneered by Zimmer's proprietary *Cancellous-Structured Titanium™* (*CSTi™*) Porous Coating.

An exclusize Zimmer sintering process "locks" *CSTi* porous coating to the cobalt-chrome (CoCr) substrate of the femoral component. The *SinterLock™ CSTi* process successfully combines the wear properties of CoCr with the biocompatibility of titanium. Compared to other conventional porous coatings, the *SinterLock CSTi* process demonstrates the excellent shear/tensile static strength and cyclic fatigue properties.

Versatility and System Overview

The *Natural-Knee* II Revision System is composed of modular components that can be customized intraoperatively to accommodate the individual patient's clinical needs and surgeon's preference. Component thickness, stem length and diameter, insert thickness and degree of constraint may be determined intraoperatively.

The surgeon has the choice of eight optional femoral component implants. Primary femoral and revision femoral components with increased distal and posterior buildup are available, each in posterior cruciate ligament (PCL) -retaining and PCL sacrificing versions (Figure 1).
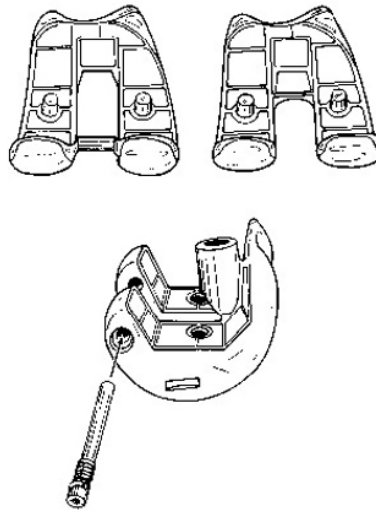

Fig. 1

Each implant is available in porous-coated and nonporous-coated versions, both of which are manufactured from cast cobalt-chrome for a preferred articular surface.

Primary femoral components can be used only if minimal distal femoral bone loss is present, otherwise proximal transposition of the joint line will occur. The primary femoral components are anatomic, asymmetrically shaped with a deep patellar groove for increased range of motion and patellar stability. The *Natural-Knee* II Primary and Primary posterior stabilized femoral components are available in seven anatomic sizes.

The *Natural-Knee* II Revision femoral components are available in six anatomic sizes. The articular geometry is the same as the *Natural-Knee* II Primary femoral component and may be used with primary or revision tibial components. A modular posterior stabilizer bar may be inserted intraoperatively for conversion of the *Natural-Knee* II Revision femoral component to a posterior stabilized implant.

Anatomical unicompartmental augmentation spacers are available in 4mm, 8mm and 12mm thicknesses (Note: size 00 is not available in 12mm thickness) (Figure 2).
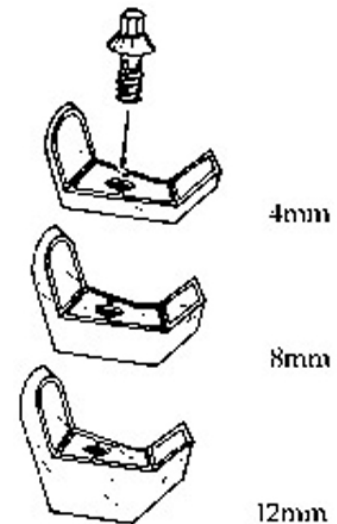

Fig. 2

The spacers are attached via mechanical fixation with or without supplemental cement. The spacers are manufactured from cast cobalt chrome with inferior and superior surfaces containing gritblasted cement pockets for enhanced cement bonding. The outer box geometry of spacers matches the inner box geometry of the *Natural-Knee* II Revision femoral component. This allows for distal transposition of the joint line intraoperatively without the need for additional bone cuts, simply by adding spacers. Three modular stem lengths (125mm, 200mm and 250mm) are available in four diameters (10.5mm,

12.5mm, 14.5mm and 16.5mm) for optimal femoral diaphyseal endosteal cortex contact thereby eliminating the need to cement the stem. The modular stems are mechanically attached to the *Natural-Knee* II Revision femoral components via a Morse taper with an additional retaining screw (Figure 3).
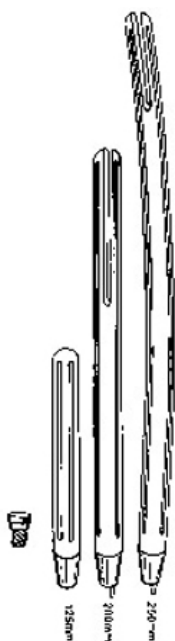

Fig. 3

The stems are manufactured from wrought cobalt-chrome. The straight 200mm and curved 250mm stems have a coronal slot proximally to provide flexibility at the tip to avoid thigh pain.

Ten optional tibial components are available to accommodate bone loss, status of the posterior cruciate ligament and surgeon preference. All tibial components are asymmetrically shaped for optimal tibial plateau coverage. Primary tibial components can be used with revision femoral components because of identical surface geometries (Figure 4a).
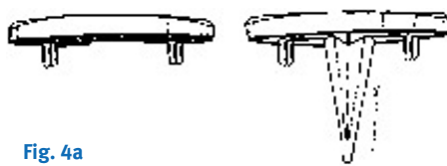

Fig. 4a

The most conservative implant type is the *Natural-Knee* II resurfacing tibial baseplate which is available in seven anatomic sizes, right and left configurations. This baseplate is manufactured from wrought titanium and is porous coated with *CSTi* coating. It is recommended for use with the congruent insert and in minimal bone resections where excellent bone quality is present. The *Natural-Knee* II stemmed tibial baseplate may also be used in minimal bone loss situations. The stemmed tibial baseplate is manufactured from cast titanium, is available in seven asymmetric sizes, and is offered in both porous-coated and nonporous-coated versions. The central stem is cruciate-shaped for maximal bone conservation. The porous version has a nonporous-coated stem and four nonporous pegs at the periphery to prevent stress shielding. The *Natural-Knee* II stemmed tibial baseplate will accommodate congruent, ultracongruent and posterior stabilized polyethylene inserts.

In revision total knee replacements where a longer stemmed implant is used, the *Natural-Knee* II +4mm revision baseplate (Figure 4b) (4mm thicker than the primary baseplate) is available in six asymmetric sizes.
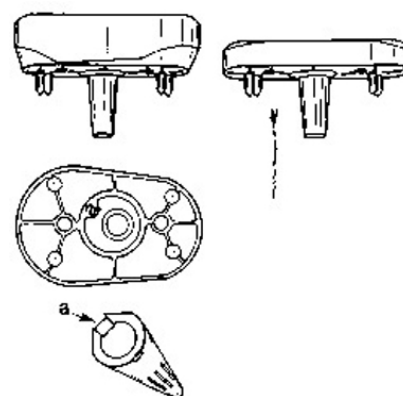

Fig. 4b

The *Natural-Knee* II +14mm revision baseplate (14mm thicker than the primary baseplate) replaces even greater tibial bone loss. Its conical-shaped stem has a one size decrease, proximal to distal, to replicate the natural flare of the tibia. The +14mm baseplate is available in five asymmetric sizes. Both the +4mm baseplate and +14mm baseplate are manufactured from wrought titanium, are offered in both porous- and nonporous- coated versions, and will accept congruent, ultracongruent and posterior stabilized polyethylene inserts. Both the +4mm and +14mm *Natural-Knee* II tibial baseplates employ modular conical-shaped titanium stems available in six lengths (60mm, 90mm, 120mm, 155mm, 180mm and 215mm) (Figure 5).
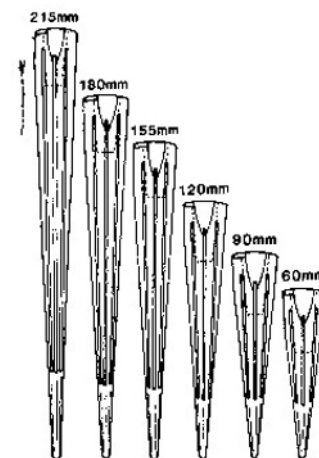

Fig.5

The stem is secured via a Morse taper in a position offset slightly anterior and medial to the midline, allowing utilization of longer stems without lateral tibial endosteal cortical impingement.

Titanium unicompartmental spacers for asymmetrical tibial bone defects are available in seven sizes, medial and lateral configurations and 4mm and 8mm thicknesses (Figure 6).
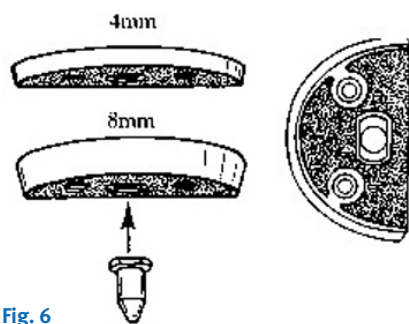

Fig. 6

They are designed to allow for mechanical and/or cement fixation to all *Natural-Knee* II tibial baseplates. The inferior and sagittal surfaces of the spacers are porous coated with *CSTi* coating. The superior surface of the spacers contains grit-blasted cement pockets for enhanced cement/implant bonding.

All *Natural-Knee* II tibial inserts are manufactured from ultrahigh molecular weight polyethylene (UHMWPE) and feature an enhanced snap/lock mechanism which eliminates tibial insert/baseplate motion and increases pull out strength. The congruent, ultracongruent and posterior stabilized inserts (Figure 7) are available in three asymmetric sizes (size 00, 0 insert for sizes 00 and 0 baseplates, size 1, 2 insert for sizes 1 and 2 baseplates, and size 3, 4, 5 insert for sizes 3, 4 and 5 baseplates) and seven thicknesses (9mm to 22mm).
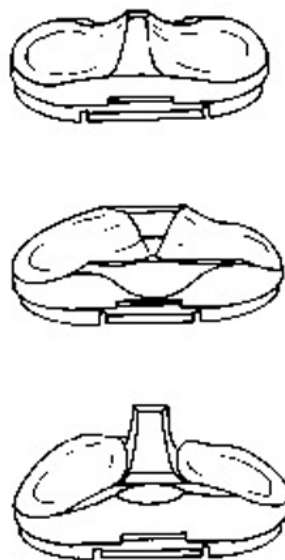

Fig. 7

The *Natural-Knee* II congruent tibial insert is designed for PCL retention. It is asymmetric in shape with a 4mm anterior lip height which aids in resisting anteroposterior forces. The *Natural-Knee* II ultracongruent tibial insert is designed for PCL deficiencies. It has a 12mm anterior lip height which serves to resist posterior subluxation of the tibial without the need for a posterior stabilized femoral component. The *Natural-Knee* II posterior stabilized tibial insert is a cruciate-substituting tibial insert with a central eminence designed to engage the posterior stabilizer bar on the *Natural-Knee* II Primary and Revision posterior stabilized femoral components. It has an 8mm anterior lip height to resist anteroposterior forces.

All-polyethylene tibial components are available in the congruent and ultracongruent articulating surface geometries in seven asymmetric sizes and five thicknesses (9mm to 19mm) (Figure 8).
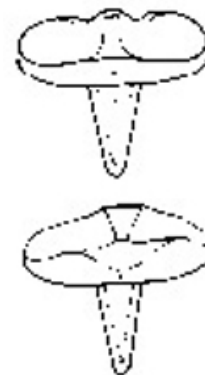

Fig. 8

They have an asymmetric inferior surface with dovetail grooves for macro cement interdigitation between the implant and the bone.[5,6] Each component has a central cruciate-shaped stem.

The *Natural-Knee* patella implants (Figure 9) are sombrero shaped components designed to conform with all *Natural-Knee* II femoral components throughout the total range of motion.
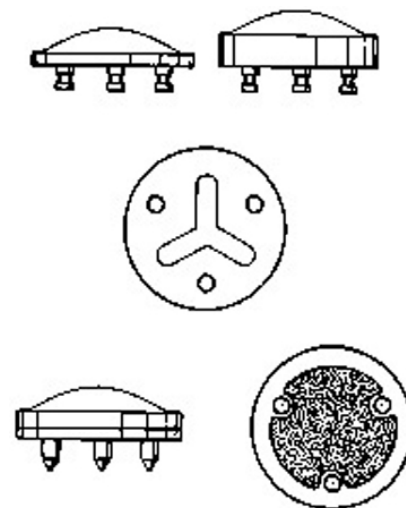

Fig. 9

The all-polyethylene patellar components are available in four diameters and two thicknesses (7mm and 10mm). The *Natural-Knee* metal-backed (*CSTi* coating) patella is 10mm thick and is also available in four diameters.

Adaptability

A few additional instruments that adapt to the primary instruments are required for revision knee surgery utilizing *Natural-Knee* II Primary or Revision components or combinations of both. Once a surgeon is familiar with the *Natural-Knee* II Primary surgical technique, use of the *Natural-Knee* II Revision instruments is an easy extension.

Alignment

Revision implants and instruments are designed to provide precise anatomic alignment by referencing the anatomic axis via the intramedullary canal of both the femur and tibia. Alignment is achieved by placing the tibial component 90 degrees to the anatomic axis of the tibia and the femoral component in 6 degrees of valgus based on the anatomic axis of the femur (Figure 10).
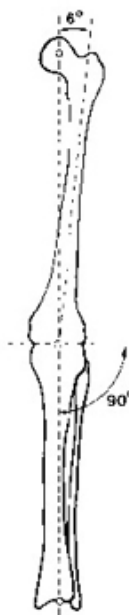

Fig. 10

Using these landmarks, it is possible to restore the mechanical axis of the extremity with the center of the knee lying on a line from the center of the femoral head to the center of the ankle.

Preoperative Planning

In revision total knee replacement surgery, preoperative planning is important to assist in determining proper placement of the joint line for the knee to be balanced in flexion and extension.[1] Instrumentation cannot be relied upon, as in a primary knee replacement, for proper joint line positioning since bony landmarks used as reference points are absent. If possible, the pre-total knee replacement radiograph of the involved knee should be obtained. Frequently it is not available, so the contralateral knee radiograph is used. If the contralateral knee has also been replaced, it can still be used as long as it is functioning well.

Assuming one is using a normal knee radiograph for comparison, the first step is to verify that the radiographs are of the same magnification, otherwise any measurements will need to be factored by the magnification difference. The second step is to determine the correct femoral component size from the primary or revision femoral templates using the normal lateral radiograph. The third step is to measure the distance from the joint line to the adductor tubercle (usually 40mm to 50mm) (Figure 11a) and lateral epicondylar ridge on the anteroposterior radiograph and to the junction of the posterior femoral condyle and femoral shaft on the lateral view (Figure 11b).
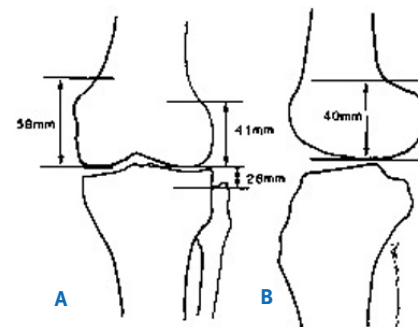

A   **B**

Fig. 11

The fourth step is to transfer these measurements to the abnormal knee anteroposterior and lateral radiographs to determine where the joint line should be (Figures 12a and 12b).
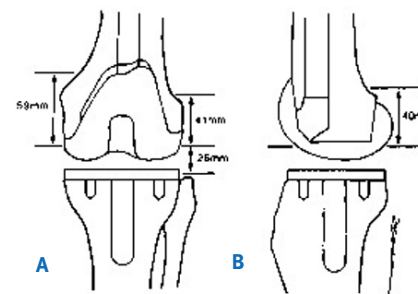

A   **B**

Fig. 12

The fifth step is to place the correct size primary or revision femoral template on the abnormal knee anteroposterior and lateral radiographs at the correct joint line position (Figures 13a and 13b).
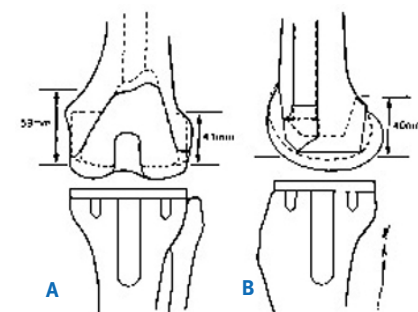

A   **B**

Fig. 13

1 Gustke, K.A., MD, "Planning and Techniques for Unconstrained Revision Total Knee Replacements," Fu, F.H., Harner, C.D. and Vince, K.G., editors, Knee Surgery, Baltimore, MD, Williams and Wilkins, 1994, pp. 1553-1562.

This will then demonstrate whether a primary or revision femoral component should be used. Using the distal end of the femoral component that is being revised as a reference, templating will illustrate how much additional distal femoral resection will be necessary during surgery. The templating step may also show if additional distal femoral buildup with spacers will be necessary.

Preoperative templating is also helpful in determining the maximum size and length of the femoral stem. On the tibial side, preoperative measurements using the fibular head as a reference point will show if tibial bone loss is present and which type of tibial component, stem, augmentations or bone grafts will be necessary. Noting the relationship of the inferior pole of the patella can also be helpful in placing the joint line at the correct level.

Ten Basic Steps

Ten basic steps are required to align and seat the femoral and tibial components in revision total knee replacement surgery. Precise cuts can be achieved using instruments that reference off of and are stabilized via the intramedullary canals of the femur and tibia. The preferred method is to prepare the tibia prior to the femur. The following represent the 10 basic steps:

1) Tibial alignment and proximal tibial cuts

2) Tibial medullary canal preparation

3) Femoral medullary canal preparation

4) Femoral alignment and distal femoral cut

5) Femoral rotation and anterior and posterior femoral cut

6) Femoral chamfer cuts

7) Trial reduction

8) Femoral routing if posterior stabilizer device is used

9) Patellar preparation

10) Component implantation

The Incision

Because of decreased skin vascularity over the knee, the incision must be carefully chosen taking into consideration all previous incisions. If multiple anterior skin incisions are present, the most anteromedial or anterolateral is chosen followed by a parapatellar capsular incision. A mid-quadriceps splitting incision is used rather than a subvastus medialis approach.

The most difficult part of exposure in revision knee surgery is getting the knee flexed and everting the patella without avulsing the tibial tubercle. Initially, the quadriceps should be split as far proximally as possible. A lateral patellar retinacular release is performed if there is thick scar tissue lateral to the patella. If the patella cannot be everted, a decision is made at this point whether to direct further releases proximal or distal to the patella. An extended tibial tubercle osteotomy is indicated if there is relative inferior positioning of the patella ("patella baja"). Proximally, the incision can be carried laterally across the quadriceps tendon ("quadriceps snip") or an inverted "V" can be made in the vastus lateralis tendon. For very stiff knees, the lateral quadriceps mechanism incision is carried distally to the tibia allowing inversion of the patella.

Component Removal

Bone preservation and ligament preservation are the major goals with component removal. The femoral component is removed first. Based on preoperative radiographic measurements, the desired level of the new distal femoral cut is marked off with a ruler using the existing femoral component distal flange as a reference. If grossly loose, it can be removed with alternating taps on the medial and lateral flanges or with the *Natural-Knee* II femoral impactor/extractor with the slaphammer (1/4-inch threaded or Natural-Hip) attached. If partially loose or rigidly fixed, the implant-bone or implant cement interfaces must be released completely or unnecessary bone loss or fracture may occur. Thin flexible osteotome blades of various widths are ideal for this purpose (Figure 14a). They are angled around pegs and also through the notch (Figure 14b).
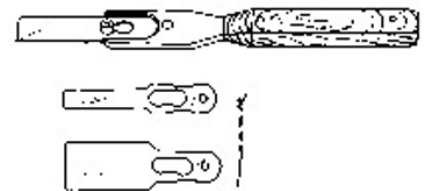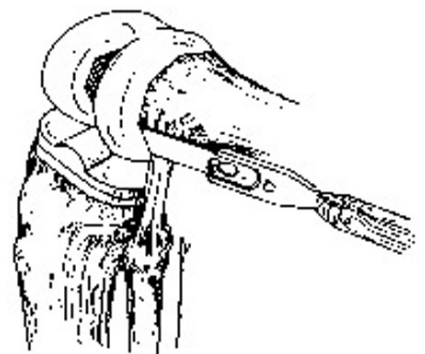

Fig. 14a

Fig. 14b

Alternate instruments to release the interfaces are thin oscillating saw blades or a gigli saw. The *Natural-Knee* II femoral impactor/extractor with the slaphammer is attached and used to axially remove the femoral component (Figure 14c).
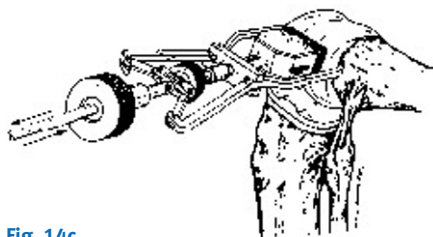
Fig. 14c

Any fixed cement is left on the femur at this point to help maintain bone integrity. The femur should be retracted posteriorly while working on the tibia. Tibial component exposure is facilitated by releasing soft tissue from around the medial and lateral tibial plateaus.

A cemented all-polyethylene tibial component is removed by loosening the implant-bone interface with thin flexible osteotomes or an oscillating saw. Cutting across the top of the stem may assist removal if the stem is not loose. The stem is then removed separately.

If a stemmed metal tray tibial component with screws is present, the insert is first removed with standard osteotomes (Figure 14d).
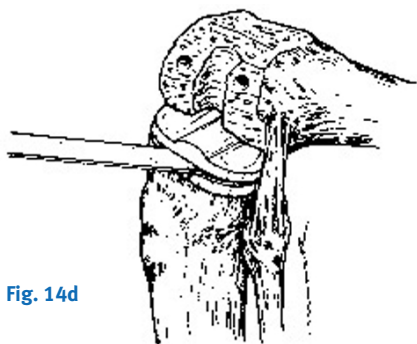
Fig. 14d

The implant-bone or implant-cement interface is then released with thin flexible osteotomes (Figure 14e) or an oscillating saw.
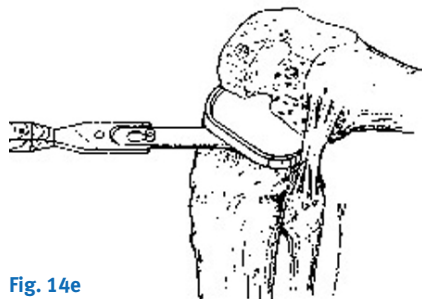
Fig. 14e

A standard ½-inch osteotome is then placed under the lateral plateau and the implant is impacted proximally. If the stem is porous coated, a large amount of bone may remain attached to the stem. In this situation, two vertical slots are made in the anterior tibial metaphysis corresponding to each side of the stem. Thin flexible osteotomes are then angled through these slots along the sides of the stem to release some of the stem-cement or stem-bone interface prior to component removal.

Any cement present on the tibia is then removed. Fixed femoral cement is left in place until femoral component preparation has begun.

If the patella component requires revision, removal of the component is left until after femoral and tibial preparations are complete to lessen the chance of patellar fracture during retraction. All polyethylene patellar component removal is accomplished with release of the implant-cement interface and transection of polyethylene fixation pegs with thin flexible osteotomes or an oscillating saw. Metal-backed patellar components with smooth pegs are impacted vertically after release of the interface. Uncemented metal-backed

patellar components with porous-coated pegs present a major challenge to remove without excessive bone loss. A gigli saw or metal cutting tool is used to transect the pegs. The pegs and cement are then removed separately.

Tibial Alignment and Proximal Tibial Cuts

Direct vertical exposure of the tibial plateau is necessary. This is facilitated by soft tissue releases around the tibial metaphysis, medial and lateral soft tissue retraction with the small angled knee retractors and subluxation of the femur posteriorly with the large angled knee retractor (Figure 15).
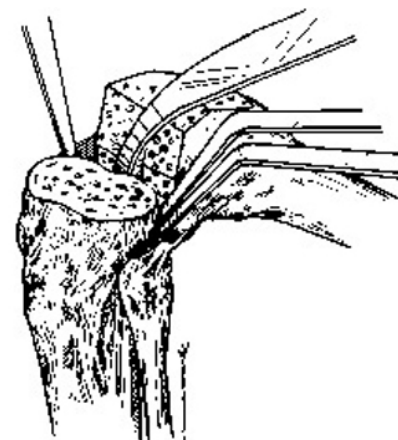
Fig. 15

If a viable PCL is present, it is left intact. If there is any question of its integrity or strength, it is sacrificed now rather than risk postoperative rupture. The tibia cut is performed using the proximal tibial alignment guide with the intramedullary adapter attached or the intramedullary tibial cutting guide.

Intramedullary Tibial Option

Reference Hole

Placement of the intramedullary guide is accomplished by first drilling a 5/16-inch hole in the proximal tibia. This reference hole should be centered from medial to lateral. Anterior/posterior positioning should fall between the middle and anterior one-third of the tibial plateau (Figure 16).
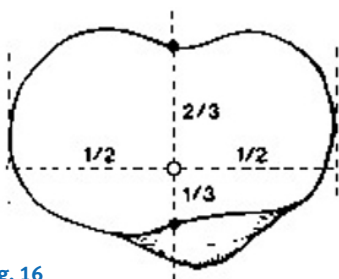

Fig. 16

Preoperative templating of the lateral tibial radiograph may assist in accurate location. The ¼-inch, fluted intramedullary rod is slowly inserted to locate the medullary canal.

The rod is removed and reinserted through the preassembled intramedullary guide consisting of the alignment guide with the saw guide and tibial stylus affixed (Figure 17).
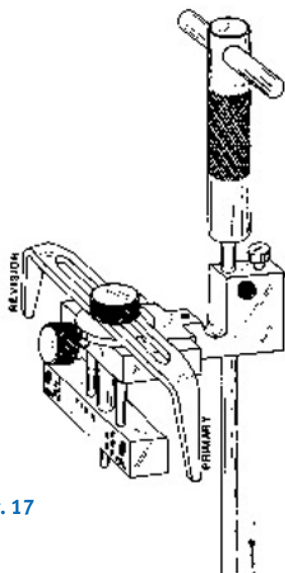
Fig. 17

Rotational Alignment

Rotation is selected based on any remaining landmarks, i.e., posterior tibial condyle, tibial tubercle and the malleoli of the ankle (if using extramedullary guide with intramedullary adapter) as in the primary technique. The most reliable landmark will be the tibial tubercle. The distal pin of the cutting block should be positioned just medial to the tibial tubercle (Figure 18).
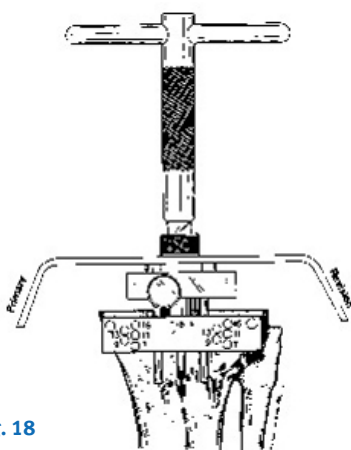
Fig. 18

As a second reference, the posterior surface of the cutting block should be parallel to the posterior edge of the tibial plateau if the bone is not deformed or deficient (Figure 19).
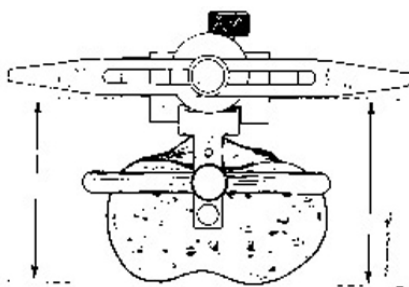

Fig. 19

Ideally, both references should be used. Rotation is then locked in place by impacting the set pin with a mallet (Figure 20). Additional stability can be obtained, if necessary, by drilling and pinning through the auxiliary hole located anteriorly.
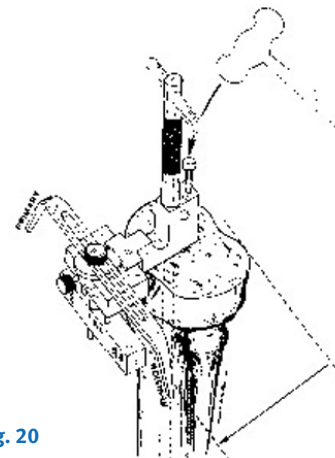

Fig. 20

Posterior Slope

No anatomical landmarks are usually remaining to select the posterior slope angle. The posterior slope is preset at 5 degrees by lining up the black line in the center of the tibial intramedullary guide with the back of the anterior swivel portion of the same instrument (Figure 21).
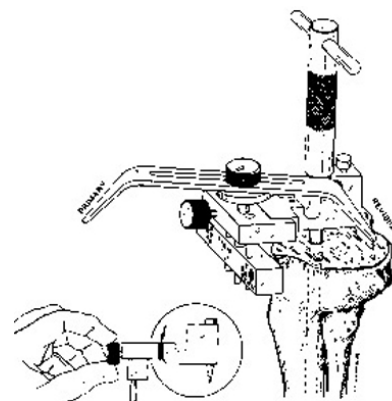

Fig. 21

Level of Resection

The "REVISION" end of the stylus is used to determine the tibial saw guide position for minimal resection of the proximal tibia (Figure 22).
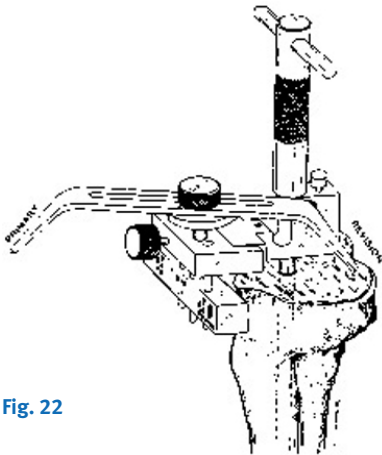

Fig. 22

This end of the stylus will position the tibial saw guide 1.5mm below the point of reference. If there is minimal difference in bone loss on the medial and lateral side, the tip of the stylus is placed on the lower side at a point which will allow at least one-half of the cortex on that side to contact the implant. A conservative bone-sparing cut is desired rather than trying to obtain a perfectly flat bone surface. If there is greater than 4mm difference in bone loss medial to lateral, the stylus tip is placed on the higher side and use of a tibial spacer is planned (See Tibial Spacer Preparation section).

The cutting guide is then stabilized by drilling and pinning through the 9mm medial and lateral holes of the cutting guide (Figure 23).
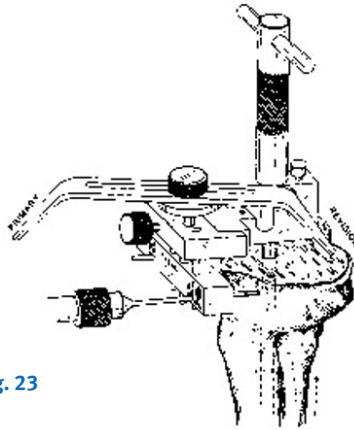
Fig. 23

This allows for 2mm adjustment proximally and 7mm distally. The lateral drill point is first placed after retracting the patellar tendon, followed by the medial drill point. If the medial drill point appears to "walk," this can be easily avoided by marking the entry point through the block, then drilling outside the block to pierce the cortex. Redrill the hole through the block. Disassembly of the jig is then achieved by removing the stylus and intramedullary rod. A slaphammer hole is located posteriorly on the guide to aid in removal of the intramedullary rod and jig, leaving the saw guide fixed to the anterior face of the tibia.

The tibial alignment checker and rod is placed on the tibial saw guide. The rod should pass through the center to no more than a few millimeters lateral to the center of the ankle (Figure 24a). The +2, -2 degree varus/valgus saw guide can be used if correction of the angle of the cut is necessary (Figure 24b).
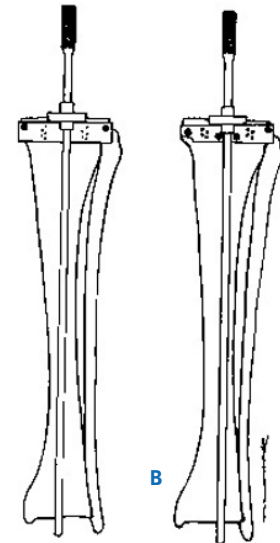

A   B

Fig. 24

Cutting the Proximal Tibia

A "free" saw blade or cutting gauge is placed on the tibial saw guide along the medial and lateral edge of the tibia to confirm the level of desired tibial resection. The saw capture is placed on the tibial saw guide. If it appears that an inadequate resection will occur, the level can be lowered by adjusting the tibial saw guide in 2mm increments. Angled retractors are used to protect soft tissue and ligaments.

The proximal tibia is cut with an oscillating saw with the appropriate saw blade for the saw capture (Figure 25).
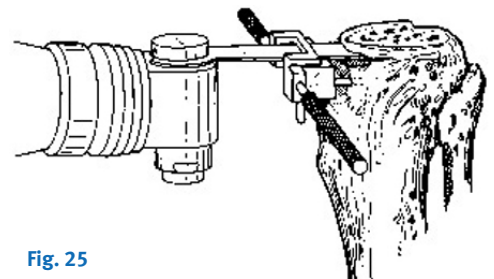

Fig. 25

Note: Saw blades especially designed for this system are recommended. The blades are 1-inch wide with a shank thickness of 35-thousandth (.035 inch) and 38-thousandth tooth offset (.038 inch), and will best match the saw guide and capture.

Proximal Tibial Baseplate Drill Guide

To avoid soft tissue impingement, the appropriate-size tibial baseplate drill guide is selected that completely fills but does not overhang the proximal tibia. The medial/central hole is drilled and filled. Final rotational alignment is referenced off the tibial tubercle with the handle of the guide just medial to the tubercle. It is then stabilized with six pins as the holes are drilled using the 1/8-inch by 5-inch drill bit (Figure 26).
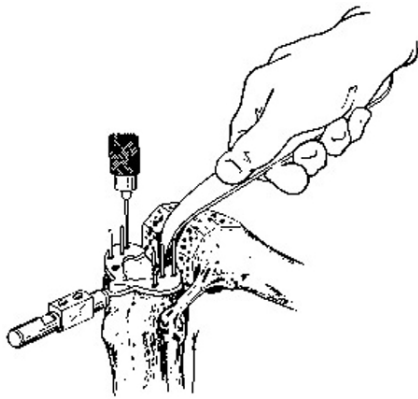
Fig. 26

The alignment of the tibial cut is again checked with the rod through the handle of the baseplate drill guide.

Tibial Stem Preparation

At this point a decision is required as to which type tibial component will be used. If minimal central tibial bone loss is present and the proximal tibial cortex

is mostly intact, a primary stemmed tibial baseplate or all-polyethylene tibial component may be used. The appropriate size and style tibial broach (size 00, 0, size 1, 2, or size 3, 4, 5) is applied to the proximal tibial baseplate drill guide and impacted into the bone (Figure 27).
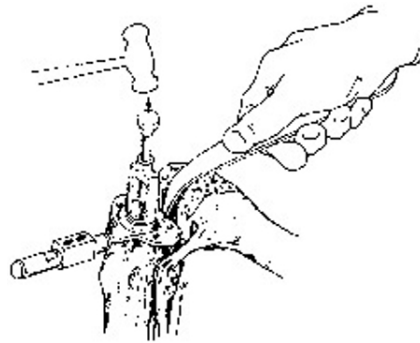
The broach is removed with aid of the slaphammer. If there is central tibial bone loss and/or a weakened or deficient proximal cortical rim, a revision tibial baseplate is preferred. The appropriate reamer guide (size 00 and 0, size 1 and 2, or size 3, 4 and 5) is selected to match the baseplate drill guide. The reamer guide (#1) alone with the reamer (#2) and handle (#3) (Figure 28a) is applied to the baseplate drill guide with the pin in the anteromedial hole (Figure 28b).
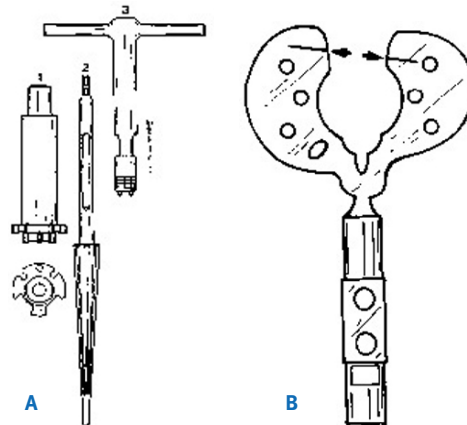
A   **B**

Fig. 28

Progressively larger reamers are used until the reamer's cutting edge can be felt engaging the tibial endosteal cortex (Figure 29).
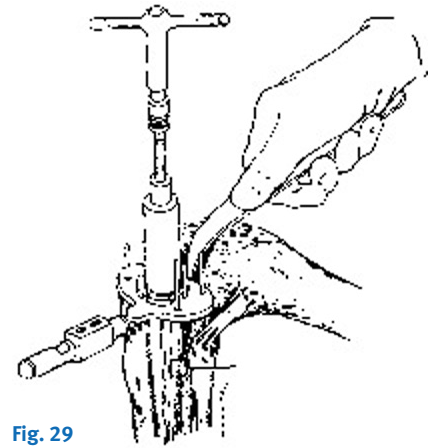
Fig. 29

The reaming is done with a power reamer or with the tibial reamer handle attached via a Zimmer-type fitting. In cases of excessive varus or valgus bowing of the tibia, a shorter stem is required to prevent malalignment of the tibial component as a result of stem impingement.

Tibial Trial Insertion

If a resurfacing tibial baseplate, primary stemmed tibial baseplate or all-polyethylene tibial component is to be used, the appropriate-size tibial baseplate trial is inserted. The trial may be left in place during preparation of the femur to protect the cut tibial surface. If a revision tibial baseplate is utilized, initial placement of a +4mm over a +14mm tibial baseplate is preferred since it will allow more exposure of the femur. The appropriate-length modular tibial stem is secured to the +4mm tibial baseplate with the screw. The pin on the trial tibial stem is placed in the right or left hole in the baseplate (Figure 30). The tibial trial baseplate and stem is driven onto the proximal tibial, lining up the pins in

the previously drilled holes (Figure 31). Attention at this point is directed to the femoral preparation.
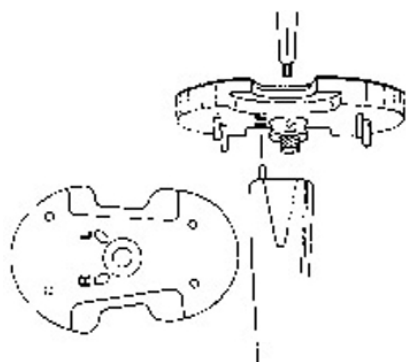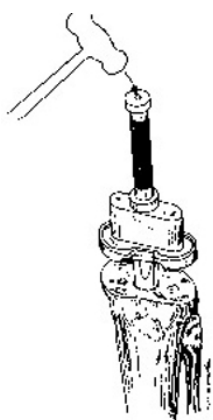

Fig. 30

Fig. 31

Femoral Medullary Canal Preparation

The roof of the intercondylar notch is identified. A starting hole is made with a 5/16-inch drill point and intercondylar drill guide just above the center of the intercondylar notch. The 5/16-inch intramedullary fluted rod is inserted into the canal. If use of a revision femoral component is anticipated from preoperative planning, the canal is then reamed with progressively larger femoral stem reamers starting with the 10.5mm reamer until cortical bone is contacted in the diaphysis (Figure 32).
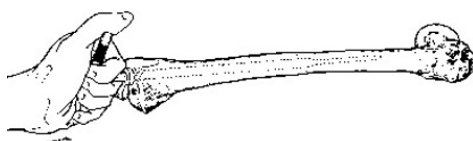
Fig. 32

Femoral Alignment and Distal Femoral Cut

The appropriate size femoral sleeve is attached to the distal femoral alignment guide with the 5/16-inch intramedullary fluted rod. The revision distal femoral saw guide is also attached to the distal femoral alignment guide (Figure 33).
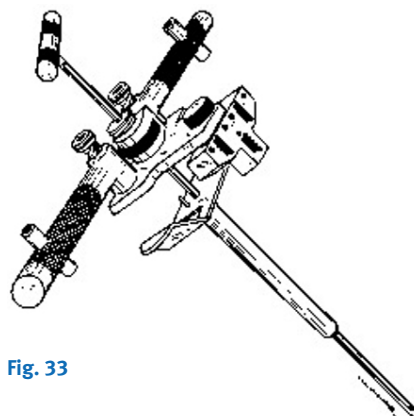
Fig. 33

The distal femoral alignment guide with sleeve is advanced until at least one side of the face of the guide is in contact with the distal femur. The adjustment screw is advanced to contact bone on the side opposite the more prominent distal femoral condyle. The distal femoral alignment guide is rotated to approximately the correct femoral rotation and then fixed with two free 1/8-inch x 5-inch pins passed through the cannulated adjustment screws. If the previous femoral component rotation was correct, the posterior condyle can be used as a reference, otherwise it is internally rotated 10 degrees from the femoral epicondylar line (Figure 34).
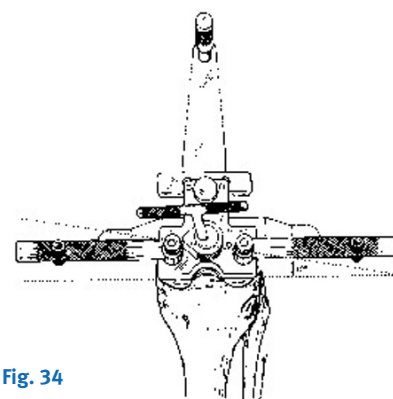

Fig. 34

Femoral Varus/Valgus Alignment Check

The extramedullary axial alignment guide can be used to double check the femoral varus/valgus alignment. The axial alignment rod should point toward the femoral head (Figure 35). Fine adjustments of the distal femoral alignment guide can be made by dialing the medial/lateral adjustment screw in or out if a large medullary canal is present.
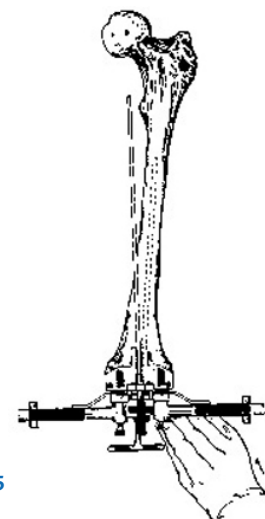

Fig. 35

Distal Femoral Resection

The cutting gauge is placed on the cutting surface of the distal femoral saw guide. If there is minimal distal femoral bone loss and use of a primary femoral component is indicated, the saw guide is dialed down to the least distal femoral cut. If there is more than 10mm of original distal femoral bone loss, use of a revision femoral component is indicated. The saw guide is dialed down to the previously marked level for the new distal femoral resection level based on preoperative planning. The saw guide is stabilized by using 1/8-inch by 3-inch pins on the medial and lateral side and one proximally (Figure 36).
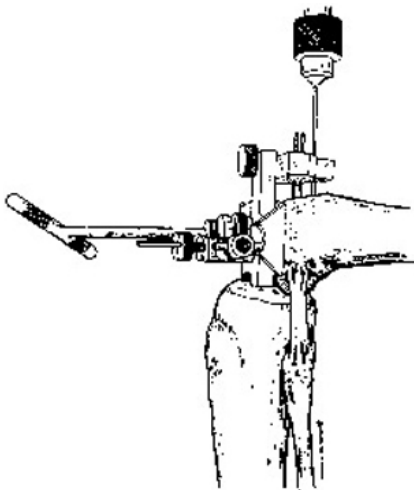
Fig. 36

The distal femoral alignment guide is now removed by loosening the thumb screw, leaving the saw guide on the distal femur. If more or less bone resection is desired, the saw guide (Figure 37) is advanced proximally or distally in 2mm increments by moving the saw guide on the smooth stability pins.

The distal femur is now cut by inserting an oscillating saw with the appropriate

blade thickness through the saw capture (Figure 38). After the saw capture is removed, the cut is checked for flatness with an auxiliary cutting block. The distal femoral saw guide is removed along with the 1/8-inch pins.
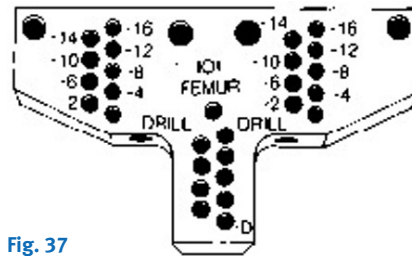
Fig. 37
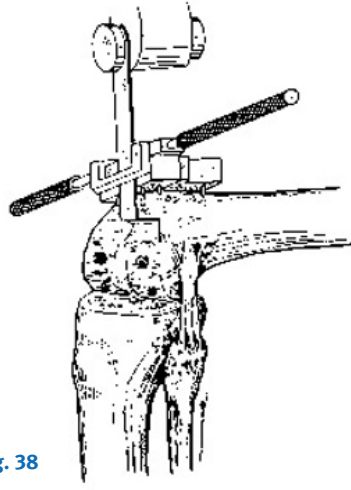
Fig. 38

Anterior/Posterior and Chamfer Cuts

Revision Femoral Component

If there is minimal distal femoral bone loss (less than 10mm), use of a primary femoral component can be considered. If there is greater than 10mm of original distal femoral bone loss, a revision femoral component is used. Based on the last revision femoral reamer size used, the appropriate size femoral stem trial is threaded into the appropriate size

revision anterior/posterior chamfer saw guide. The saw guide should match the size femoral component determined from preoperative templating. Alternately, femoral trials can be held up against the distal femur to see which size best fits in the medial/lateral dimension. The knee is flexed to 90 degrees and the previously balanced collateral ligaments are placed under tension with the ligament tensor device (See Soft Tissue Balancing section).

The revision anterior/posterior chamfer block is impacted onto the distal femur parallel with the tibia (Figure 39).
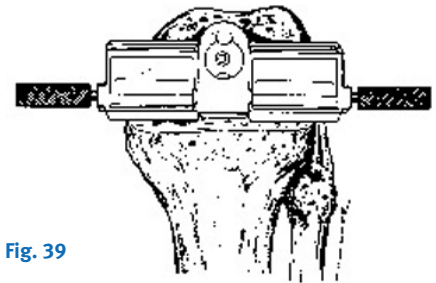

Fig. 39

The four pins on the face of the jig are impacted into the distal femur. A cutting gauge is placed through the anterior slot in the block to confirm sizing and ensure that anterior femoral notching will not occur.

The ligament device is removed. The anterior, posterior and anterior chamfer cuts are made through the block (Figure 40a, 40b and 40c). The appropriate-size femoral stem trial is attached to the femoral boss reamer and inserted into the femoral canal to ream for the femoral boss (Figure 41).
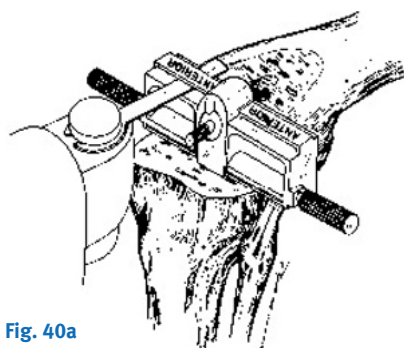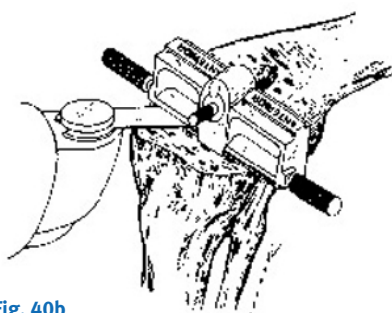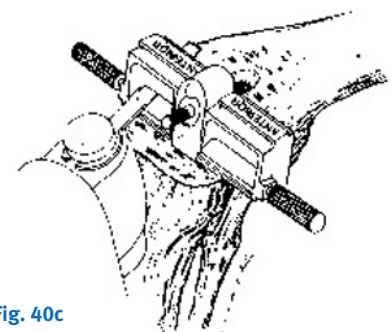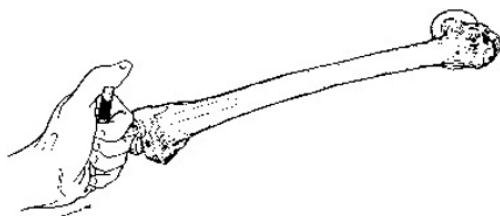
Fig. 40a

Fig. 40b

Fig. 40c

Fig. 41

Trial Reduction

A flat or congruent tibial insert trial of the estimated thickness and appropriate size to be used with the baseplate is inserted. To avoid a false sense of stability, this step should be performed even if an ultracongruent or PS insert is planned. If a primary femoral component is being used, the appropriate primary femoral trial is impacted onto the distal femur and checked for fit. If a revision femoral component is to be used, the appropriate revision femoral trial is assembled with the appropriate length and diameter femoral trial stem (Figure 42) and any spacers required (see Femoral Augmentation Spacer Section).
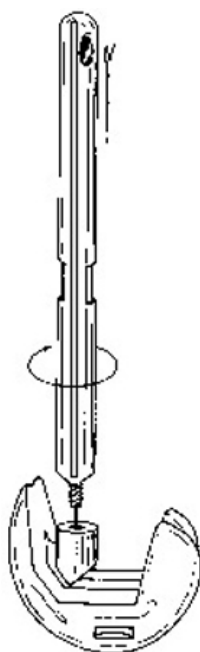
Fig. 42

The knee is then checked for stability in flexion with the patella reduced. If the knee is loose, progressively thicker tibial insert trials are placed until the flexion space is adequately tensed (Figure 43). If a very thick tibial spacer is required or more replacement is needed, the +4mm tibial baseplate trial can be removed and a +14mm revision tibial baseplate trial with stem trial inserted.
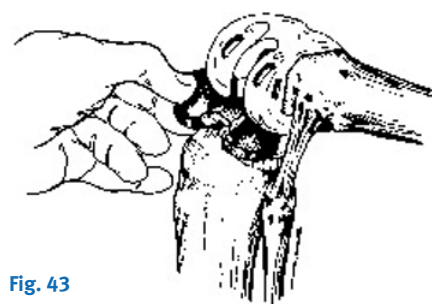

Fig. 43

The knee is then taken into extension. If laxity in extension is present, the femoral component has been placed too proximal. If a primary femoral component trial is present, the distal femur is recut for a revision component. If a revision femoral component trial is present, femoral spacers are applied to both the medial and lateral side of the femoral trial in 4mm increments until the extension space tension equals the flexion space. Since the inner box geometry of the spacers matches the inner box geometry of the revision femoral component, no additional bone cuts are needed.

If the knee cannot come into full extension, more distal femur will need to be resected. The revision distal femoral saw guide is reapplied to the distal femur using the more distal holes in the saw guide. Approximately 4 degrees extension per millimeter of additional resection can be obtained. The new distal femoral resection is performed, followed by the anterior, posterior and chamfer cuts with the revision anterior/posterior-chamfer block. The trial femoral component is reapplied and the knee checked again for full extension.

The knee is also checked for medial/lateral imbalance. If present, the collateral ligaments are released or tightened as necessary. The knee is also checked for excessive posterior laxity. If laxity is present, an ultracongruent insert trial or posterior stabilized component trials are inserted and the knee is taken through a range of motion.

The *Natural-Knee* universal impactor/extractor (Figure 44a) or slaphammer extractor can be used to remove the femoral trial (Figure 44b) and the slaphammer/extractor used to remove the revision tibial baseplate trial (Figure 45).
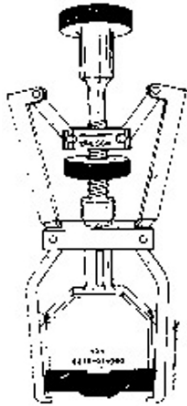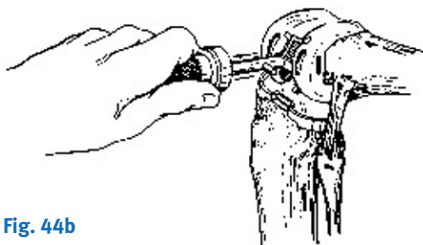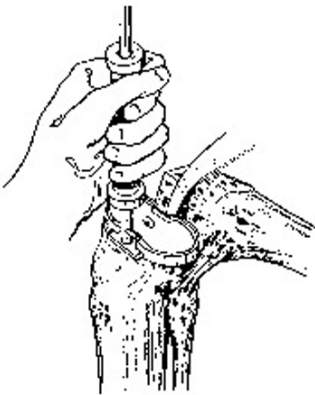

Fig. 44a

Fig. 44b

Fig. 45

Patellar Preparation

The patella caliper is used to measure the existing patellar thickness (Figure 46). This measurement is compared to the preoperatively-determined patellar thickness which usually ranges between 20mm and 26mm. The amount of additional bone resection required to reproduce the normal patellar height with either a 7mm or 10mm patella is determined. If enough patella exists, the patella osteotomy guide is applied to the patella parallel to the dorsal surface with the stylus set to the desired additional bone resection (Figure 47). The patella is then cut using an oscillating saw. If use of a metal-backed patella is desired, 3mm less bone is resected. This will allow countersinking of the metal edge. The patella size is selected using the patella sizing template (Figure 48).
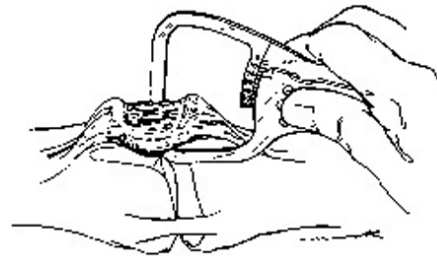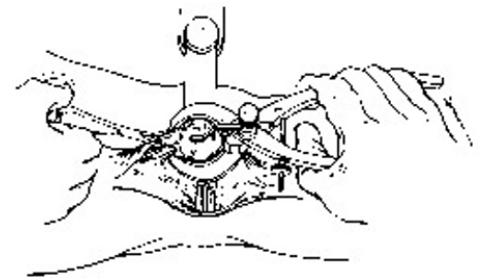

Fig. 46
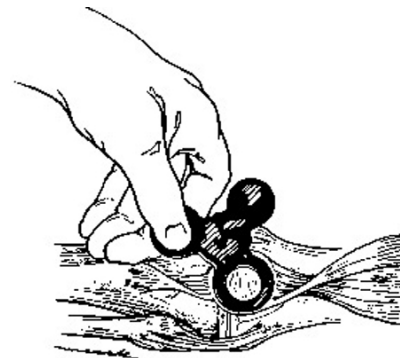
Fig. 47

Fig. 48

The appropriate-size patellar bushing is applied to the patella 3mm to 4mm medial to the midpoint. The bushing is affixed to the parallel patella clamp (Figure 49).
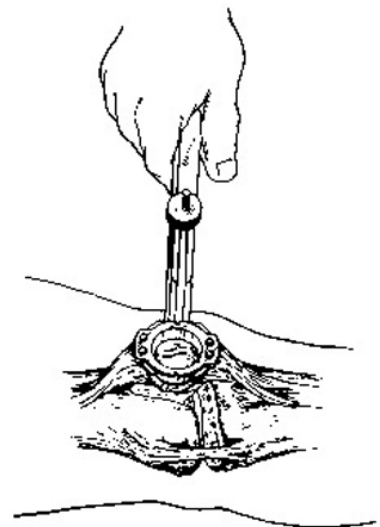

Fig. 49

The same size patellar reamer is used to smooth the surface if the all-polyethylene component is to be used; an additional 3mm of bone must be reamed to allow countersinking if the metal-backed patellar component is used (Figure 50). The patella drill guide is inserted into the patella bushing. For the metal-backed patella component, the 1/8-inch drill holes are drilled and filled successively with 1/8-inch by 5-inch

smooth pins. The 3/16-inch patellar stop drill is used for the all-polyethylene patellar components.
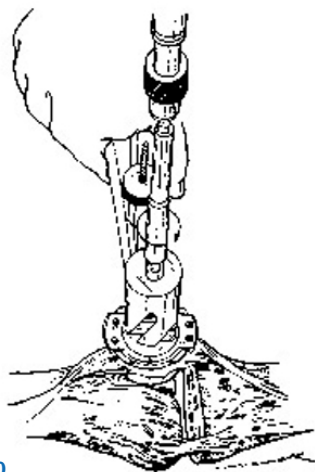

Fig.50

Patellar Trial

The appropriate-size and style patella trial component is applied to the patella. The composite is checked for overall thickness. The knee is then taken through a range of motion. Ideally, the patella component should track independent of any downward force from the surgeon. If subluxation or tilting occurs, a lateral retinacular release is necessary. If patella impingement on the anterior edge of the tibial component occurs, an extended tibial tubercle osteotomy with proximal advancement can be considered.

Implantation of Components

Warning: Zimmer recommends that Natural-Knee II porous tibial baseplates used without bone cement and with supplemental screw fixation be used with tibial articular surfaces manufactured from highly crosslinked polyethylene.

Tibial Component

If an all-polyethylene tibial component is being used, the bone surface is cleaned with water lavage. The all-polyethylene tibial component and stem are cemented in place. If a porous resurfacing or stemmed baseplate is desired, the implant is impacted into place after coating with cement. Two optional 6.5mm by 50mm cancellous screws are placed medially and laterally. The screws are directed along the inner tibial cortex, not through the cortex, for maximal purchase. If the screws lack sufficient purchase, "match stick" pieces of cancellous bone are placed into the screw hole prior to screw placement.

If a revision tibial baseplate with stem is to be used and central bone loss exists, a trial stem can be used to pack cancellous bone around the stem to fill
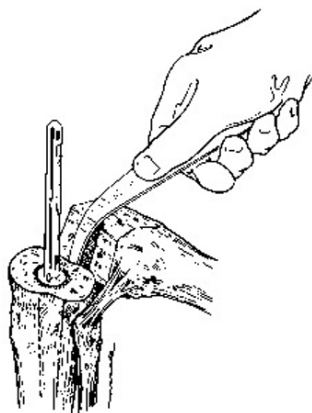

Fig.51

Fig.52

the defects. A femoral stem trial can be threaded to the tibial stem trial for handling (Figure 51). The appropriate-size tibial stem is then driven onto the Morse taper of the baseplate (Figure 52).

The revision tibial implant and stem are then impacted into place (Figure 53). Two optional 6.5mm by 50mm cancellous screws are placed into the medial and lateral sides for additional fixation (Figure 54).
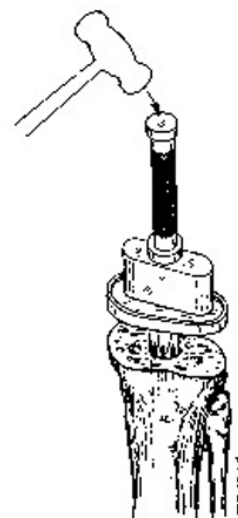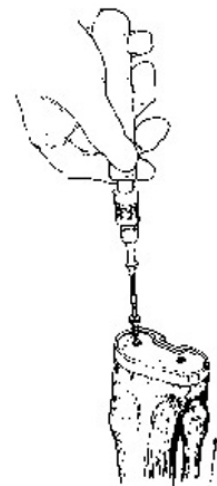

Fig.53

Fig.54

The appropriate-size and thickness congruent, ultracongruent or posterior stabilized all-polyethylene insert is then impacted onto the tibial baseplate with the aid of the tibial insert impactor (Figure 55).
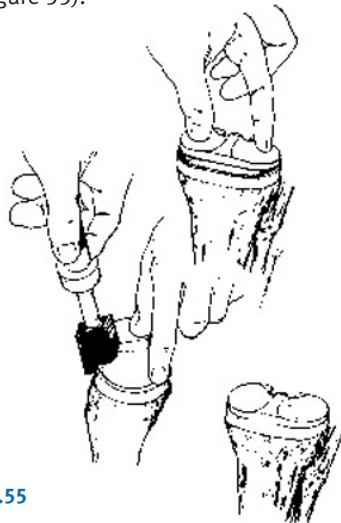

Fig.55

Implantation of the Femoral Component

After coating with cement, a porous or nonporous primary femoral component is impacted in place with the femoral impactor. Cement is also digitally pressurized into the cut bony surface. If a revision femoral component is being used, the appropriate-size stem is impacted onto the femoral component with the revision femoral stem impactor and further secured with the locking screw utilizing a hex-head screwdriver (Figure 56a). An all-polyethylene screw plug is then inserted over the screw head (Figure 56b). After coating with cement, the revision femoral component with stem is impacted into place utilizing the universal impactor/extractor tool or the femoral impactor.

A   B
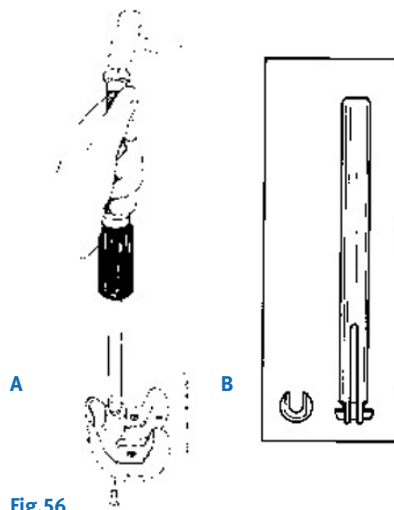
Fig.56

Implantation of the Patellar Component

Prior to implantation of the metal-backed patella, take a small amount of the rim away on each side with a ronguer to create "windows." The patellar component is implanted into place with the patella inserter (Figure 57). Cement is applied to the all-polyethylene or metal-backed implant prior to insertion. When the metal-backed patella component is implanted, full seating of the implant into the countersunk area is confirmed through the "windows" in the countersunk bone.
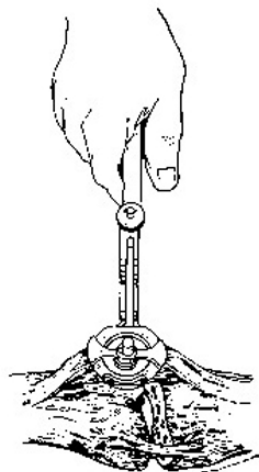

Fig.57

Closure and Postoperative Care

A final check of range of motion, alignment and stability is performed. At this time, check for any loose cement or bone fragments, particularly in the posterior compartment. The knee is taken through a range of motion to observe patella tracking. A lateral release should be done if the patella tends to track laterally. Attempts are made to save the lateral superior geniculate artery. Most knees will not require a lateral release with this anatomic replacement. It is preferred to release the tourniquet prior to closure and obtain hemostasis via electrocautery. Insertion of a large (1/4-inch) drain is recommended for 48 hours. The quadriceps and patellar fascia are closed in layers with interrupted sutures.

Postoperative Care
A surgical support stocking or a Jones bulky compressive dressing is applied and continuous passive motion begun in the recovery room. Depending on the quality of bone present, weight bearing is restricted from 20 pounds to 50 percent weight bearing for 6 weeks. A cane is used until good quadriceps strength is achieved and no extension lag is present. Hinged bracing is used for 3 months only if ligamentous repairs or advancements were performed.

Primary Femoral Component/Anterior Referencing Guide

(When using a Primary Femoral Component in a Revision Case)
If there is minimal distal femoral bone loss (less than 10mm), use of a primary femoral component can be considered. In this situation, the anterior referencing distal femoral drill guide can be used.

The anterior stylus is secured on the anterior-referencing distal femoral drill guide for the size femoral component needed, as determined from preoperative radiograph templating. The knee is placed in 90 degrees of flexion and the previously balanced collateral ligaments are placed under tension with the ligament tensor device. The anterior-referencing distal femoral drill guide is fixed to the distal femur with the anterior stylus against the anterior femoral cortex and the posterior surfaces rotated parallel to the proximal tibial (Figure 58). Correct sizing can be confirmed with a cutting gauge through the medial and lateral slots (Figure 59). The 1/8-inch holes are drilled and filled and the two peg holes are drilled with the ¼- inch drill (Figure 60).
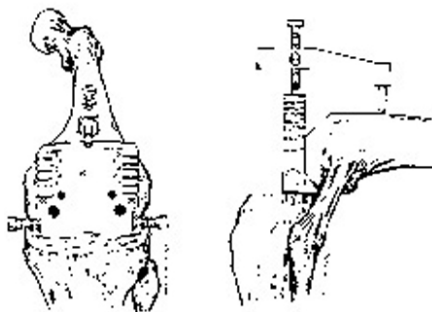
Fig.58
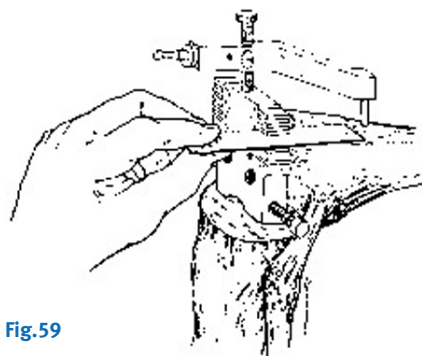
Fig.59
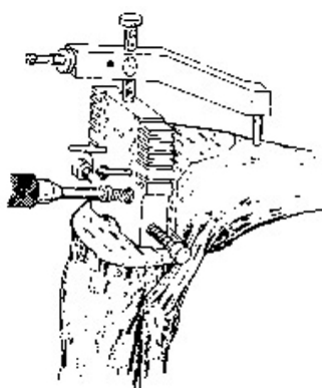
Fig. 60

The appropriate-size primary anterior/ posterior saw guide is impacted onto the distal femur. The anterior and posterior femur is cut using the saw capture while protecting the collateral ligaments with retractors (Figure 61). Next, the appropriate-size primary chamfer block is impacted onto the distal femur and is used to make the anterior and posterior chamfer cuts and the trochlear notch cut (Figure 62).
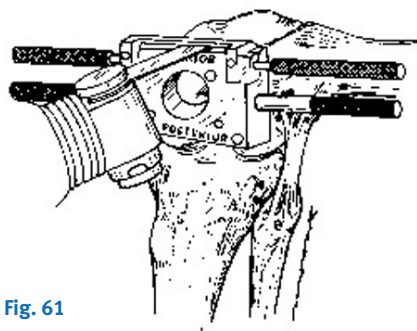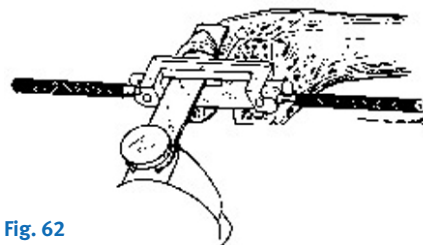

Fig. 61

Fig. 62

Posterior Stabilization

If a posterior stabilized implant is desired, the modular posterior stabilized bar trial is inserted into the femoral trial with a hex head screwdriver. The femoral stem trial is attached to the revision femoral boss reamer and the intercondylar notch reamed to accept the femoral component stem boss (Figure 63). The femoral trial assembly is then impacted onto the distal femur.
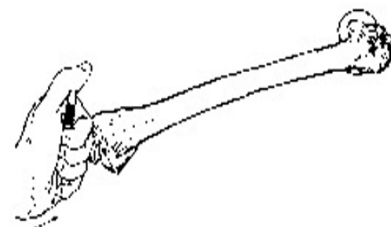

Fig. 63

If a posterior stabilized implant is being used, the posterior stabilized router assembly is pressed against the femoral trial. With the pins in the tracks of the trial, a small amount of intercondylar bone is removed to accommodate the spine of the tibial insert. While continuing to apply downward pressure, begin moving the PS guide/bit assembly in a posterior direction until the route guide stops. Repeat this action in the anterior direction (Figure 64a). This anterior/posterior sweeping motion may be repeated until all of the intercondylar bone has been removed (one or two times is usually sufficient to remove all of the bone).

The modular posterior stabilizer bar trial is inserted through the condyles of the revision femoral trial (Figure 64b), the PS insert trial inserted and the knee taken through a range of motion (Figure 64c).

The modular posterior stabilized bar implant is inserted into the femoral component across the femoral condyles with the PS bar torque wrench (Figure 64d).
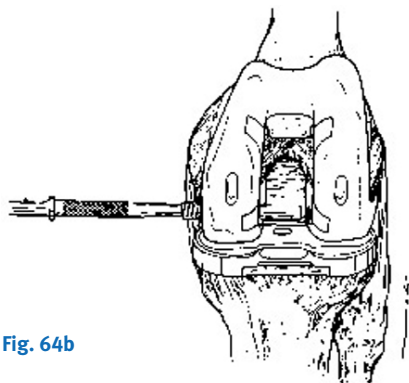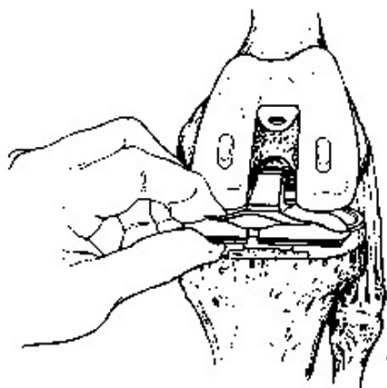
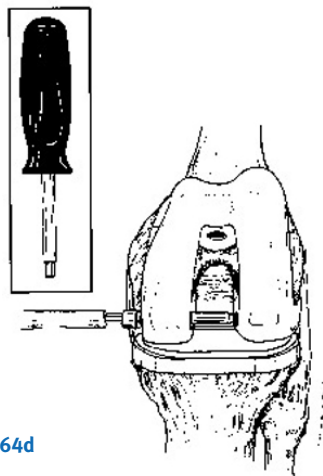

Fig. 64a

Fig. 64b

Fig. 64c

Fig. 64d

Tibial Spacer Preparation

If a tibial spacer is required and after standard preparation of the proximal tibia, the spacer cutting guide and alignment plate are assembled for size 00, size 0, sizes 1 and 2, or sizes 3, 4 and 5 tibias. The assembly is set for medial or lateral, and left or right, using the reference marks on the end of the spacer alignment plate. The alignment plate is stabilized using three smooth pins (Figure 65) placed through the drill holes in the nondefective tibial plateau surface previously drilled with the proximal tibial drill guide.
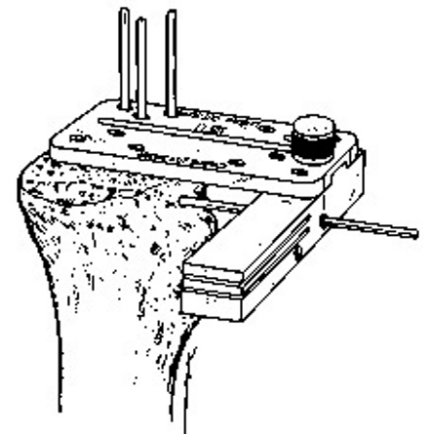
Fig. 65

For added stability, at least one pin is placed through one of the holes located anteriorly on the spacer cutting guide.

A vertical osteotomy is made using a calibrated 1-inch wide saw blade. This saw cut is approximately 4mm or 8mm deep depending on the size of the defect (Figure 66).
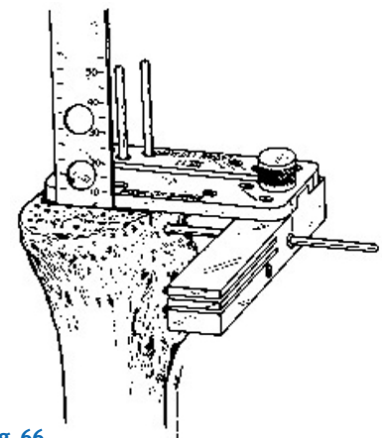

Fig. 66

A free saw blade is left imbedded in the bone to act as a protector to avoid undercutting the uninvolved tibial plateau surface when the horizontal osteotomy is performed.

The horizontal portion of the step cut is then made through the 4mm or 8mm slot (Figure 67), depending on the size of the defect.

The appropriate size, thickness and side trial tibial spacer is applied to the appropriate size baseplate trial and the proximal tibia (Figure 68).

The tibial spacer implant is either cemented to the tibial baseplate allowing placement of a cancellous screw through the spacer or mechanically fixed with the screw and lug (Figure 69), thus eliminating the possibility of screw fixation on that side.
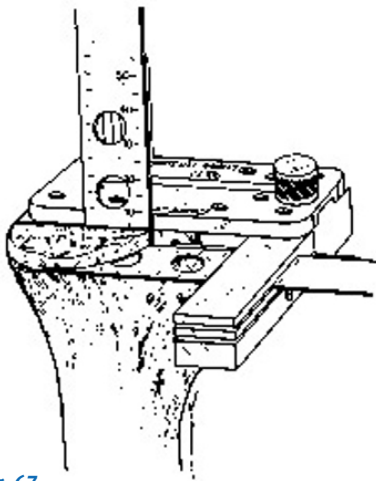
Fig. 67
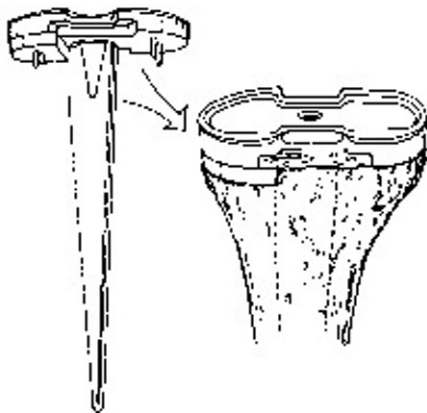
Fig. 68
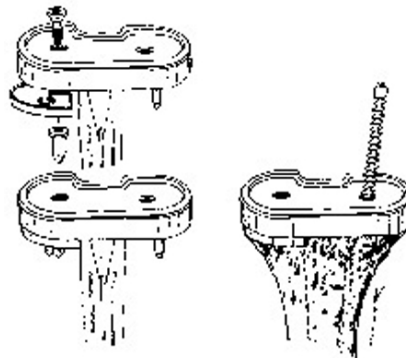
Fig. 69

Femoral Augmentation Spacers

If there is marked asymmetrical distal femoral bone loss, use of a femoral spacer is indicated. The distal femoral saw guide is first stabilized at the "drill" holes to make the resection on the least-involved condyle (Figures 70a and 70b). After the initial resection on the least affected side, the saw guide is moved proximally in 4mm increments to a maximum of 12mm for sizes 0 to 5 and a maximum of 8mm for size 00. The affected condyle of the femur is then cut (Figures 70c and 70d). The cuts are checked for flatness with an auxiliary cutting block after the saw capture is removed. The distal femoral saw guide is removed along with the 1/8-inch pins.
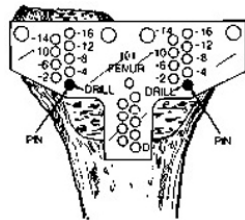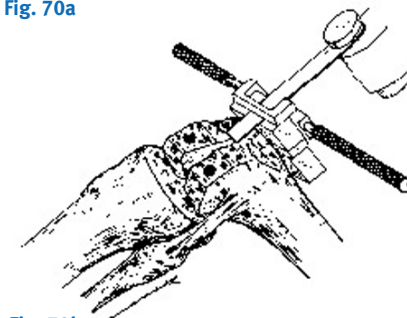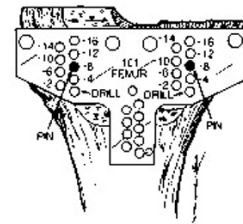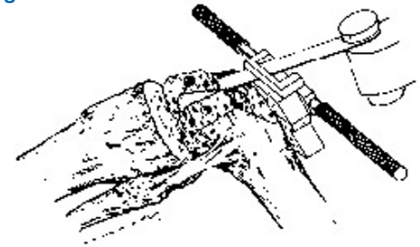

Fig. 70a

Fig. 70b

Fig. 70c

Fig. 70d

One side of the revision anterior/posterior chamfer block is allowed to slide onto the bone on the side prepared for a spacer (Figure 71). The anterior, posterior and anterior chamfer cuts are made through the block.
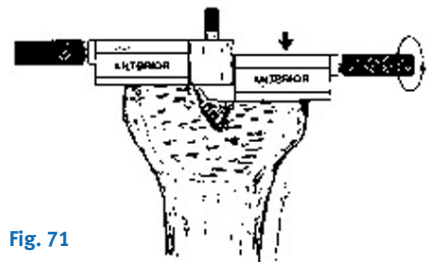

Fig. 71

The femoral spacer trial is mechanically fixed to the femoral trial by manually screwing the lug trial into the femoral trial and then tightening it with the femoral torque wrench (Figure 72a). The lug trial acts as a broach for the lug implant. The femoral spacers are mechanically fixed to the femoral component, with or without cement, by tightening the lug with the torque wrench (Figure 72b). The femoral component and spacer composite are impacted into place utilizing the universal impactor/extractor tool or the femoral impactor (Figure 73).
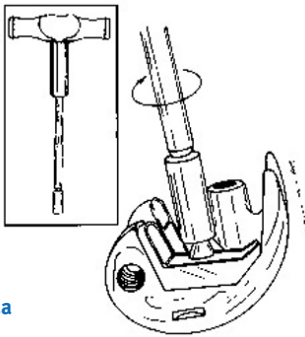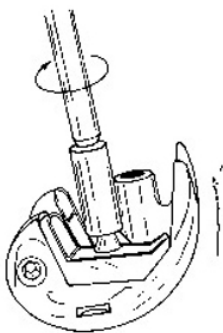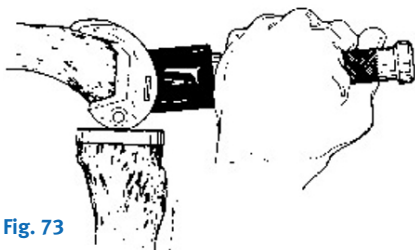

Fig. 72a

Fig. 72b

Fig. 73

Intramedullary/Extramedullary Tibial Adapter

The starting point for the tibial intramedullary adapter is centered on the tibial plateau from medial to lateral. The correct anterior/posterior position can be determined from preoperative templating of the lateral tibial radiograph but is usually a point approximately one-third from the anterior cortex and two-thirds from the posterior cortex (Figure 74). The 5/16- inch drill is used to open the medullary canal if necessary.
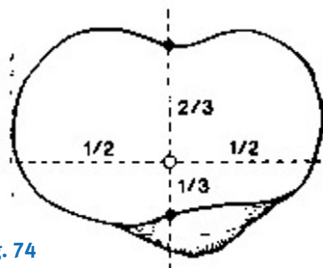

Fig. 74

The tibial saw guide, tibial stylus and tibial intramedullary adaptor with built-in 5 degree posterior slope are assembled to the proximal tibial alignment guide (Figure 75). The 5/16- inch fluted intramedullary rod is inserted through the intramedullary adaptor. The ankle cradle is placed against the anterior tibial crest just proximal to the ankle. The ankle cradle position and proximal tibial alignment guide length is secured.
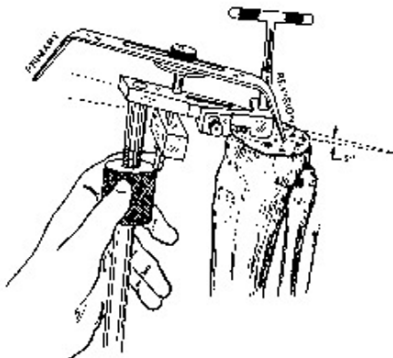

Fig. 75

Rotation is selected based on any remaining landmarks, i.e., posterior tibial condyle (Figure 76), tibial tubercle (Figure 77) and the malleoli of the ankle (Figure 78) as in the primary surgical technique.
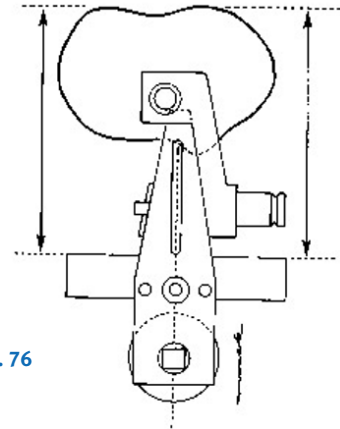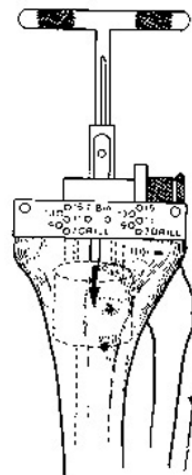

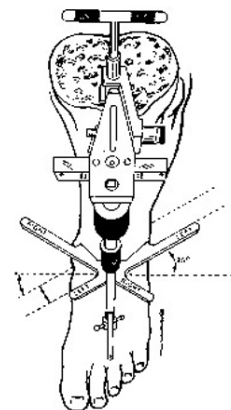**Fig. 76**

Fig. 77

Fig. 78

Tibial Bulk Bone Grafting

The surgeon may prefer to use a bulk bone graft instead of a metal spacer. Bulk bone grafts smaller than 1cm lack structural integrity and should be avoided. The best material for bulk bone grafts include fresh-frozen allograft femoral heads and distal femoral condyles and autograft bone from the contralateral tibial condyle resection.

Bone grafts do best when loaded under compression, so the tibial defect should be first cut perpendicular to the mechanical axis. Use of spacer instrumentation or lowering the tibial saw guide will accomplish this. Squaring off the tibial defect and the bulk bone graft material will also allow better hostgraft bone apposition for healing. The graft is then secured temporarily while the tibial saw guide is brought back up to the level of the opposite tibial condyle resection (Figure 79). The proximal surface of the graft is then cut flush with the opposite condyle. The graft is permanently fixed with one or two screws placed vertically through the graft into the host bone, either outside the tibial baseplate or though it.

Fig. 79

Distal Femoral Bone Grafting

Certain defects may require bone grafting. The distal femoral saw guide is used to make a perpendicular cut through the distal femur on the defect side. The bone graft is also cut, the flat surfaces apposed, and the graft secured temporarily with obliqued Kwires (Figure 80). The other femoral jigs are applied and the remainder of the femoral cuts made. The graft is then fixed to the host bone with cancellous bone screws.
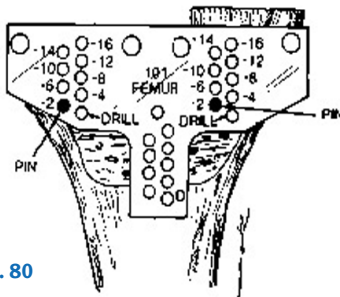

Fig. 80

Soft Tissue Balancing

Collateral Ligament Balancing

The ligament tensor device or two lamina spreaders can be placed between the tibial baseplate and the distal femur with the knee in full extension. The medial and lateral sides are distracted with equal tension (Figure 81). The height of the medial and lateral joint spaces should be equal. If imbalanced, but with a difference less than 1cm, the collateral ligament on the correct side should be released. If the imbalance is greater than 1cm, the lax collateral ligament should be advanced.
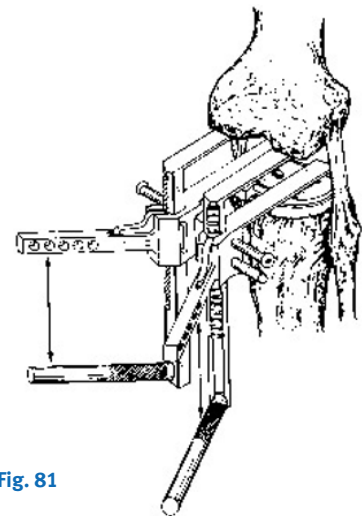

Fig. 81

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