TOTAL
JOINT
ORTHOPEDICS

KLASSIC® KNEE SYSTEM | KLASSIC ONE®

SURGICAL TECHNIQUE MANUAL:
MEASURED RESECTION

EFFICIENCY BY DESIGN®

TABLE OF CONTENTS

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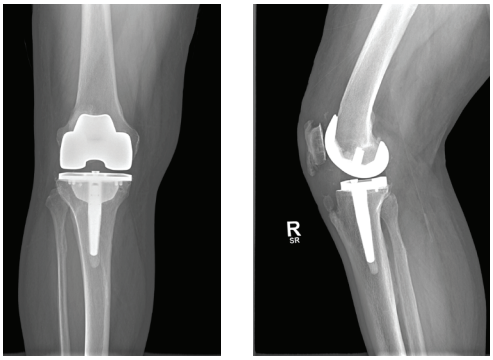


The Klassic® Knee System with a 50mm Stem Extension; radiograph courtesy F. Johannes Plate, MD, PhD

KLASSIC® DESIGN

The Klassic® Knee System is a modern universal design that offers an Evolution of Stability® to restore natural kinematics that will accomodate a variety of patient anatomy.[1] Streamlined instrumentation requires a maximum of two trays, minimizing operating room turnover time and reducing sterilization costs.[2]

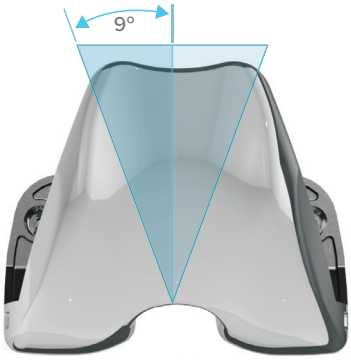
A spectrum of options provides the flexibility to progress the level of stability from a cruciate-retaining primary knee to a maximally stabilized revision within one efficient family of instrumentation. The Klassic ONE® offers an innovative design allowing up to 90% of cases to be performed with one tray, no pre-op imaging, disposables, or customization required.

The Klassic® Knee is a posterior-referencing system that seamlessly accomodates a variety of surgical workflows, from a measured resection to a gap balancing technique. This manual describes a measured resection approach for all products within the Klassic® Knee family; please refer to the Klassic® Knee System with Klassic ONE® Surgical Technique Manual: Gap Balancing for a gap balancing approach.

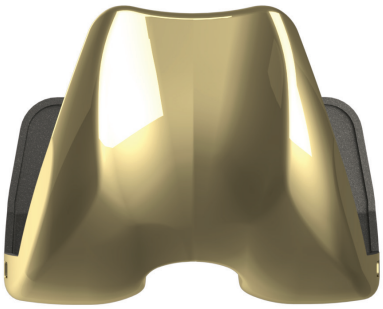
The Klassic® Knee System is designed to replicate the patient's natural anatomy by using measured resection, which references the least affected portion of the femoral condyle, the least-affected portion of the tibial plateau, and the thickest portion of the patella. Replacing bone millimeter for millimeter with the implants restores bony anatomy, near-normal kinematics, and rotational stability throughout the range of motion.[3]

Since the normal posterior tilt of the tibia is not a constant angle (it ranges from 4-12°), the tibial cut should be adjusted in order to reproduce each patient's normal posterior slope. If the posterior slope is fixed or if the tibia is cut perpendicular to the tibial shaft axis, the normal kinematics of the knee may not be simulated. The Klassic® Knee System includes adjustability for the tibial cut to be made parallel to the joint line on the anterior-posterior plane in order to reproduce each patient's natural posterior slope and to avoid cam impingement or laxity throughout the range of motion. Cutting the tibia parallel to the patient's natural posterior slope has also been shown to improve compressive strength of supporting bone by up to 40% versus a cut perpendicular to the tibial shaft axis.[4] If the tibial cut closely matches the anatomic posterior slope, anterior subsidence may be avoided.

The Klassic® Tibial Baseplate is designed to optimally cover the tibial plateau using universal geometry. The M/L edges of the Tibial Baseplate and Inserts have matching conforming geometry to provide consistent polyethylene thickness all the way to the peripheral edges.[5-7]



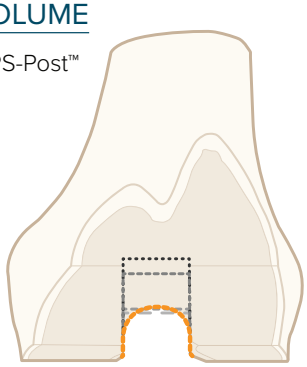
A 9° double Q-angle optimizes patellar tracking on both left and right anatomy



Klassic® Femur with Aurum® Technology

RESECTION VOLUME

- TJO Klassic® PS-Post™
- Persona
- Attune
- Triathlon
- Vanguard



The low volume anatomical resection of the Klassic® PS-Post™ is an industry-leading design for bone conservation[10]

KLASSIC® IMPLANTS

The Klassic® Knee system is designed from first principles to restore patient mobility and let them return to their favorite activities while providing an efficient surgical experience that allows the surgeon to concentrate on the patient and reduce costs.

The patented[8] Klassic® Femur has a unique deepened trochlear groove that allows optimal patellar tracking along a 9° double Q-angle for both left and right anatomy while retaining a neutral outside profile of the anterior flange.[9] Features include anatomically tapered posterior condyles, a proportional AP/ML ratio, and an optimized bone-covering geometry that minimizes potential lateral overhang. The Klassic® Femur is compatible with both cruciate-retaining CR/Congruent and the PCL-sacrificing Ultra-PS® Inserts.

The Klassic® Femur with Aurum® Technology features the same patented geometry and articulation as the Klassic® Femur, and offers a revolutionary ballistically bonded Titanium Nitride surface to provide a premium implant without the deliberate addition of common metal sensitizers such as Nickel, Cobalt, and Chromium.[32]

The Klassic® PS-Post™ Femur includes a post-and-cam mechanism to create femoral rollback during high flexion while interacting with the articular surface of the insert to provide stability through the entire range of motion. Additional varus/valgus stability may be achieved by using the Klassic® PS-Max® Insert and may be supported with augments and stems.*

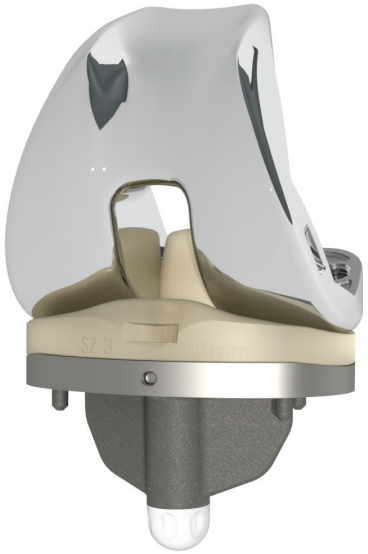
The low-profile box cut is prepared with an industry-leading anatomical resection to conserve bone and eliminate stress risers while supporting a 14mm minimum jump height.[10] The Klassic® PS-Max® Insert shares the same femoral footprint, allowing additional stability without removing additional bone. Modular Pegs are available to provide additional rotational stability if desired.

All femoral cuts and peg locations are shared between the Klassic® PS-Post™ Femur and the Klassic® Femur, so decisions on articulation type may be made or changed intraoperatively at any time before cutting the intercondylar box.

The Klassic® Porous Femur features Cobalt 3D®, an ultraporous, three-dimensional sintered porous coating for biological fixation and bony ingrowth.[11] The femoral pegs are uncoated to prevent stress-shielding while increasing stabilization.

The titanium Klassic® Tibial Baseplate is offered in both cemented or cementless options and is modular to allow for stem extensions in both primary and revision cases. The Baseplate offers a central stemmable keel and four peripheral pegs for mechanical fixation and rotational stability.[12,13] Stems are available to provide additional stability in primary cases, if needed, or for heavier patients.[14,15]

The Klassic® Porous Knee with optional 25mm Stem Extension



The Klassic® PS-Post™ Knee

The Klassic® Tibial Baseplate is designed to optimally cover the tibial plateau using a universal geometry. The M/L edges of the Tibial Baseplate and Inserts have matching conforming geometry to provide consistent polyethylene thickness all the way to the peripheral edges. A smooth proximal surface combines with an aggressive locking mechanism to minimize polyethylene wear.[16,17]

The Klassic® Porous Tibial Baseplate features Ti-Coat®, an ultraporous, three-dimensional sintered porous coating. The pegs are uncoated to decrease stress-shielding, sized to allow for an incremental amount of press-fit, and elongated to provide additional fixation.

The Klassic® All-Poly Tibia is available in both cruciate-retaining and Ultra-PS® options. It features a roughened backside surface and dovetail pockets for cement fixation, and a swept-back keel with an elongated stem for stability.

The Klassic® Knee System offers traditional post-and-cam, ultra-congruent, and cruciate-retaining insert options.

The Klassic® PS-Post™ Insert was designed to provide smooth articulation across the range of sizes. The PS-Post™ achieves a low-velocity interaction between the post-and-cam in deep flexion by optimizing the J-Curve and insert conformity. During roll-back, cam engagement is low on the post to reduce cyclic stress on the contact areas and to increase jump height during high flexion. The enhanced congruity of the anterior condyle offers outstanding mid-flexion stability until the post-and-cam engagement initiates rollback.[18]

The Klassic® PS-Max® Insert requires no additional preparation and offers the same low velocity interaction in deep flexion. The more substantial post provides increased varus/valgus stability while maintaining the kinematics of the PS-Post™.

The Ultra-PS® Insert provides a high anterior jump height and increased conformity to provide stability through a range of flexion without a post-and-cam design.

Klassic® Tibial Insert sizes are matched one-to-one with tibial/femur sizes to maximize congruency and enhance mid-flexion stability while maintaining the flexibility to be compatible one size up or down. The posterior lip for all Klassic® Tibial Inserts is relieved to minimize impingement and maximize flexion.

The Klassic® Tibial Insert's locking mechanism incorporates a Tibial Set Screw along with an anterior snap and M/L constraints. The stable locking mechanism combines with the smooth proximal surface of the Tibial Baseplate to minimize backside wear.[17] The Insert features an anti-backout mechanism to ensure retention of the Screw.

The geometrically-forgiving Klassic® Sombrero and Klassic® Domed Patellae optimize patellofemoral contact area during tracking while requiring a minimal resection of just 7mm (Sombrero only). Pegs are uniformly placed to provide intraoperative flexibility.

**Options not available for sale in the US*

EFFICIENCY BY DESIGN®

The Klassic® Knee System is designed to significantly reduce the amount of inventory needed to perform a knee replacement without modifying the preferred surgical technique. The result is a streamlined system that offers surgeons both ease and flexibility of use while reducing costs for the hospital or surgery center. Our goal is to make state-of-the-art, efficient products that provide reliable, reproducible results in any surgical setting.

Designed from the ground up for efficiency, the Klassic® Knee System instruments are carefully designed for precise, intuitive surgical flow, and are manufactured from titanium, stainless steel, and high performance plastics for long-lasting performance and a solid feel.

Klassic ONE® instrumentation comes standard with the Klassic® Knee System. Its inherent efficiency allows a single tray of instruments to support up to 90% of cases with no patient-specific customization, templating, additional imaging, or disposables. An auxiliary tray includes micro/macro sizing to allow 100% of primary cases to be performed with two trays.

Reducing the number of trays required for each surgery reduces OR time and sterilization costs, helps reduce the incidence of infection, and optimizes efficiency and ergonomics. Using the Klassic ONE® System could save up to $1,350 per case (compared to a typical eight tray implant system).[19-21]

Trays may be customized to surgeon workflow preferences. Once the workflow is set, the trays support cases without the need for individual patient customization. All instrument trays meet AORN standards for weight and are fully validated for cleaning and sterilization.

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The Klassic ONE® instrumentation system

Total Hip & Knee Cases Per Year:

100

Trays Currently Used for Total Hip & Knee Cases:

8

Select TJO System for Comparison

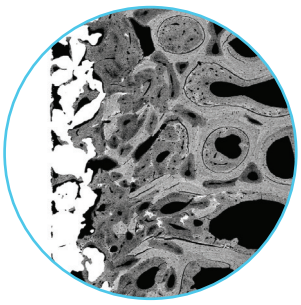
Klassic ONE® System (single tray)

Potential Savings:

$ 135,000

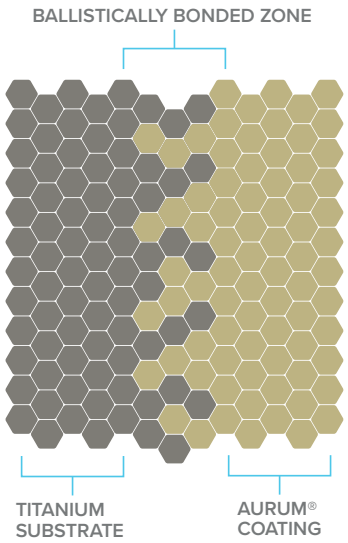
Visit tjoinc.com to see your potential cost savings

Ti-coat® ultraporous coating



Magnification of bony ingrowth on Ti-Coat®

E-Link® Polyethylene



Aurum®'s proprietary ion beam enhanced deposition (IBED) ballistically bonds TiN to the Ti substrate

FIXATION

The Klassic® Knee System for use with cement offers a grit-blasted surface with undersurface pockets to optimize cement mantle adherence.[22,23]

The backside of the Klassic® Femur and Klassic® Tibia are grit-blasted to improve implant cement fixation. The Klassic® Tibial Baseplate has a recessed pocket and sub-ribs. Keel and stem fit line-to-line.[22,23]

The Klassic® Porous Knee System features three-dimensional porous coatings for biological fixation, with a mean porosity of 60% for demonstrated bony ingrowth.[11] The Klassic® Porous Femur offers Cobalt 3D®, an ultra-porous coating made from hand-applied crushed CoCr fragments. The Klassic® Porous Tibia offers Ti-Coat®, an ultra-porous commercially pure titanium coating comprised of hand-applied asymmetrical grains. The keel is grit-blasted for bone on-growth.

MATERIALS

E-Link® Poly is a Vitamin E stabilized highly cross-linked ultra high molecular weight polyethylene (UHMWPE). Vitamin E is blended into the GUR 1020 UHMWPE in powder form, compression molded, and cross-linked by Gamma radiation to 10MRads. E-Link® Poly utilizes Vitamin E to quench free radicals generated during the cross-linking process, yielding oxidative stability.[24]

A never-irradiated, compression-molded polyethylene made from GUR 1050 is also available. Similar polyethylenes have been shown to resist oxidation throughout long use.[25]

All of our polyethylene products are ethylene-oxide (EtO) sterilized to minimize oxidative potential.

Aurum® uses a proprietary ion beam enhanced deposition (IBED) process to ballistically bond a five-micron thick titanium nitride coating to the titanium substrate using a low energy nitrogen ion beam. The IBED process creates a well-structured, ceramicized surface layer that is interdigitated with the substrate while preserving the material and geometric properties of the implant. The result is a hardened surface that offers equivalent hardness and wear characteristics to Cobalt Chrome femurs without the deliberate addition of common metal sensitizers such as Nickel, Cobalt, and Chromium.[32]

WARNINGS AND PRECAUTIONS

Please refer to the Total Joint Orthopedics Klassic® Knee System Instructions For Use at tjoinc.com/ifu for warnings, precautions, adverse effects, and other essential product information.

KLASSIC® DESIGN ERGONOMICS

The innovation for the Klassic ONE® Instrumentation includes a complete overhaul of functionality, aesthetics, and ergonomics. The resulting instruments are light weight and intuitive.

All interfaces have been replaced with quick connections to help reduce fatigue and repetitive stress, and color and texture indicate adjustability. Instruments have been engraved and filled with a dark laser mark for longevity and visibility.

Color
Turquoise accents indicate adjustable features, and black coatings differentiate variations of work flow options. Dark laser-marking is used to define numerical features.

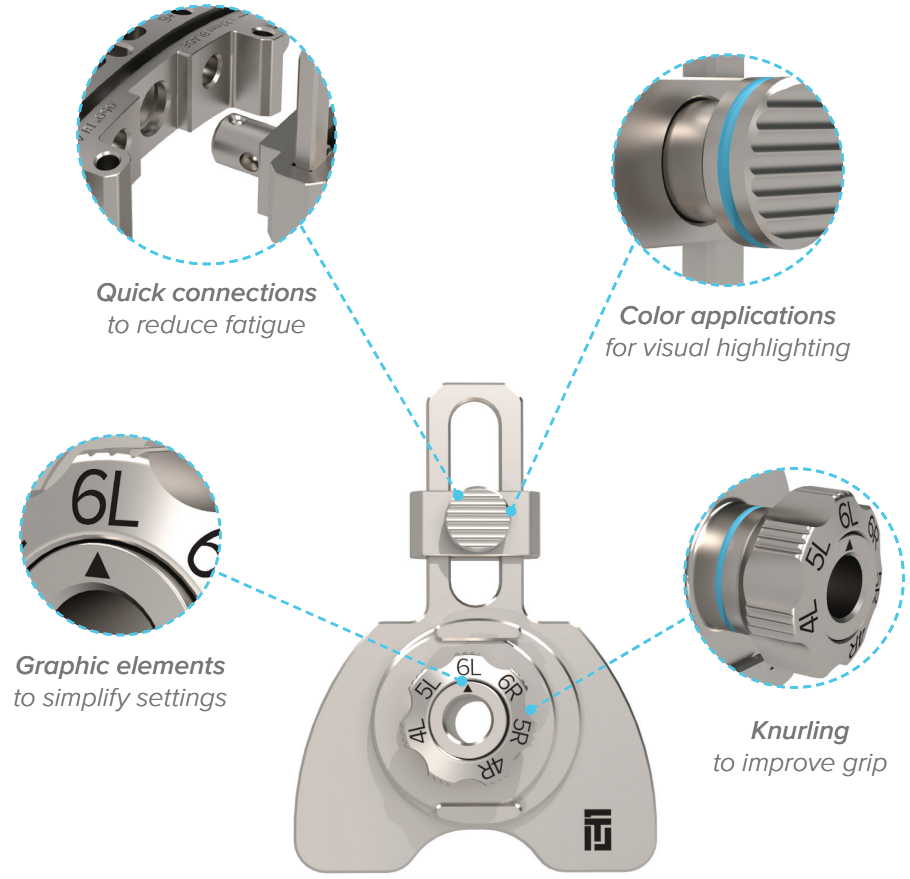
Texture
Linear knurling is applied to features that require user input or adjustability; it provides visual contrast, increases grip, and helps users identify adjustable features through tactile response.

Adjustable Features
Push buttons, twist knobs, pull buttons, and quick release interfaces are standardized for form and function.

Graphic Elements
A system of graphic elements indicates alignment or position and points to surfaces. Graphic elements include lines, carets (▲), and lock icons (🔒).

Physical Indicators
TJO has developed a proprietary physical indicator system for tray identification through touch.* The purpose of the system is to allow tray identification through the sterile wrapping to reduce the incidence of confusion for mis-labeled or unlabeled sterile sets.

*Patent pending

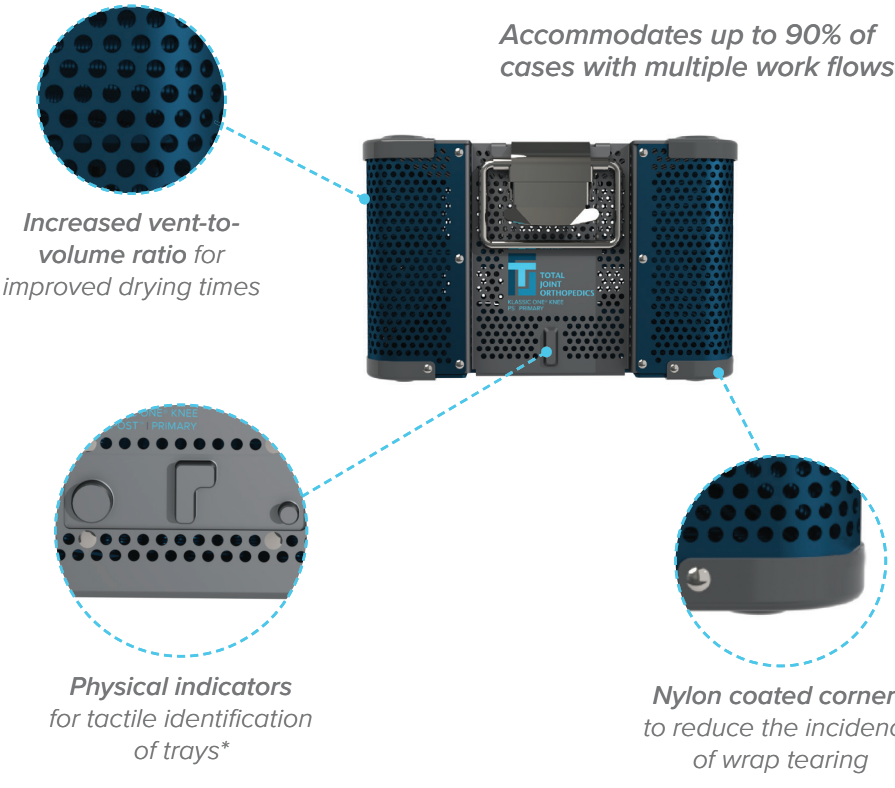


Quick connections *to reduce fatigue*

Color applications *for visual highlighting*

Graphic elements *to simplify settings*

Knurling *to improve grip*



Increased vent-to-volume ratio *for improved drying times*

Accommodates up to 90% of cases with multiple work flows

Physical indicators *for tactile identification of trays**

Nylon coated corners *to reduce the incidence of wrap tearing*

PIN GUIDE

The Klassic® Knee with Klassic ONE® instrumentation uses 3.2mm pins throughout the surgical technique to provide consistent instrument performance. Disposable Pin Packs are available depending on surgeon preference. Though any type of 3.2mm pin may be used with this system, the technique described in this manual primarily uses a combination of headed Guide Screws and non-headed Pins.

Guide Screws

Guide screws are used whenever a surgeon would like to tighten an instrument down against the bone. They have a low profile head which makes them easier to work around while in place. These may be used throughout trialing to secure the Tibial Baseplate Sizer/Trial and the PS-Post™ Femur Trial, and require the use of the Hex Head Driver for installation and removal.

Pins

Non-headed pins such as the Short or Long Smooth Pins are used when the surgeon may reposition the instrument by sliding it off of the pins. For example, the Universal Cut Block can be repositioned by removing it and replacing it over the Pins in a different location. Smooth Pins are inserted by hand into a pre-drilled hole and are removed with the Pin Puller.

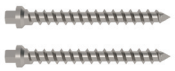
Additional pin types to accommodate a variety of work flows are available by request. Please refer to the Product Catalog at tjoinc.com for additional offerings.

STANDARD SCREW PIN PACK
2705.00.000

3.2mm Twist Drill (x1)

Long Smooth Pin (x2)

Short Smooth Pin (x2)



For use with

Guide Screw, Hex Head (x2)

Hex Head Driver
2007.00.000

STANDARD SMOOTH PIN PACK
2703.00.000

3.2mm Twist Drill (x1)

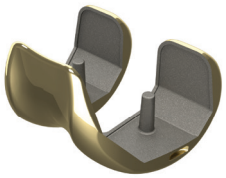
Long Smooth Pin (x2)

Short Smooth Pin (x4)

KLASSIC® KNEE SYSTEM PRODUCT OFFERINGS

Klassic® Femur, Nonporous
Sizes: 1-7

Klassic® Femur | Aurum®, Nonporous
Sizes: 1-7



Klassic® Femur, Porous
Sizes: 1-7

Klassic® Femur | PS-Post™
Sizes: 1-7

Klassic® Tibial Insert, CR/Congruent
Sizes: 1-6
Thicknesses: 10, 11*, 12, 14, 16**, 18**mm
*Available in Std. Poly or E-Link® Poly (*E-Link® only, **Std. Poly only)*

Klassic® PS-Post™ Tibial Insert
Sizes: 1-6
Thicknesses: 10, 11, 12, 14, 16mm
Available in E-Link® Poly

Klassic® Tibial Insert, Ultra-PS®
Sizes: 1-6
Thicknesses: 10, 11*, 12, 14, 16, 18**mm
*Available in Std. Poly or E-Link® Poly (*E-Link® only, **Std. Poly only)*

Klassic® PS-Max® Tibial Insert
Sizes: 1-6
Thicknesses: 10, 12, 14, 16, 18mm
Available in Std. Poly

Klassic® Tibial Baseplate
Sizes: 1-6

Klassic® Tibial Baseplate, Porous
Sizes: 1-6

Klassic® Tibial Stem Extensions
Sizes: 25, 50, 100, 150mm

Klassic® All-Poly Tibia, CR/Congruent
Sizes: 1-6
Thicknesses: 10, 12, 14, 16mm
Available in Std. Poly

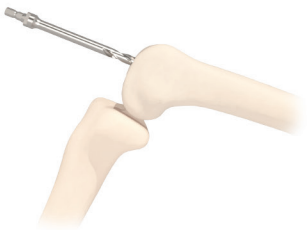
Klassic® All-Poly Tibia, Ultra-PS®
Sizes: 1-6
Thicknesses: 10, 12, 14, 16mm
Available in Std. Poly

Klassic® Domed Patella
Size, Thickness:
1, 8mm
2, 9mm
3, 10mm
4, 11mm
Available in Std. Poly or E-Link® Poly

Klassic® Sombrero Patella
Sizes: 1-4, Thickness: 7mm
Size: 5, Thickness: 10mm
Available in Std. Poly or E-Link® Poly

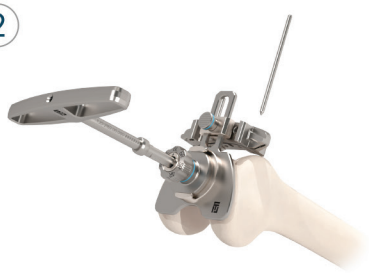
SURGICAL STEPS: MEASURED RESECTION

1



Drill the entry hole approximately 5mm above the roof of the intercondylar notch. Proper alignment is crucial to the success of the surgery.

2

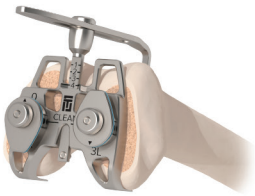


Set the Distal Femoral Cut Guide at the desired valgus angle for the affected limb. Place the I/M Rod through the entry hole and fully seat. Pin the Cut Block in place.

3

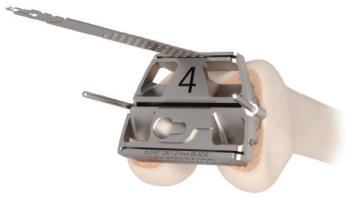
Remove the Alignment Guide and resect the distal femur.

4



Set the desired femoral rotation and size the femur. The Klassic® Knee System is posterior referencing if between sizes, size up.

5

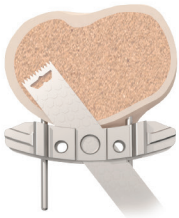


Pin the Femur Cut Block in place and make the anterior, posterior, and chamfer cuts.

6

Place Tibial Alignment Guide Assembly using the “frog eyes” to set resection level. Make any adjustments to slope and alignment, pin the Cut Block in place, and remove the alignment jig.

7



Resect the proximal tibia.

8

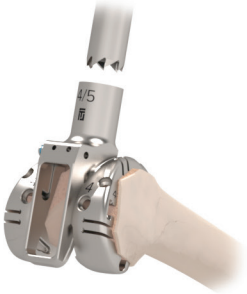
Place the Tibial Baseplate Sizer/Trial on the medial anterior cortex of the cut surface and externally rotate to size and set rotation; do not internally rotate. Pin in place and drill the four peg holes.

9

Select the Tibial Broach Assembly for the chosen size and optional Stem Extension and attach it to the Tibial Baseplate Sizer/Trial. Broach the tibia.

SURGICAL STEPS: MEASURED RESECTION

10



If using the Klassic® PS-Post™ Femur, secure the Femur Trial in place. Attach the PS-Post™ Reaming Guide and prepare the box using the PS-Post™ Box Reamer.

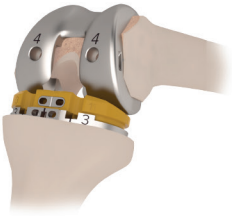
11

Clean up any edges with the saw blade.

12

Set the stylus on the Patella Osteotomy Guide to the appropriate height and resect the patella.

13



Insert Femur, Tibia, Tibial Insert, and Patella Trials. Check range of motion and make adjustments to soft tissue as needed. Remove trials. Drill peg holes for the Klassic® Femur (femoral pegs are optional for the Klassic® PS-Post™ Femur).

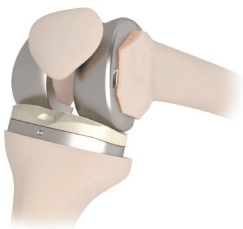
14

Implant the Klassic® Patella, Femur, and Tibial Baseplate. Engage the Klassic® Tibial Insert locking mechanism.

15

Use the Screwdriver to engage the Tibial Set Screw until it bottoms out. Do not apply excessive force.

16



Verify range of motion, irrigate, and close the wound.

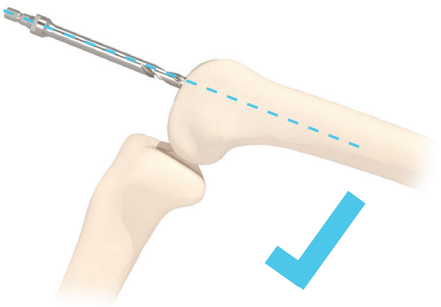


Fig. 1: Drill the entry point directly up the I/M canal

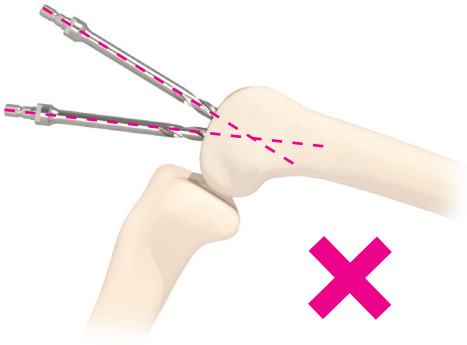


Fig. 2: Avoid incorrect positioning that will place the femur in undesired flexion or extension

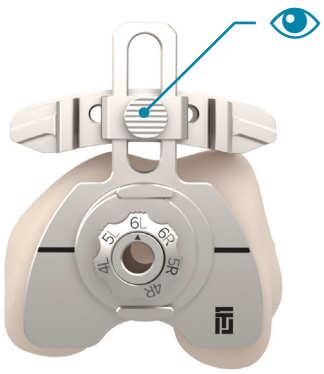


Fig. 3: Set the preferred valgus angle of the distal cut by rotating the knob on the Distal Femoral Cut Guide

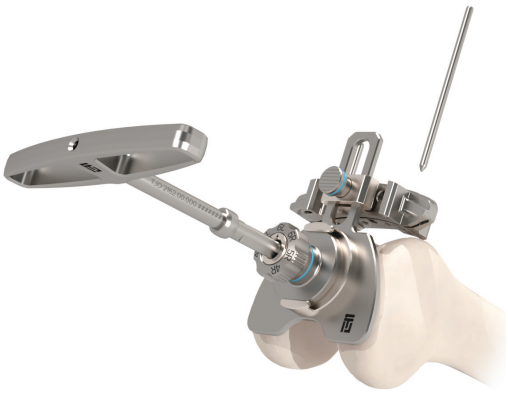


Fig. 4: Pin the Distal Femoral Cut Guide Assembly

PREOPERATIVE PLANNING

Obtain a long standing anteroposterior and lateral radiograph of the knee, as well as a merchant or sunrise view of the patella. The entire femur should be visualized to rule out any structural abnormality, as the distal femoral cut will be referenced from an Intramedullary Rod in the medullary canal.

Templating for size is most accurate on the lateral radiograph since many patients present with a flexion contracture that distorts magnification on the anteroposterior radiograph.

1. EXPOSING THE JOINT

Expose the knee joint with the surgeon's preferred method. It is essential that the exposure allow safe visualization and access for the instrumentation. After completing the arthrotomy, maximally flex the knee. Excise any osteophytes on the medial or lateral aspect of the joint that influence ligament tension as well as oteophytes in the femoral notch to allow full exposure of the cruciate ligaments.

2. RESECTING THE DISTAL FEMUR

Localize the proper entry point by extrapolating the femoral intramedullary canal seen on both the A/P and lateral radiographs. In general, the starting point will be approximately 5mm above the true roof of the intercondylar notch (Fig 1).

Incorrect posterior placement of the entry hole may lead to flexion of the femoral component, while incorrect placement anteriorly may lead to extension of the femoral component (Fig. 2).

Using the 3-in-1 Drill, make a hole in the distal femur to gain access to the intramedullary canal, ensuring that the drill tip remains within the center of the canal. Toggle the drill while exiting to vent the femoral canal.

Attach the Universal Cut Block to the Distal Femoral Cut Guide with the elevated pin holes (frog eyes) pointing toward the front of the Guide and the curve matching the anterior portion of the distal femur. Set the preferred valgus angle of the distal cut (4, 5, or 6°) for the appropriate side by rotating the knob on the Distal Femoral Cut Guide (Fig. 3). Insert the I/M Rod into the Distal Femoral Cut Guide and place the assembly on the distal femur by inserting the I/M Rod into the canal. Ensure the Cut Guide is touching the least affected condyle (Fig 4). The Universal Cut Block will slide to rest on the distal femur.

The Distal Femoral Cut Guide features a quick connect button for easy assembly/disassembly.

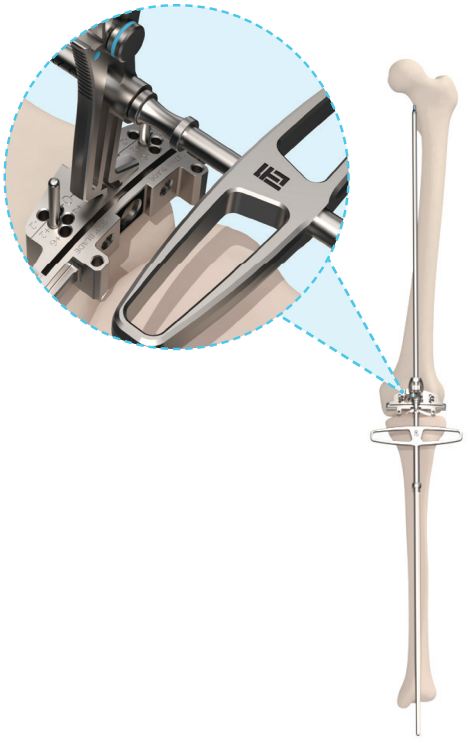


Fig. 5: Optional: check alignment with the Alignment Rod, I/M Rod, and Modular Alignment Handle

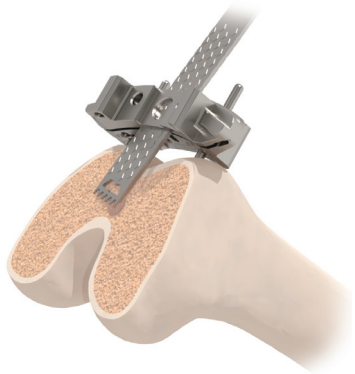


Fig. 6: Cut distal femoral condyles

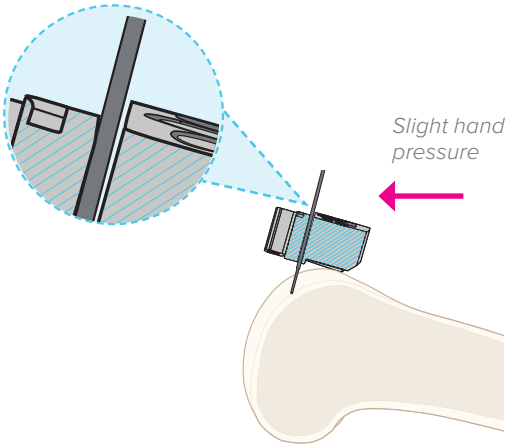


Fig. 7: Use the saw capture as a guide to ensure accurate cuts

Stabilize the Universal Cut Block by pinning through the [0] holes. The holes may be pre-drilled using the 3.2mm (1/8") Drill. Use a Kocher clamp on one of the pins to secure the Cut Block in place.

Surgical Pearl: Attach the Modular Alignment Handle to the Universal Cut Block and thread the Alignment Rod into the handle of the I/M Rod to create a long shaft as an external alignment gage (Fig. 5).

Detach the Universal Cut Block from the Distal Femoral Cut Guide. The I/M Rod and detached Cut Guide may be removed.

Cut the distal femoral condyles through the Universal Cut Block using a 1" wide 1.27mm (.050") thick saw blade (Fig. 6). In the absence of a fixed flexion contracture or bony erosion, the thickness of the bone resection from the most prominent condyle should be 10mm thick. If needed, the Cut Block may be shifted proximally in 2mm increments to ensure an adequate resection. If the most prominent condyle is eroded, take care to avoid over-resection and joint line elevation.

Surgical Pearl: Multiple saw blade passes ensure a more accurate cut with less skiving.

Saw blade temperatures may exceed 200˚C; thermal necrosis occurs at 55˚C.[26] Irrigating the saw blade with saline when making cuts will help ensure the freshly cut bone remains viable. This is especially important when using a cementless implant.[27]

The 3˚ Flexion/Extension Block may be used to adjust the distal resection. If recutting, place the Flexion/Extension block over the pins used to secure the Universal Cut Block.

After resecting the distal femur, remove the pins using the Pin Puller.

Surgical Pearl: Saw captures are an integral part of accurate cutting technique. The tolerance of the saw capture using the appropriate 1.27mm (.050" blade), with slight hand pressure toward the cut surface, will ensure accurate cuts (Fig. 7). Too much pressure may bind the blade and potentially tilt the block, creating inaccurate cuts.

Surgical Pearl: Check the distal femoral cut for flatness by placing the flat side of a Femoral Cut Block on the cut surface of the distal femur.

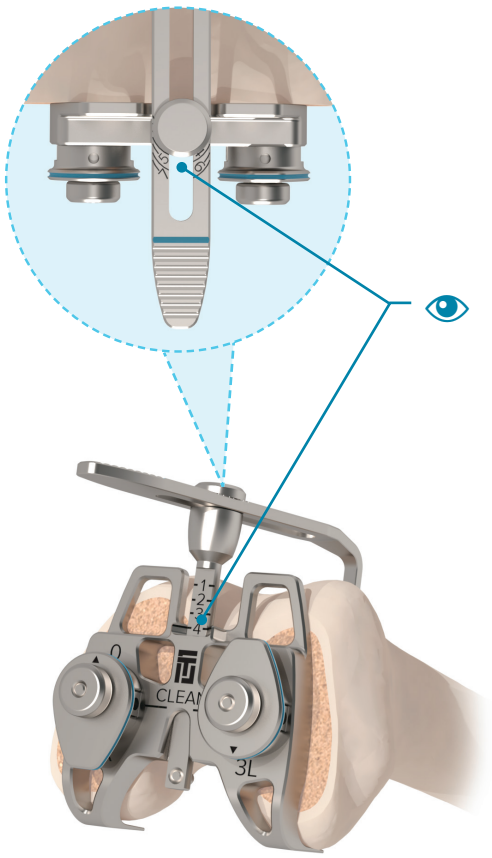


Fig. 8: Use the A/P Sizer to evaluate the femoral component size

3. SIZING THE FEMUR

Remove the Gap Block and maximally flex the knee. Set the desired external rotation on the A/P Sizer by aligning the dials to either 0˚ or 3˚ (left or right). The dial for the medial side should be set to 0˚. Center the A/P Sizer on the distal femoral cut and ensure the posterior skids are in contact with the posterior condyles. Use the A/P Sizer as a caliper to determine the correct anterior/posterior femoral size by reading the size on the front of the A/P Sizer (Fig. 8). Once rotation and sizing are established, use a mallet to tap the pins on the A/P Sizer into the distal femur. Markings on the stylus reference the height of the anterior flange for each size. Remove the A/P Sizer.

The size may be verified on the A/P Sizer using the vertical slide, or optionally, the stylus arm.

If between sizes, choose the larger size. Once cuts are made, the femur may be re-cut for a smaller implant by making the anterior and anterior chamfer cuts with the smaller sized cut block. The posterior resection and chamfer remain the same for all sizes. Once the anterior cut has been made for a given size, you cannot size up as you have already removed additional anterior bone.

KLASSIC® FEMUR & KLASSIC® FEMUR | AURUM® SIZING

Size	A/P (mm)	M/L (mm)
1	54	59
2	57.5	63
3	61	67
4	64.5	71
5	68	75
6	71.5	79
7	75	83

There is a 3.5mm difference between sizes at the anterior cortex.

Femoral pegs are uniform in distance between sizes. Selecting an alternate femur after drilling the peg holes does not require drilling additional holes.

Optimized congruency is achieved when either the femur and tibia are matched in size or when the femur is one size larger than the tibia. If using a larger size of tibia than femur, care should be taken to closely evaluate external rotation and other alignment to ensure proper joint function and kinematics.

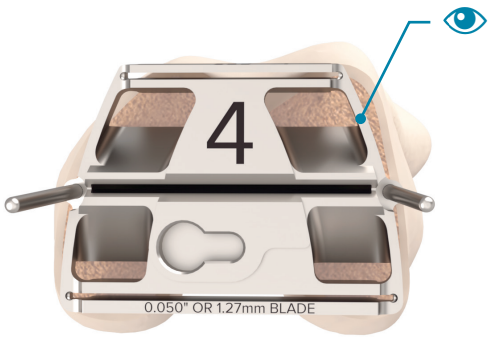


Fig. 9: Pin the Femoral Cut Block in place for stability

4. PREPARING THE FEMUR

Place the appropriately sized Femoral Cut Block on the distal femoral resection, inserting the pins in the block through the previously established holes in the distal femur.

Ensure the Femoral Cut Block is completely seated against the distal femoral cut. If necessary, use several sharp taps with a mallet in the center of the Cut Block. Tapping the periphery of the Block may cause cantilevering, resulting in bone damage.

Once the position of the Femoral Cut Block is set, stabilize it by pinning through the oblique holes (Fig. 9).

The outline of the Femoral Cut Blocks matches the distal profile of the final implant to aid with visualization of size.

Place the Angel Wing through the anterior slot of the Femoral Cut Block to visualize the exit path of the saw blade during the anterior cut (Fig. 10). If the cut appears that it will notch, choose one size larger Femoral Cut Block or use the 3° Flexion/Extension Cut Block to adjust flexion angle. Remove the Angel Wing and use a .75" wide saw blade to make the anterior, posterior, posterior chamfer, and anterior chamfer cuts (Fig. 11).

Surgical Pearl: The system will accommodate a 1" wide saw blade, though a narrower blade may help reduce chatter.

Remove the pins with the Pin Puller to remove the Femoral Cut Block. Check the flatness of the cuts with the bottom of the Femoral Cut Block.

Note: The femur may be re-cut for a smaller implant by making the anterior and anterior chamfer cuts with the smaller sized Cut Block. As the cuts are posteriorly referenced, the thickness of the posterior cuts and posterior chamfer do not change between sizes.

Remove any remaining posterior osteophytes.

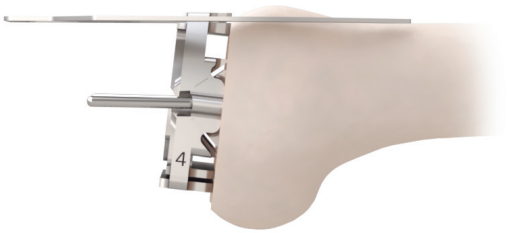


Fig. 10: Check anterior resection with the Angel Wing

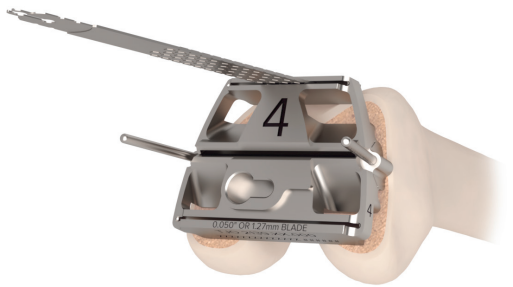


Fig. 11: Resect anterior, posterior, and both chamfers

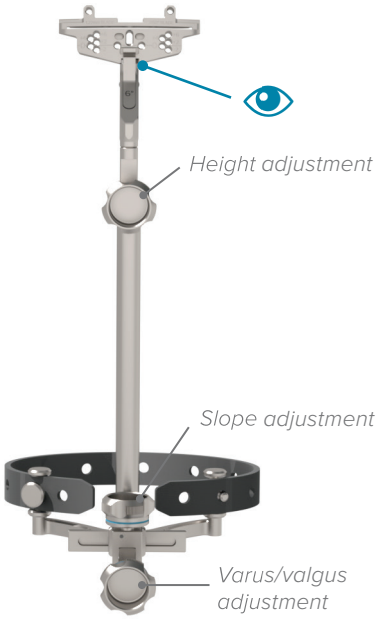


Fig. 12: Assemble the Tibial Alignment Guide

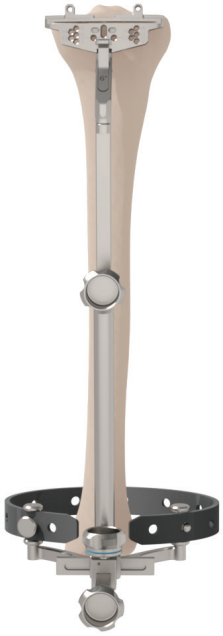


Fig. 13: Place the assembled Tibial Cut Guide on the tibia

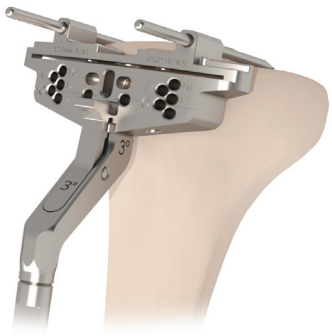


Fig. 14: Place the Long Pins to rest on the proximal tibia

5. RESECTING THE PROXIMAL TIBIA

The proximal tibial resection should produce a resection surface that:

1. Is perpendicular to the mechanical axis of the tibia in neutral varus/valgus
2. Has the appropriate posterior slope
3. Provides an adequate resection depth to allow insertion of the thinnest Tibial Insert without excessive soft tissue tension

Maximally flex the knee and excise the anterior cruciate ligament along with any remaining meniscus. Expose the articular surface of the proximal tibia by placing the tip of the Large Knee Retractor on the central posterior cortex of the tibia in subperiosteal fashion. Use the Retractor to subluxate the tibia anteriorly from beneath the distal femur. Place a Small Knee Retractor medially. Place two Small Knee Retractors laterally with one anterolaterally to retract the patellar tendon and fat pad.

To assemble the Tibial Alignment Guide, stand the base of the Lower Tower on the table and tighten the varus/valgus and slope adjustment knobs to lock the Tower portion upright. Insert the Upper Tower into the Lower Tower. Attach the Universal Cut Block to the top of the Upper Tower using the quick connect button such that the elevated pin holes (frog eyes) are up and the curve matches the anterior portion of the proximal tibia (Fig. 12).

The Tibial Alignment Guide features a quick connect button for easy assembly/disassembly.

After adjusting the tibial alignment guide to the approximate tibial length, place the ankle cradle in neutral position and place against the length of the tibia. Attach the ankle strap (Fig. 13). Set the rotational alignment by using the tibial tubercle as a guide. When properly oriented, the posterior edges of the true proximal tibial plateau (excluding osteophytes) should be aligned parallel to the Universal Cut Block.

If desired, stabilize rotational alignment by inserting a pin through the central vertical slot in the Universal Cut Block. This will maintain rotational stability while allowing slope and varus/valgus adjustments to be made prior to the final pinning through the [0] holes.

Place a Long Pin through each of the elevated pin holes (frog eyes) on the universal cut block and rest them on the proximal tibia, ensuring the Long Pins come into contact with the posterior tibial plateau (Fig. 14). Lock the height adjustment knob.

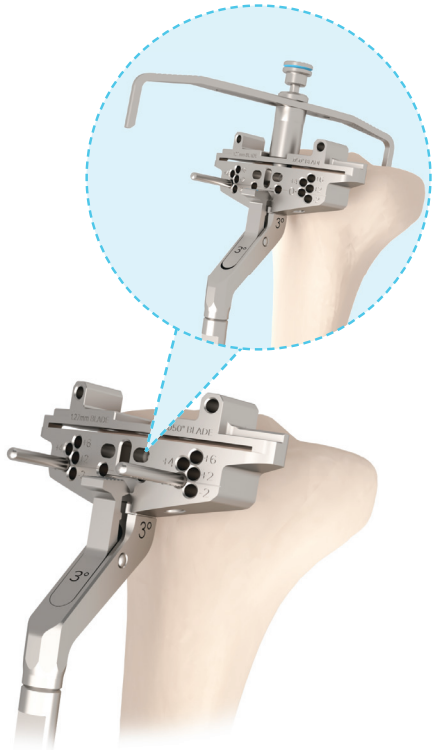


Fig. 15: Stabilize the Universal Cut Block with pins, then remove the Long Pins or Tibial Stylus and the Tibial Alignment Guide, if desired

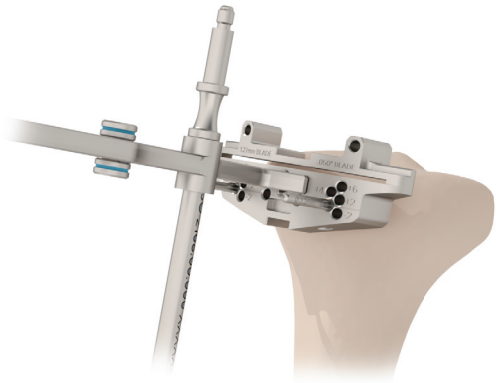


Fig. 16: Check varus/valgus alignment with the Alignment Rod dropped through the Modular Alignment Handle

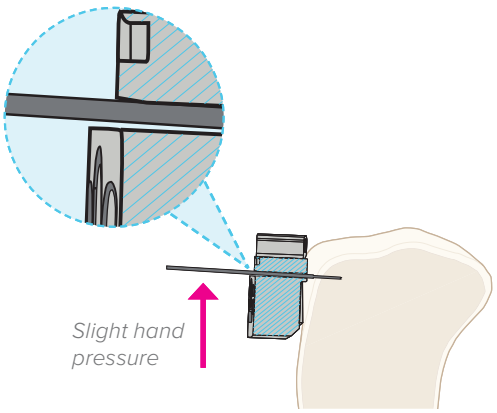


Fig. 17: Use the saw capture as a guide to ensure accurate cuts

Aligning the Long Pins with the posterior tibial plateau will reference the slope if adjusted parallel to the proximal tibia and will provide an 8mm depth of cut. Alternatively, the Tibial Stylus may be used to check the depth of resection (Fig. 15).

The large knob at the base of the Tibial Alignment Guide allows the slope to be adjusted based on surgeon preference.

Avoid excessive posterior slope, especially if sacrificing the PCL.

RECOMMENDED SLOPE FOR THE KLASSIC® KNEE SYSTEM	
CR/Congruent	Match the patient's native tibial slope
Ultra-PS®	Make the cut 2-3° flatter than the patient's native tibial slope
PS-Post™	Make the cut perpendicular to the tibia
PS-Max®	

Check varus/valgus alignment by aligning the Tibial Alignment Guide with the tibial tubercle and using the center of the ankle as a reference. The Tower is available in 0, 3, and 6° of slope to allow for flexibility in positioning. Adjust the guide as needed using the large knob at the base. Stabilize the Universal Cut Block with two pins through the [0] holes (Fig. 15). Use a Kocher clamp on one of the pins to secure the Universal Cut Block in place.

Alternatively, low profile left and right Tibial Cut Blocks are available and require the use of the Tibial Stylus.

Note: The Tibial Alignment Guide may remain in place for the proximal tibial cut; it does not need to be removed prior to making the cut. The Tibial Alignment Guide may be removed after the Cut Block is secured.

If desired, use the Modular Alignment Handle and the Alignment Rod to verify the alignment. The tip of the Alignment Rod should fall 1-2cm lateral of the center of the ankle for a 2° varus cut, or to the center of the ankle for a perpendicular cut (Fig. 16).

Surgical Pearl: Saw captures are an integral part of accurate cutting technique. The tolerance of the saw capture using the appropriate 1.27mm (.050" blade), with slight hand pressure toward the cut surface, will ensure accurate cuts (Fig. 17). Too much pressure may bind the blade and potentially tilt the block, creating inaccurate cuts.

Saw blade temperatures may exceed 200°C; thermal necrosis occurs at 55°C.[26] Irrigating the saw blade with saline when making cuts will help ensure the freshly cut bone remains viable. This is especially important when using a cementless implant.[27]

Most patients require a minimum of 8mm of resection to allow for the use of at least a 10mm Tibial Insert in a PCL-sacrificing procedure.

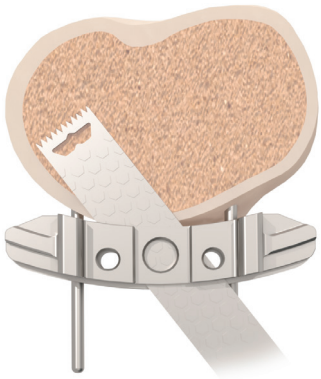


Fig. 18: Cut the proximal tibia

Additional proximal tibial resections may be made by shifting the Cut Block in 2mm increments if the initial resection is deemed inadequate. The varus/valgus angle of the cut may be adjusted by using the 2.5° Varus/Valgus Cut Block, which uses the same pin pattern as the Universal Cut Block.

Using a 1" wide, 1.27mm (.050") thick saw blade, cut the proximal tibia through the slot of the Universal Cut Block (Fig. 18).

Surgical Pearl: The tibial cut should be perfectly flat, especially if using the porous tibia. Place the Tibial Baseplate Sizer/Trial on the cut surface and touch each corner. If there is a rocking motion, consider recutting the tibia to even out the surface.

Remove the Cut Block and remove the pins using the Pin Puller.

Surgical Pearl: Retain the cut proximal tibial wafer on the back table to create a bone slurry during final implantation when using the Klassic® Porous Tibia. Intraoperative use of bone slurry at the bone/implant interface provides up to three times the amount of bone ingrowth compared to specimens implanted without the use of bone slurry.[26-28]

6. SIZING THE TIBIA

Remove any remaining osteophytes at the tibial resection margin prior to determining the optimal size. Attach the Modular Alignment Handle to the Tibial Baseplate Sizer/Trial.

If using the Klassic® Ultra-PS®, PS-Post™, or PS-Max® Insert, the PCL must be removed.

To rigidly lock the Modular Alignment Handle to the Tibial Baseplate Sizer/Trial or other instrument, slide the button toward the Lock icon ( ).

Place the Tibial Baseplate Sizer/Trial on the resected proximal tibia at the anterior medial cortex and select the Tibial Baseplate Sizer/Trial that does not overhang and allows some lateralization (Fig. 19).

It is crucial to remove all posterior osteophytes in order to properly seat the Tibial Baseplate and accurately set its rotation.

Vertical lines on the anterior face of the Tibial Baseplate Sizer/Trial may be used as a reference point for marking rotation.

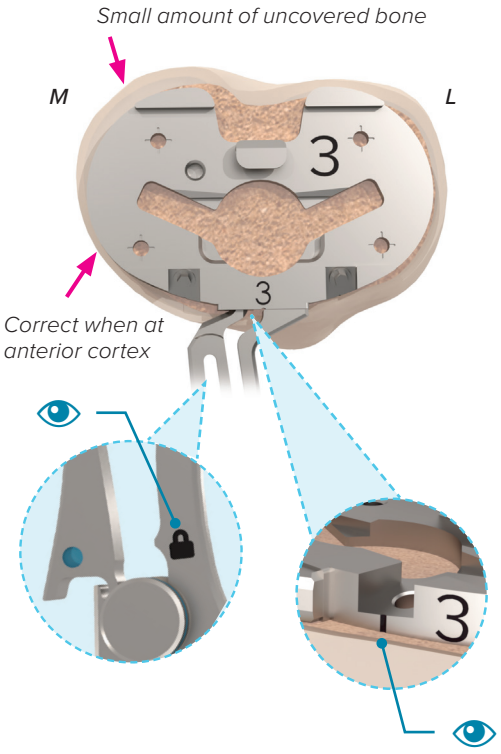


Fig. 19: Determine the tibial sizing and rotation

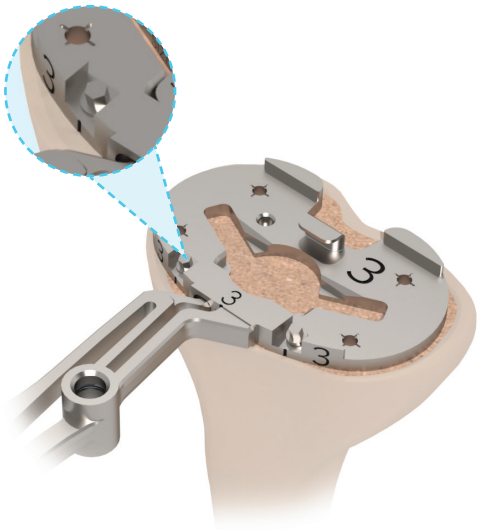


Fig. 20: Once the alignment is set, pin the Tibial Baseplate Sizer/Trial in place

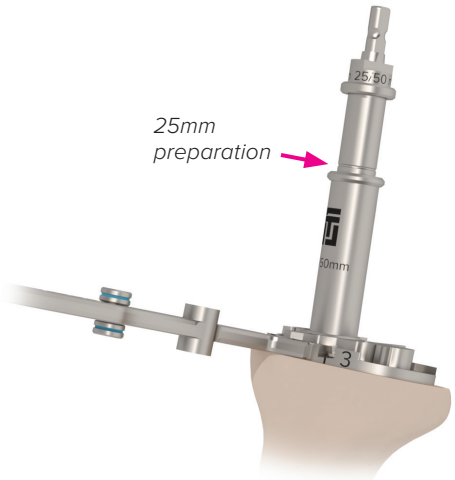


Fig. 21: Ream to prepare for 25 or 50mm Stem Extension

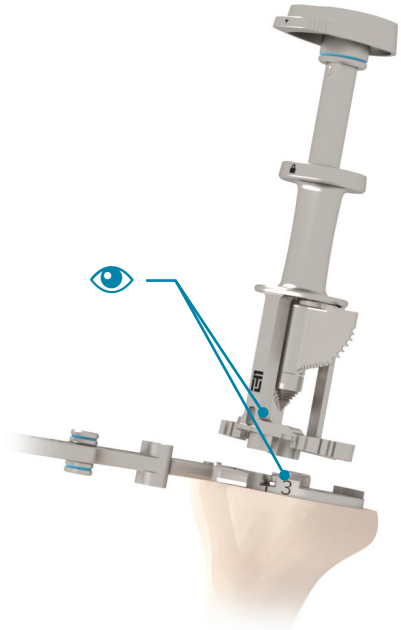


Fig. 22: Broach Keel and Stem

KLASSIC® TIBIAL BASEPLATE SIZING		
Size	A/P (mm)	M/L (mm)
1	41	64
2	43	67
3	45	71
4	47	75
5	49	79
6	51	82

Optimized congruency is achieved when either the femur and tibia are matched in size or when the femur is one size larger than the tibia. If using a larger size of tibia than femur, care should be taken to closely evaluate external rotation and other alignment to ensure proper joint function and kinematics.

7. PREPARING THE TIBIA

If desired, verify the alignment by placing the Alignment Rod through the Modular Alignment Handle. Once alignment is accepted and position verified, set the position with two Guide Screws through the anterior holes (Fig. 20).

This step will set rotation for the final implant; avoid internal rotation.

If using a Stem Extension, assemble the Reamer Tower to the Tibial Baseplate Sizer/Trial. Ream to the line on the Stem Extension Reamer to prepare for a 25mm stem extension and to full depth for a 50mm Stem Extension (Fig. 21).

Attach the Broach Tip to the Tibial Broach and connect it to the Tibial Broach Impactor. Rotate the strike plate 180˚ so that the marks are aligned and the Tibial Broach Assembly is locked. Place the Broach Tower on the Tibial Sizer/Trial and ensure it is securely seated (Fig. 22). A Kocher clamp on the anterior portion of the Tibial Broach Assembly may be used to add additional stability.

Holes in the Tibial Broach Tower, Reamer Tower and Tibial Baseplate Sizer/Trial accept a Kocher clamp for enhanced stability.

The standard Starter Broach Tip is 13mm long; a 25 or 50mm Stem Extension Broach may be attached to the Tibial Broach Impactor for Stem Extension use.

Broach the tibia with a mallet. The Tibial Broach may be disconnected by rotating the top of the Tibial Broach Impactor.

Using the Tibial Broach without a Starter Tip or Broach Extension may cause damage to the tibia.

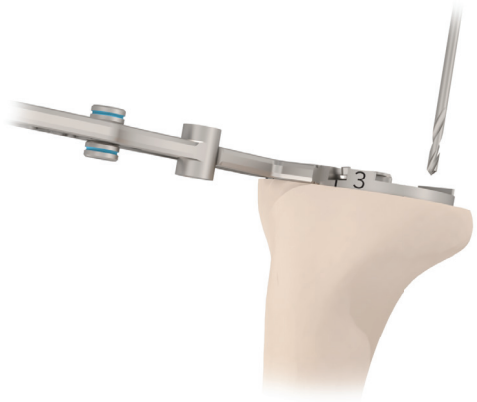


Fig. 23: Drill the peripheral peg holes

Fig. 24: Use the Patella Calipers to determine maximum thickness

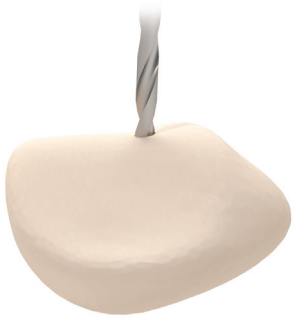


Fig. 25: Drill the apex of the medial facet

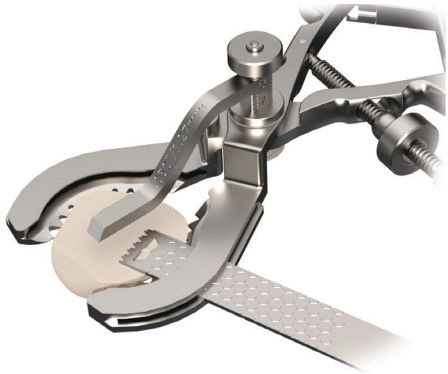


Fig. 26: Resect the patella using the Patella Osteotomy Guide

Surgical Pearl: If the Tibial Broach will not seat completely in hard bone, use a 3.2mm Drill Bit to drill several holes through the slots of the Tibial Baseplate Sizer.

If using the Klassic® All-Poly Tibia, re-broach using the appropriately sized All-Poly Tibia Broach, which is larger to accommodate the slightly wider (1mm) keel.

To leave the Tibial Broach in place, rotate the Strike Plate of the Broach Impactor 180° to separate the Broach Impactor from the Broach. It may be removed later by reattaching the Broach Impaction Handle or by using the Slap Hammer.

Use a 3.2mm (1/8”) Drill to prepare all four holes through the proximal surface of the Tibial Baseplate Sizer/Trial. All four holes must be prepared at least 5mm deep to accomodate the four peripheral pegs on the final implant (Fig. 23). A Stop Drill is provided if an alternate method is preferred. The Klassic® All-Poly Tibia does not feature peripheral pegs.

8. PREPARING THE PATELLA

Place the leg in full extension. Evert the patella and stabilize it with two inverted towel clips. Excise the soft tissue around the patella, avoiding the quadriceps tendon and the patellar ligament and remove any large osteophytes. Before making any bone cuts, determine the maximum thickness of the patella using the Patella Calipers (Fig. 24).

Avoid overthickening the patella to prevent overstuffing the patellofemoral joint.

Use the 3.2mm (1/8”) Drill to drill the highest point (patella apex) of the medial facet perpendicular to the articular surface. This acts as a guide for proper medialization of the patella (Fig. 25).

Select the desired resection thickness (see sizing chart) and adjust the stylus on the Patella Osteotomy Guide accordingly. Place the Patella Osteotomy Guide over the patella and tighten with the knob.

Resect the patella such that the implanted component will replace the resected thickness (e.g. 7mm if using a 7mm thick Sombrero Patella) (Fig. 26).

Attach the Modular Patella Sizer/Drill Guide to the Patella Clamp. Medialize the Modular Patella Sizer/Drill Guide and, using the radial marks, select the largest size of patella that will not

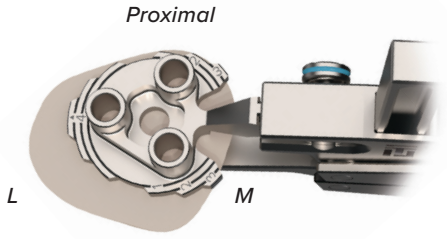


Fig. 27: Size the patella using the Modular Patella Sizer/Drill Guide

Fig. 28: Place the Femur Trial (CR and Ultra-PS) and prepare peg holes using the 3-in-1 Drill.

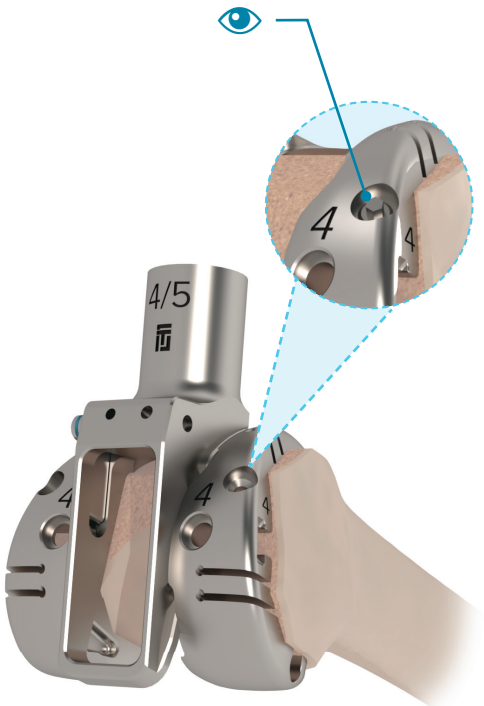


Fig. 29: Place the Femur Trial (PS-Post™ or PS-Max®), and insert optional stabilizing Screws or Pins

overhang to optimize patellar tracking (Fig. 27).[29] The previously drilled marker provides a reference location. Using the 3-in-1 Drill Tip, drill the patellar peg holes. If desired, the clamp may be held in place with the attached nut.

KLASSIC® DOMED PATELLA SIZING		
Size	Diameter (mm)	Thickness (mm)
1	28	8
2	31	9
3	34	10
4	37	11

KLASSIC® SOMBRERO PATELLA SIZING		
Size	Diameter (mm)	Thickness (mm)
1	28	7
2	31	7
3	34	7
4	37	7
5	40	10

Patella pegs are spaced uniformly regardless of size. Choosing an alternate size does not require drilling new holes.

9. TRIALING THE FEMUR

Position the Femur Trial and ensure it is fully seated slightly lateral, using the Femur Impactor or the Femur Impactor/Extractor as desired.

Surgical Pearl: Keeping the Femur Trial lateral, verify there is no overhang posterolaterally at the popliteus or anteromedial flange. If overhang is present, adjust the position or consider downsizing. Lateral placement of the Femur Trial (while avoiding overhang of the cut surface) will facilitate patellar tracking.

If a Klassic® Femur, or a Klassic® Femur with Aurum®, with a CR/Congruent or an Ultra-PS® Insert is preferred, drill the peg holes using the 3-in-1 Drill (Fig. 28) and proceed to Section 10: Trialing the Tibia and Patella. Because the preparation up to this point is the same for all Klassic® Knee System implants, implant choice may be made intraoperatively.

If the final implant will be a PS-Post™ Femur with a PS-Post™ or PS-Max® Insert, lock the PS-Post™ Reaming Guide into the PS-Post™ Femur Trial, ensuring it is fully captured. The Trial may be stabilized using the lateral anterior and distal medial pin fixation (Fig. 29).

Fixation holes are fully countersunk so Guide Screws may be left in place throughout trialing.

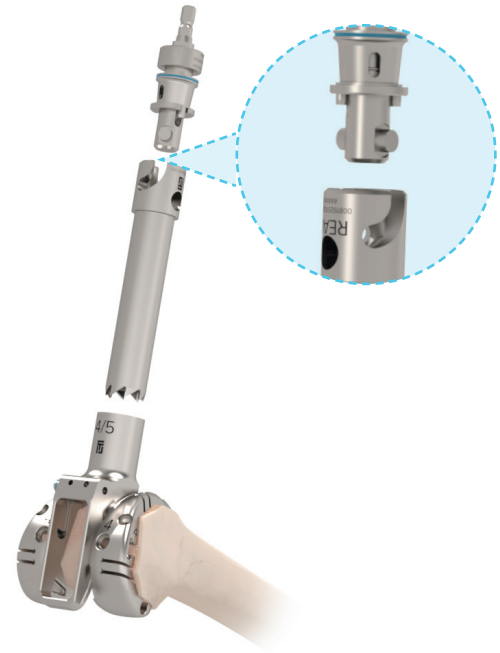


Fig. 30: Attach the Reaming Guide. Ensure it snaps fully into place prior to reaming

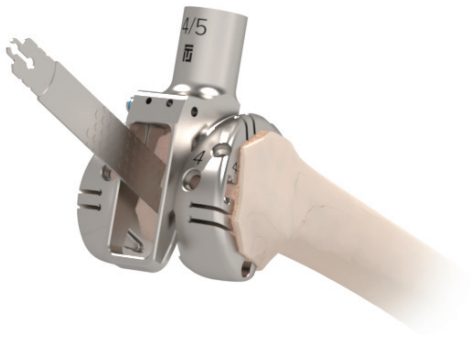


Fig. 31: Use sides of the Reaming Guide to remove remaining bone

Attach the PS-Post™ Box Reamer onto a drill using the Modular Driver, and insert the Reamer into the Reaming Guide (Fig. 30).

Ensure the power handpiece is set to [Ream], not [Drill]. The Reamer should be spinning prior to engagement with bone to help prevent fracture.

Ream to the stop without excessive pressure. Ensure the reaming guide remains fixed during reaming. Leave the Reaming Guide in place, using the sides as a guide to remove an remaining bone with an oscillating saw (Fig. 31).

Ensure the vertical walls of the box cut are flush with the Reaming Guide. Overhanging bone left after box preparation may cause a femoral condyle fracture when the final implant is placed.

If using the optional modular Femoral Pegs, drill the peg holes using the 3-in-1 Drill.

The Klassic® Femur and Klassic® Femur with Aurum® feature pegs for rotational stability; peg holes must be drilled before final implantation.

Remove the PS-Post™ Reaming Guide by depressing the button. Leaving the Femur Trial in place, attach the appropriately sized Intercondylar Box Trial. If the Box Trial does not fully seat into the Femur Trial, remove any remaining bone and soft tissue to ensure clearance.

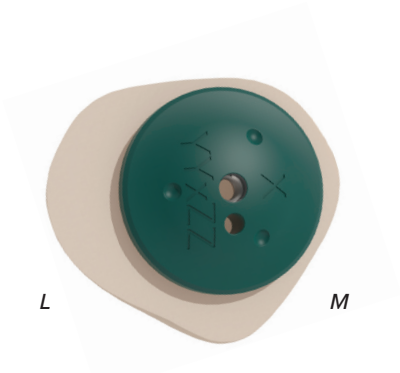


Fig. 32: Insert the Patella Trial

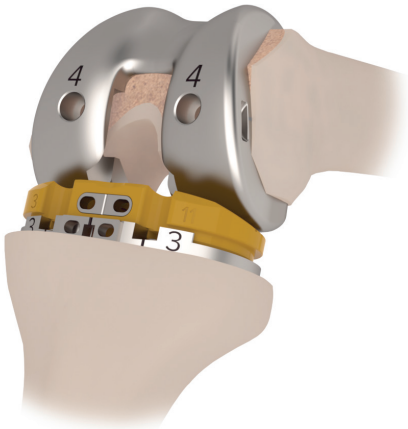


Fig. 33: Assemble the Tibial Baseplate and Insert Trials

Fig. 34: Assemble the Slap Hammer

10. TRIALING THE TIBIA AND PATELLA

Insert the appropriate Patella Trial (Fig. 32).

If using the Klassic® PS-Post™ Femur, assemble the Box Trial to the Femur Trial if not already done.

Select the appropriate thickness of Tibial Insert Trial and attach the Modular Alignment Handle and rigidly lock in place. Place the selected Tibial Insert Trial on the Tibial Baseplate Sizer/Trial (Fig. 33).

Check stability throughout the range of motion and remove any remaining posterior osteophytes that inhibit flexion. Any fine-tuning or soft tissue releases should be done at this time.

Surgical Pearl: Six keys to component placement to optimize patellar tracking:

1. *Lateralize the tibial component*
2. *Lateralize the femoral component*
3. *Ensure the femoral component is not internally rotated*
4. *Ensure the tibial component is not internally rotated by referencing the anterior medial cortex.*
5. *Ensure the components are not placed with excess valgus alignment*
6. *Medialize placement of the patella and ensure uniform thickness*

Ensure the femoral peg holes have been prepared. If using the Klassic® PS-Post™ Femur without Modular Pegs, do not prepare the peg holes.

Assemble the Slap Hammer by sliding the small end of the Slap Hammer Rod through the axial hole on the square end of the Modular Impaction Handle. Snap the other end of the handle onto the Rod to complete assembly (Fig 34).

After removing any remaining fixation screws, remove trial components using the Slap Hammer. If the Tibial Broach was left in place, remove it using the Tibial Broach Impactor.

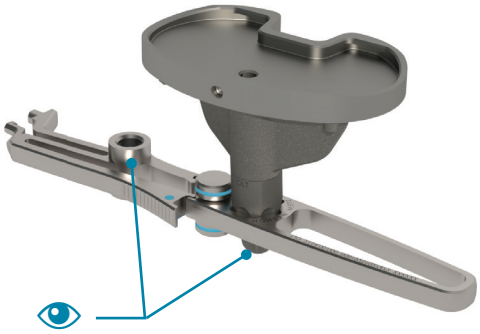


Fig. 35: Tighten Tibial Stem Extension to the Tibial Baseplate

Fig. 36: Assemble Modular Pegs, if desired (Klassic® PS-Post™ Femur only). Ensure Peg holes have been drilled

Fig. 37: Impact the Klassic® Tibial Baseplate

11. IMPLANTING THE FINAL COMPONENTS

Copiously wash the wound.

Change gloves and carefully open the components on the back table.

Use caution when opening the Tibial Baseplate Assembly. The Tibial Insert Set Screw is included in the packaging for the Tibial Baseplate Assembly and is required to fully engage the locking mechanism on the Tibial Insert.

The Tibial Baseplate Assembly includes a preassembled threaded 10mm Poly Dome on the distal end. If using a Tibial Stem Extension, remove the Poly Dome and attach the Tibial Stem Extension using the Tibial Stem Wrench in the Modular Alignment Handle. Securely tighten the Tibial Stem Extension to the Tibial Baseplate (Fig. 35).

The Modular Alignment Handle can be used to evaluate Alignment using the Drop Rod as well as help with insertion and placement of Tibial Trial components. It also serves as the wrench for assembling Tibial Stems.

If using the Klassic® PS-Post™ Femur and electing to add the modular Femoral Pegs, securely attach the Pegs to the Femur with the 3.5mm Hex Screwdriver (Fig. 36).

If cementing, apply a 3-4mm layer of bone cement to the underside of the Klassic® Tibial Baseplate, Femur, and Patella components, taking care not to coat the Femoral Pegs.

Disassemble the Slap Hammer by depressing the button near the top of the Handle. Attach the Tibial Impactor Head to the Modular Impaction Handle. If implanting an All-Poly tibial component, use the All-Poly Impactor Head.

If implanting the Klassic® Porous Tibial Baseplate, spread a thin layer of bone slurry to the proximal tibial cut surface using a flat instrument such as an osteotome or bone tamp. Use a saw blade or burr to create the bone slurry with the retained resected tibial wafer.[30]

Surgical Pearl: Porous coated implants offer an interference fit as part of the initial mechanical fixation. It is essential that the Tibial Baseplate and the cut surface of the tibia are coplanar in order to properly seat the tibia and to avoid interrupting the interference.

Impact the Klassic® Tibial Baseplate Assembly or Klassic® All-Poly Tibia (cemented only) into the proximal tibia (Fig. 37).

If cementing, ensure the cement is pressurized into the bone.

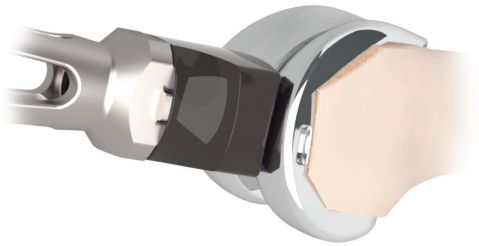


Fig. 38: Impact the Klassic® Femur

Fig. 39: Engage the Klassic® Tibial Insert locking mechanism

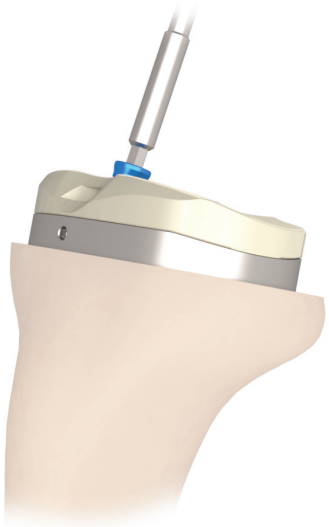


Fig. 40: Engage the Tibial Insert Set Screw

Surgical Pearl: Proper cement technique is essential to achieve long-term survivorship.[31] Use a scalpel to cut the excess cement around the implant before removing it with a curette. This technique will help retain the cement mantle under the Tibial Baseplate on sclerotic bone.

Remove the Tibial Impactor Head from the Modular Impaction Handle and replace it with the Femoral Impactor Head. Implant the femur using the Femur Impactor Assembly, the Femur Extractor/Impactor, or the Notch Impactor (Fig. 38). Ensure that proper alignment is maintained in extension and the Femur is fully seated. If cementing, remove excess cement.

Remove the Femoral Impactor Head from the Modular Impaction Handle and replace it with the Tibial Insert Impaction Head. Lightly impact with a mallet to engage the Tibial Insert locking mechanism using the Tibial Insert Impactor Assembly (Fig. 39).

Insert the Tibial Insert Set Screw into the hole in the Tibial Insert and tighten it with a 3.5mm Screwdriver (Fig. 40).

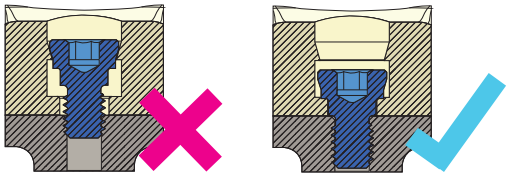


Fig. 41: Proper insertion of the Tibial Insert Set Screw

The anti-backout feature of the Tibial Insert will provide some resistance while tightening the Screw; completely bottom out the Screw with the Baseplate (Fig. 41) to ensure that it is tightened appropriately.

Surgical Pearl: If after final seating of the Tibial Insert a different size is selected for ligament balance or motion concerns, simply remove the Set Screw and place a .50in osteotome in the anterior aspect of the polyethylene (after the bone cement has cured) and lift upward on the polyethylene to release the Baseplate locking mechanism without damaging the Baseplate itself.

Note: Additional Tibial Insert Set Screws are packaged separately in the event the enclosed screw is misplaced.

The PS-Post™ System is not compatible with the Klassic® CR/Congruent, Ultra-PS®, or All-Poly Tibia Inserts.

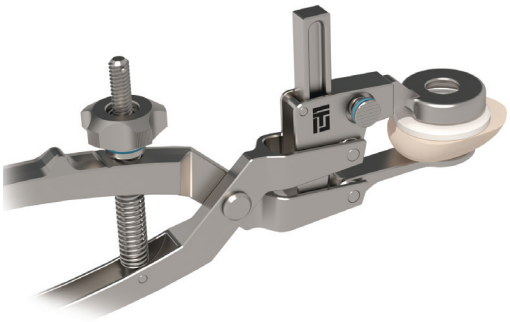


Fig. 42: Implant the Klassic® Patella with the Patella Clamp

Remove the Modular Patella Sizer/Drill Guide from the Patella Clamp, and replace it with the Patella Cement Clamp Tip. Implant the patella by lining up the patellar pegs with the previously drilled holes and tightening the Patella Clamp (Fig. 42).

Reduce the joint, ensure that components are fully seated, and check the range of motion and ligament stability again (Fig. 43). Measure the final patellar thickness and ensure proper patellar tracking.

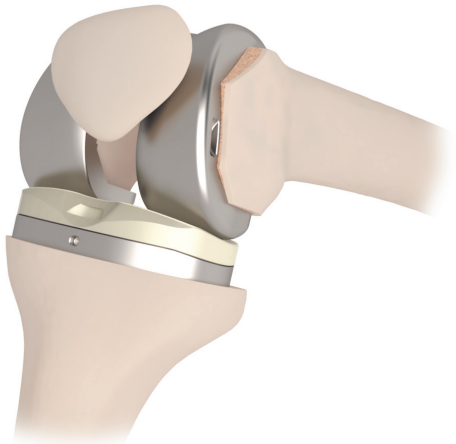


Fig. 43: Check the range of motion and ligament stability

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