KNEE3

SURGICAL TECHNIQUE

BRAINLAB

Purpose

This Surgical Technique is based on the Brainlab Knee3 software. It documents how Knee3 may be used in a clinical setting, but it is not meant as a replacement to the Knee3 Software User Guide. For questions regarding recommended use of Brainlab equipment and/or software, always refer to the Knee3 Software User Guide as your first level of product support.

The training provided to the customer is based on the product-specific training requirements. Users must be trained and qualified to operate the Knee3 navigation system. Contact Brainlab Customer Support if new users require training.

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O.R. Setup

CAMERA PLACEMENT

The ideal position for the camera is at a distance of about 1m to 1.5m on the opposite side of the surgeon's position on the table, approximately between 90° and 45° towards the foot of the patient. The camera is equipped with a laser pointer. Point the laser at the center of the knee joint when the knee is in flexion.

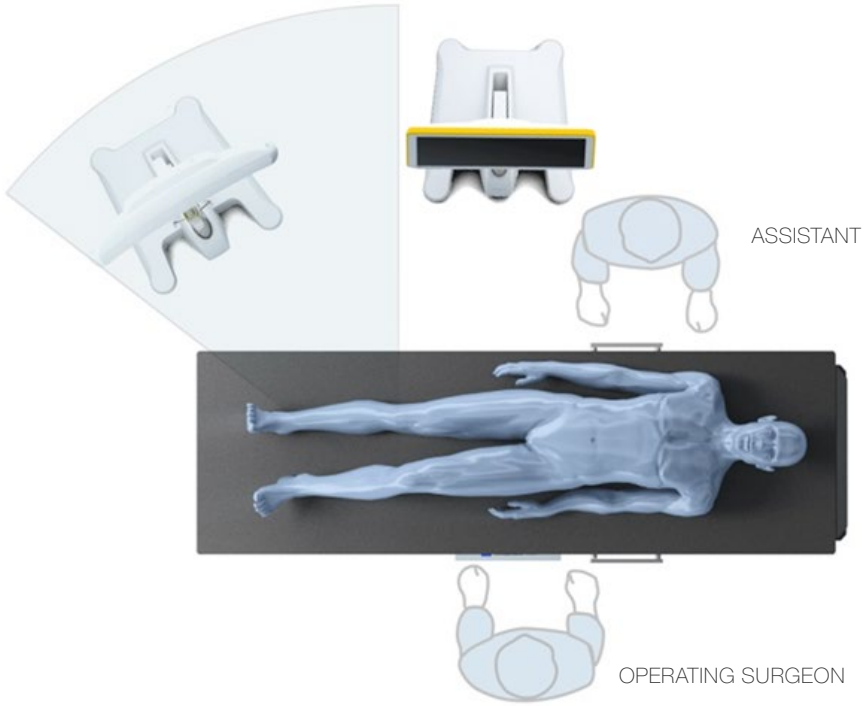
The camera should be switched on for several minutes prior to use, as the infrared source needs some time to reach maximum efficiency. Any light sources or highly reflective objects should not be within the camera's field of view, as reflections can interfere with the procedure.

SCREEN PLACEMENT

A good position for the display is on the opposite side of the surgeon's position next to the camera.

User interaction with the touchscreen is reduced to a minimum through an adaptive workflow. Nevertheless, sometimes it may be necessary to make inputs on the screen (e.g. to adjust implant size). In these cases, the optional footswitch or sterile monitor drape can optimize operating the navigation system.

Art. no. 18460 *Footswitch*
Art. no. 18071-50 *Disposable Sterile Monitor Drapes (40 pcs)*

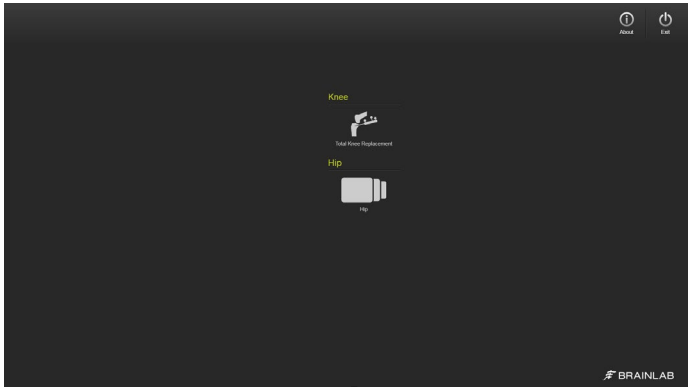


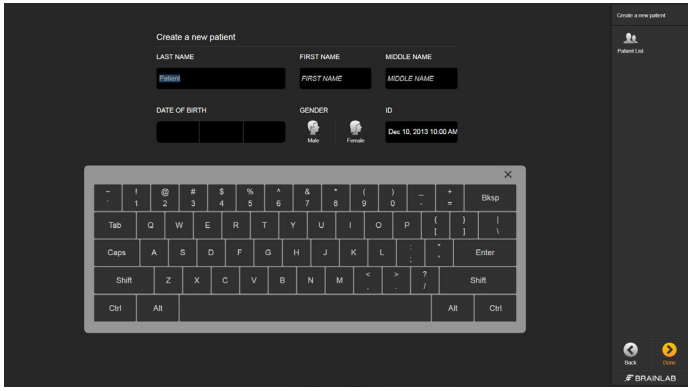
SOFTWARE START & PATIENT SELECTION

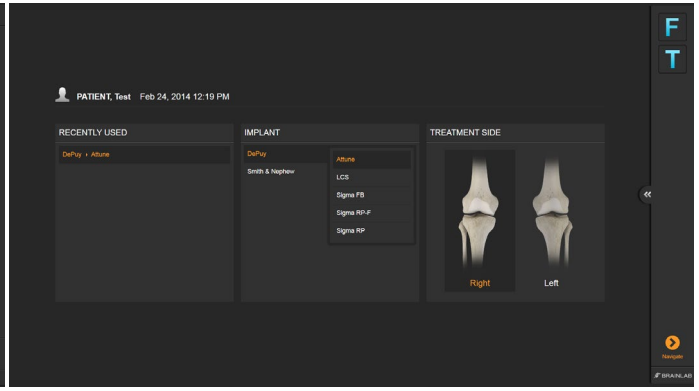
Start the knee software, enter patient name or select from list (PACS), select implant and treatment side. For more details, see the Patient Data Manager user manual.

At the scrub table, prepare instruments with marker spheres. Twelve marker spheres are needed for a surgery. Tightly screw the spheres onto the socket. If the markers are not tightly screwed on the socket, the instruments might not be detected at the correct position. If a marker is soiled the detected instrument position might be wrong. Remove reference arrays before resection to avoid soiling.

Art. no. 41774 *Disposable Marker Spheres (270 pcs)*
Art. no. 41773 *Disposable Marker Spheres (90 pcs)*







The Y-shaped array is placed on the femur; the T-shaped array is placed on the tibia. During navigation they define the position of the bones.

Art. no. 52410 *T-Array*

Art. no. 52411 *Y-Array*

The pointer is used for registration of anatomical landmarks and measurements throughout the case. To ensure that the pointer is not bent, place it into the corresponding gauge.

Art. no. 53101 *Pointer*

The Plane Tool or Universal Cutting Block Adapter are used for navigating and verifying resections. The foot of the Plane Tool is inserted into the corresponding cutting block while fixing the block onto the bone.

Art. no. 53200 *Plane Tool*

Art. no. 41866-77 *Universal Cutting Block Adapter*

Incision & Exposure

Incision and exposure to the knee joints should be performed based on the surgeon's choice of technique. Brainlab knee navigation instruments support all standard approaches. Depending on the type of incision used, reference arrays can be used inside the standard incision or through separate small incisions.

After initial exposure, remove prominent osteophytes, in particular in the medial and lateral part of the distal femoral condyles, to allow access to the intercondylar space during registration.

REFERENCE MARKER PLACEMENT

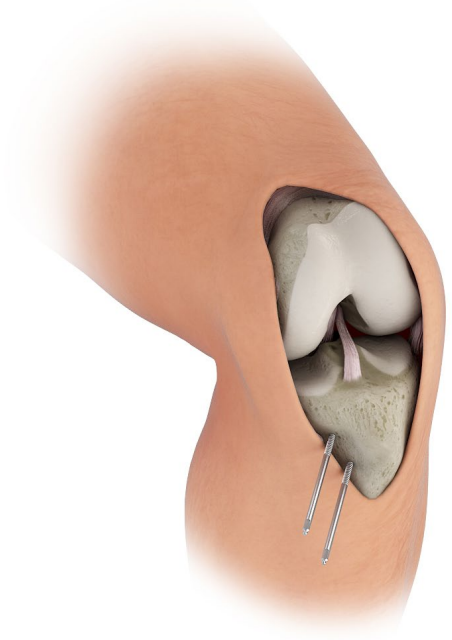
Brainlab Knee instruments are designed to be used with a variety of pins. It is recommended to use 3.2mm self-drilling, self-tapping pins as available from Brainlab. Alternatively, any pins between 3mm and 4mm can be used based on the surgeon's preference. Please refer to the respective user guide for drilling, if using different pins.

Art. no. 54932	*Adapter For AO Coupling (for 54922)*
Art. no. 54922	*Disposable Schanz Screw (AO) 3.2mm x 100mm (10 pcs)*
Art. no. 54908	*Disposable Schanz Screw (AO) 4mm x 125mm (10 pcs)*

TIBIA

The tibial array can be placed either inside or outside the incision. The pins need to be placed distant from the intended positions of both the femoral and tibial instruments to avoid any contact during bone resection and drilling.

When placing the pins inside the incision, a position slightly medial of the anticipated position of the cutting block, angled slightly downwards is recommended.



Alternatively, the pins can be placed through small stab incisions on the anterior cortex approximately in the middle of the tibia.

If the pins are angled slightly to the medial side, extramedullary tibial instrumentation can be used for cutting block placement and adjustment as well as additional stability.

Please refer to standard instructions for the placement of pins and screws, such as the AO Guidelines, for exact safe zones for angulation and placement of the pins.

Place the first pin directly at the desired location, slide the Bone Fixator 2-Pin over the first pin (make sure the fixation screw is open) and place the second pin through the pinhole. Tighten the fixation screw securely to the bone in the correct orientation.

Art. no. 52429 *Bone Fixator 2-Pin, Flip Flop, X-Press*

The T-reference array is connected to the fixation using the X-press mechanism. The T-reference has a joint with two degrees of freedom, allowing adjustment of the orientation. Recommended orientation of the T-reference is rotated towards the camera, slightly tilted upwards parallel to the tibia.

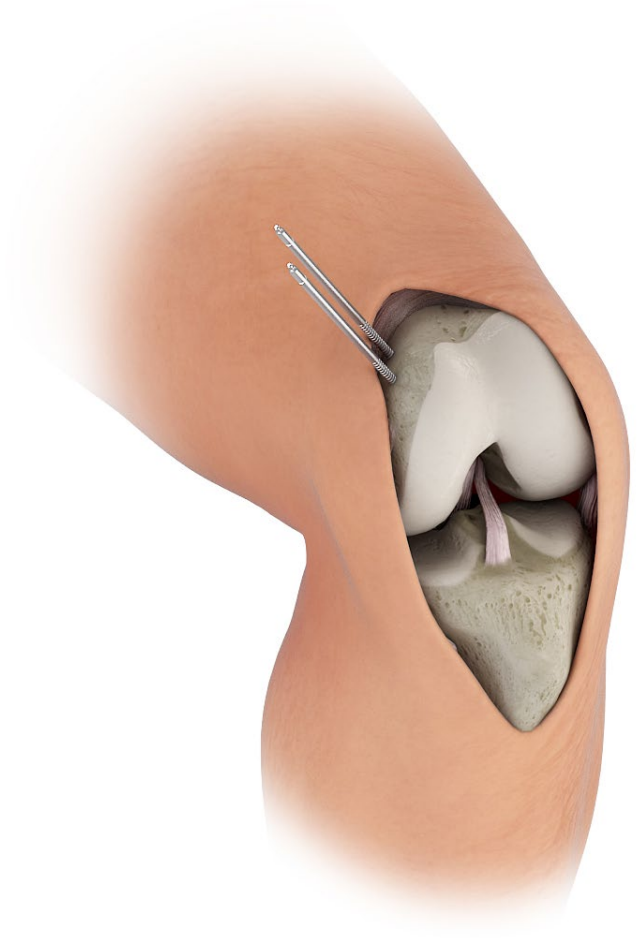
Note the adjustment mechanism allows for discrete positions in both degrees of freedom. Make sure the interface is in one of these positions before tightening the screw. If placed in-between positions, the mechanism might snap into one of the predefined positions during the procedure, losing the fixed reference.

Art. no. 52410 *T-Array*

FEMUR

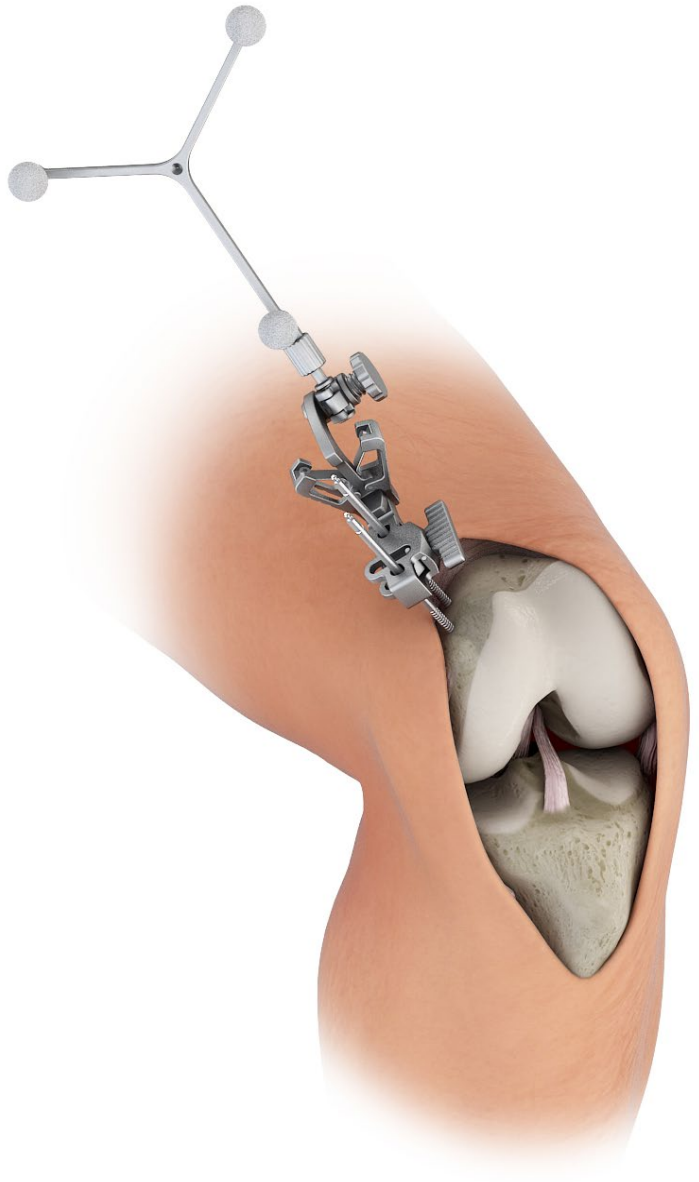
The femoral array can be placed either inside or outside the incision. If placed outside the incision, care must be taken to limit soft tissue damage. Excess stress on pin fixation must be avoided during range of motion intraoperatively. Inside the incision, make sure to leave space for femoral instrumentation as well as resections during final preparation.

Again, place the first pin directly at the desired location, slide the Bone Fixator 2-Pin over the first pin (make sure the fixation screw is open) and place the second pin through the pinhole. Tighten the fixation screw securely to the bone in the correct orientation.



Recommended orientation of the Y-reference is rotated towards the camera, substantially tilted upwards from parallel to the femur. This will allow visibility of the femoral reference even in deep flexion. Again ensure the interface is not at in-between positions before tightening the fixation screw.

Art. no. 52411 *Y-Array*
Art. no. 52429 *Bone Fixator 2-Pin, Flip Flop, X-Press*



ALTERNATIVES

The optional Brainlab adjustable cutting block allows precise adjustment of the distal femur cut, while only a rough initial placement is necessary. In addition, the femoral reference array can be attached to the base of the cutting block, therefore requiring no extra pins. Note that this allows only navigation and resection of the distal femoral cut, as the fixation pins for the block and base will interfere with the anterior femoral resection.

Art. no. 5323x	*Adjustable Cutting Block Femur Kit 1.19/1.27/ 1.37mm*
Art. no. 53211	*Adjustable Cutting Block Femur Reference Array*

Instead of the 2-pin fixation described above, 1-pin fixations can be used both on tibia and femur. 1-pin fixation requires 5mm screws to be used for fixation. Refer to the user manual for instructions. 1-pin fixation is not recommended in weak bone quality and in cancellous bone areas in particular when placed inside the incision.

Art. no. 54909	*Disposable Schanz Screw (AO) 5mm X 175mm (10 pcs)*
Art. no. 5242x	*Bone Fixator 1-Pin Size S/M/L*

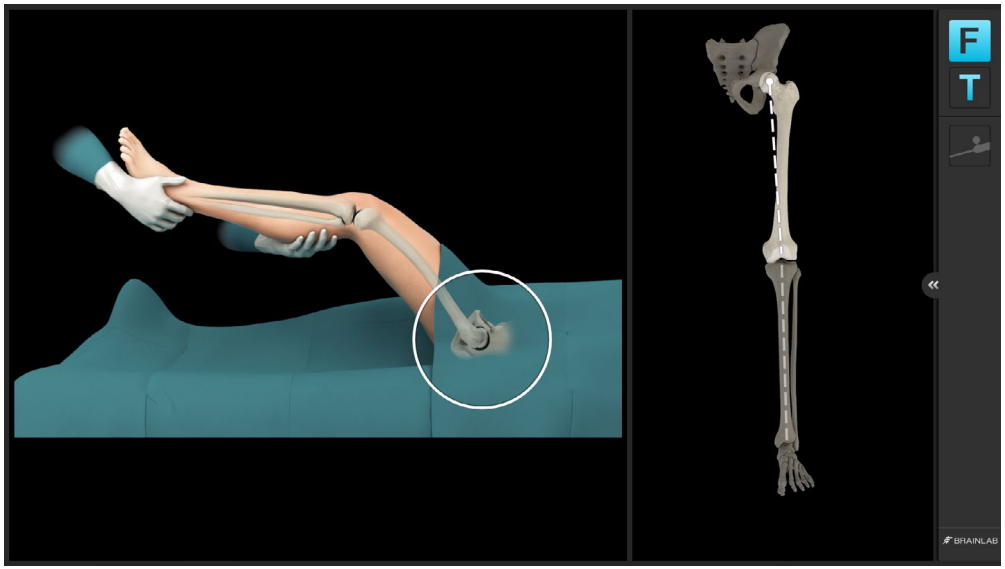
Registration

FEMUR

After again checking visibility of the reference arrays over flexion and extension of the knee, start registering the anatomical landmarks.

On the femoral side, the following bone landmarks are registered:

- Femoral head center
- Distal femoral axis point
- Medial and lateral epicondyles
- Whiteside's Line (optional)
- Medial and lateral femoral condyles (optional)
- Anterior reference point



FEMORAL HEAD CENTER

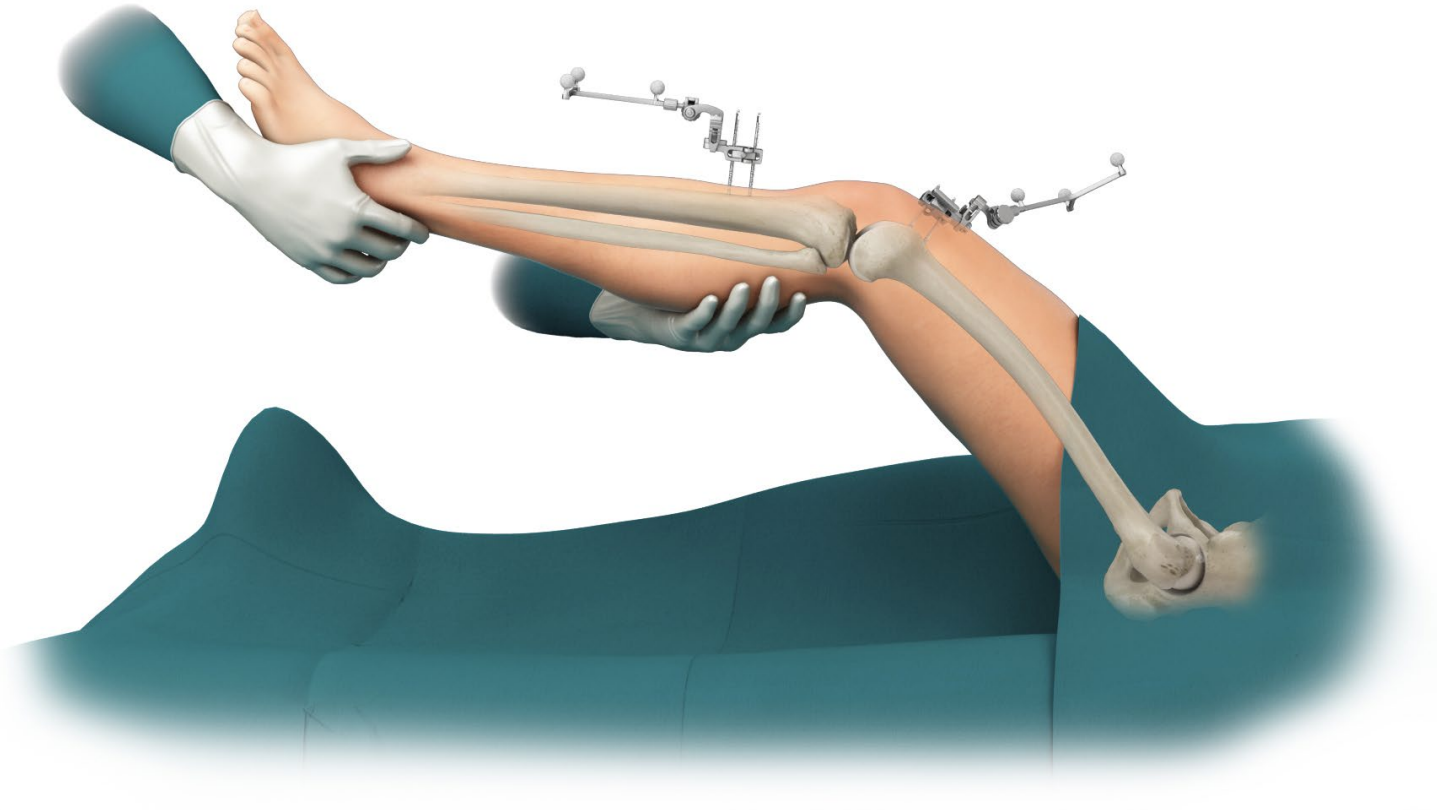
The femoral head center point defines the proximal part of the Mikulicz Line and femoral mechanical axis. Make sure the femoral reference array is visible to the camera. The system will produce a humming visibility sound (if turned on in Settings, see Appendix) while the femur reference is visible.

Bring the leg from flexion to extension and back, then slightly rotate the leg externally and repeat the flexion-extension movement. Alternatively, apply circular motions of the femur around the hip center.

The system calculates a series of points to determine the rotational center and will automatically proceed when the rotational center has been accurately calculated.

Make sure that the patient's pelvis is not moved during registration, as this may lead to miscalculation of the femoral head center. If the surgeon is having difficulty acquiring the femoral head center, it is helpful to have an assistant hold the pelvis firmly.

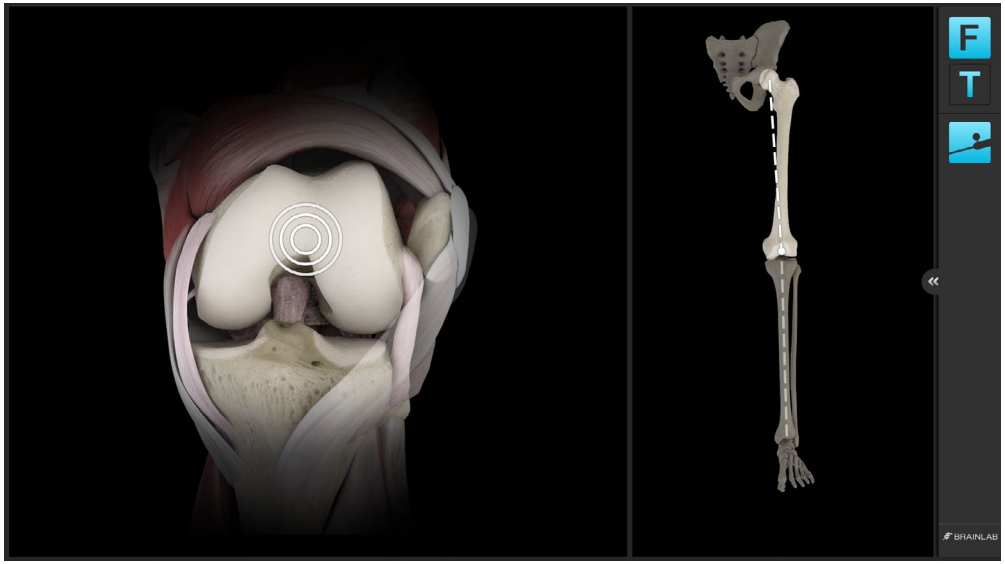
Do not move the camera while moving the leg!

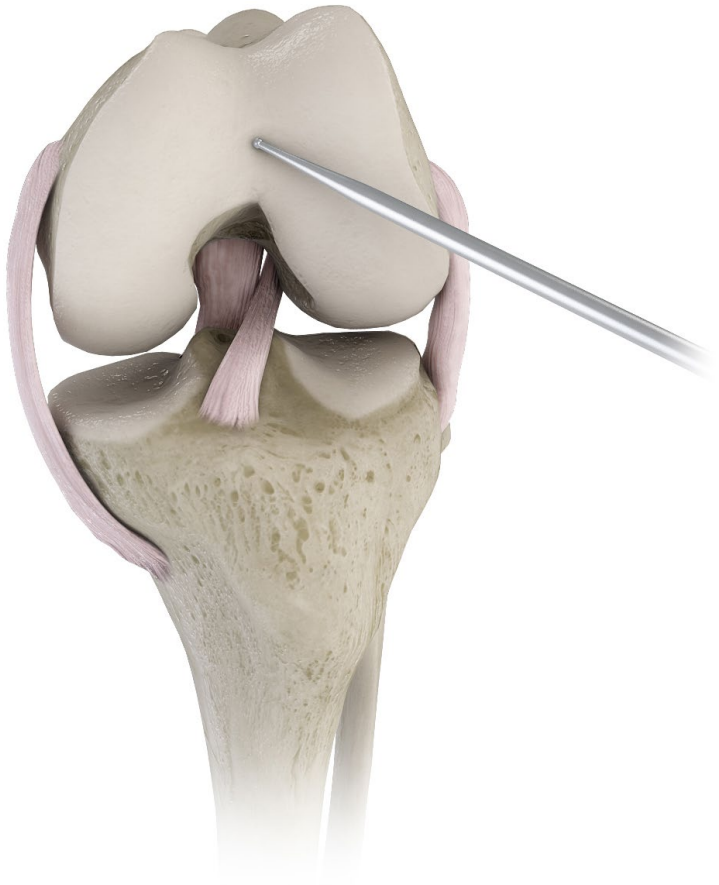


DISTAL FEMORAL MECHANICAL AXIS POINT

Defining the femoral mechanical axis is important for determining the varus/valgus and flexion/extension alignment of the femoral component, as well as overall leg alignment. Care should be taken to be as accurate as possible when collecting this point. The pointer should be placed slightly in medial at the posterior aspect of the femoral notch point (as indicated on screen).

The acquisition of this point along with the femoral head center completes the femoral mechanical axis. It is important that this point is acquired as accurately as possible. If this point is acquired too far anterior, it may exaggerate the displayed knee flexion angle. If this point is acquired too far posterior, it may exaggerate the displayed knee extension angle.

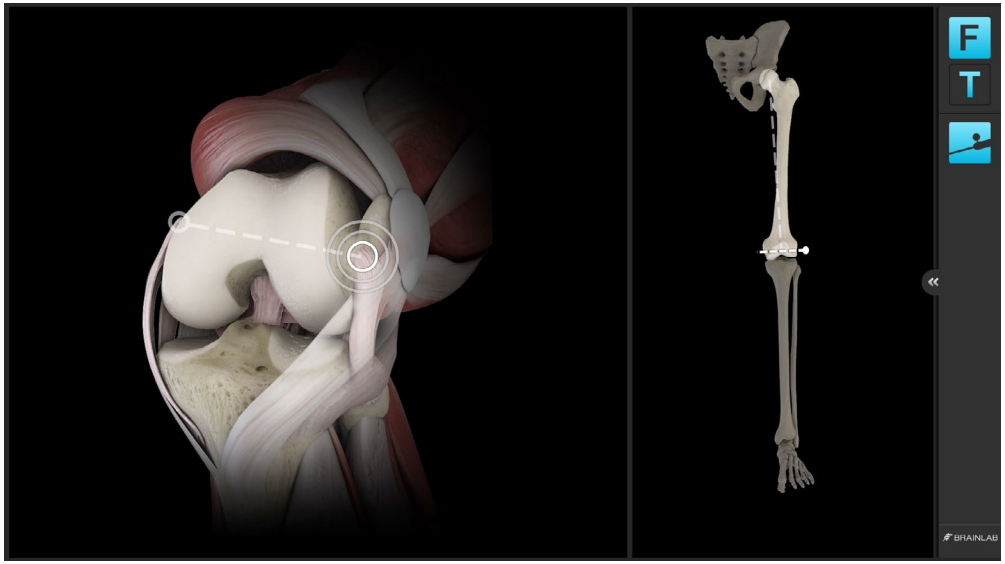


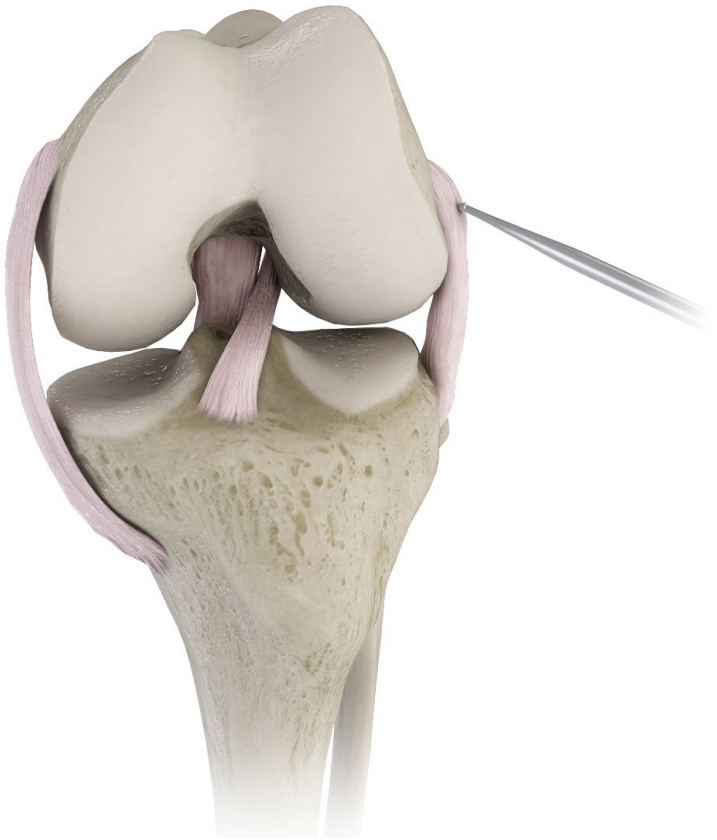


EPICONDYLAR LINE

Acquisition of the medial and lateral epicondylar points is used to define the epicondylar line as well as a reference for internal calculations.

Note that it has been shown in various studies that the epicondylar axis might be difficult to locate, in particular in knees with large deformities. It is recommended to use the surgical transepicondylar axis as defined by the most prominent points on the medial and lateral epicondyles, but keeping in mind the variability of that landmark, in particular in deformed knees, when using it as the main rotation reference.

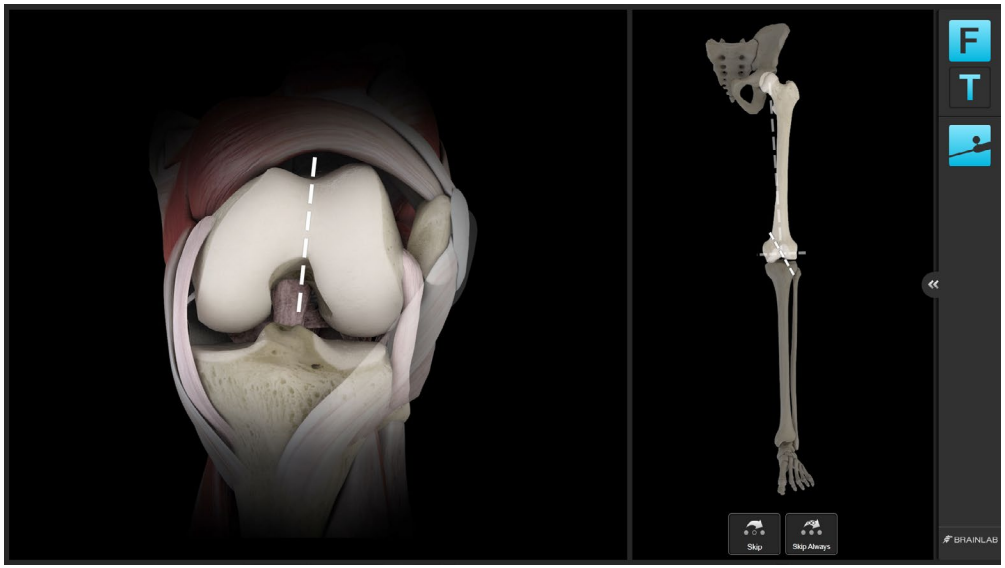




WHITESIDE'S LINE (ANTEROPOSTERIOR AXIS)

Whiteside's Line is used to define the femoral AP direction. It can be used as an optional reference for femoral component rotational alignment. It may be marked initially using electrocautery or a sterile pen. It is easiest to draw by looking along the horizon of the trochlear groove. Once the line is drawn the pointer can be held along this line.

Note: This registration step can be skipped if desired. This will result in no rotation to Whiteside's Line being displayed during navigation and planning.

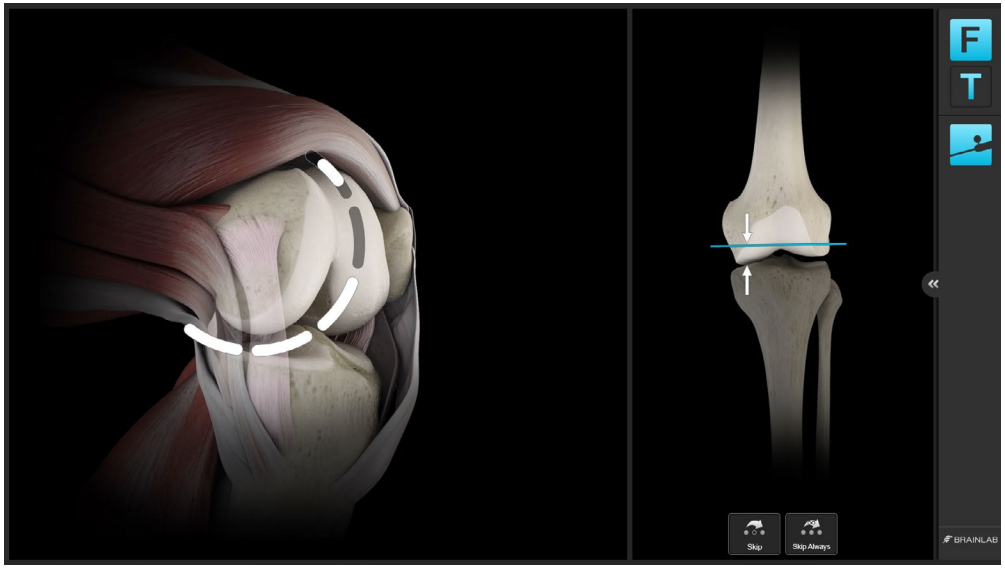


FEMORAL CONDYLES

A number of points along the surface of the medial and lateral condyles are acquired using the pointer. The tip of the pointer should 'paint' the surface of the condyles. Points should be acquired as posteriorly as possible and along the distal part of the affected condyles. The system determines the most distal and most posterior points from all the data collected.

Start with pivoting on the distal aspect of the condyle, then move to posterior in a zig-zag motion to make sure to cover the most prominent points of the condyles.

The screen shows the current position of the pointer in one of the five sectors. In each sector, a certain number of points needs to be collected. The software will proceed once all sectors are covered.

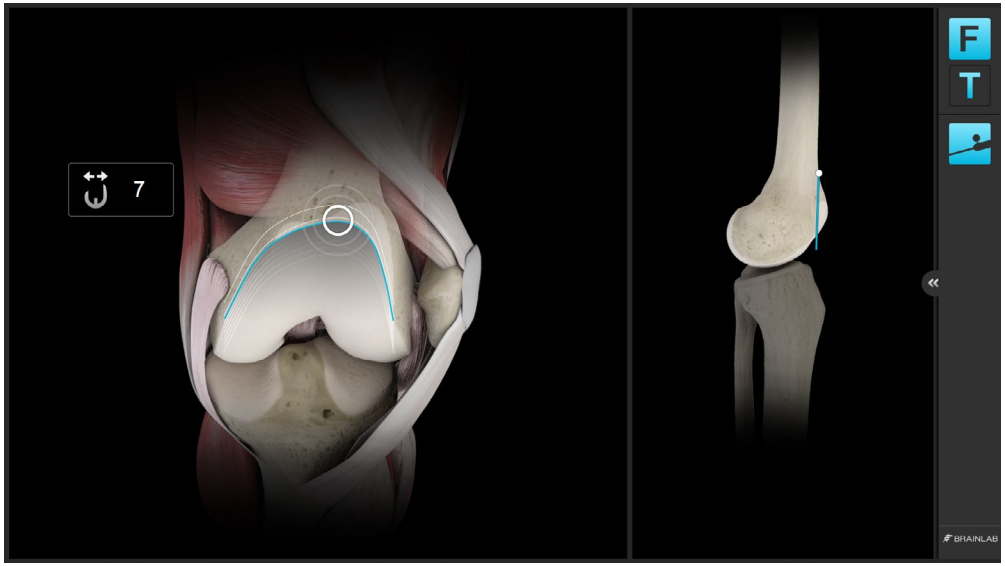


Note: Registration of one or both condyles can be skipped, if for example in a revision from a partial to a total knee replacement one condyle is missing. A skipped condyle will result in no resection levels or joint line information being displayed on the respective side, as well as no rotation to the posterior condylar line being shown during navigation and planning. All other functionalities, including gap calculations, are not affected.

ANTERIOR REFERENCE POINT

The femoral anterior reference point is acquired using the pointer. Ideally, the pointer should be placed on a point on the lateral side of the anterior femoral cortex just above the superior border of femoral implant. The anterior reference point is used as a reference for the exit of the anterior cut plane and determines the femoral components AP position.

It should indicate the place where the superior aspect of the anterior flange of the femoral component would sit flush to the anterior cortex. To assist in positioning, the software shows the femoral component size that belongs to a certain position on the bone. With an approximate size in mind, place the pointer on the lateral side of the femoral cortex at the level of this size. If in between sizes, use the larger size—never smaller size—for better anterior positioning. This does not pre-determine positioning or sizing, it simply helps finding the correct reference point.

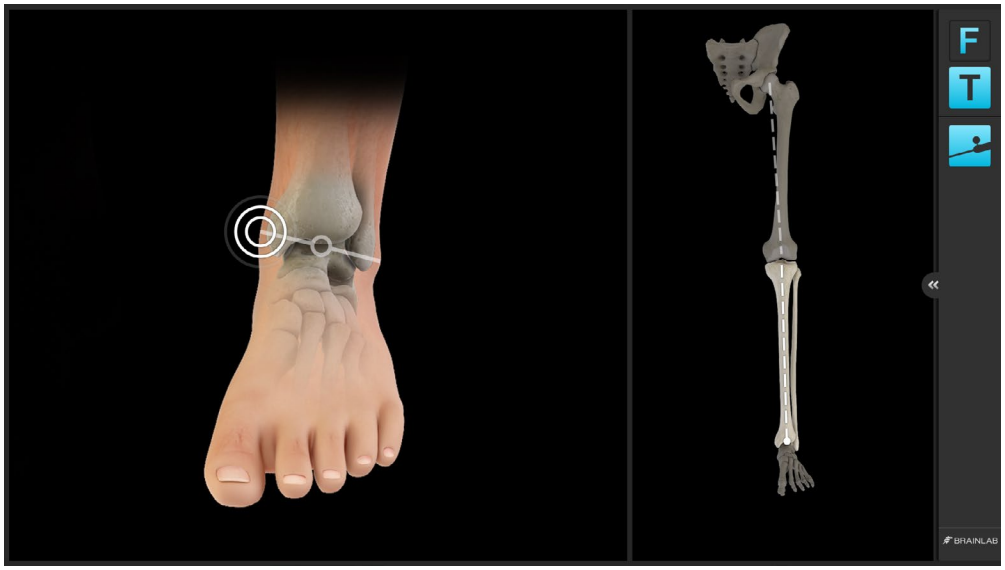


Registration

TIBIA

On the tibial side, the following bone landmarks are registered:

- Medial and lateral malleolus
- Proximal tibial mechanical axis point
- Tibial A/P direction
- Medial and lateral tibial plateau (optional)



MALLEOLI

The malleoli can usually be located by palpation of the most prominent point of the malleoli before acquiring the points. It is important that draping or bandaging is reduced to a minimum to enable the malleoli to be located.

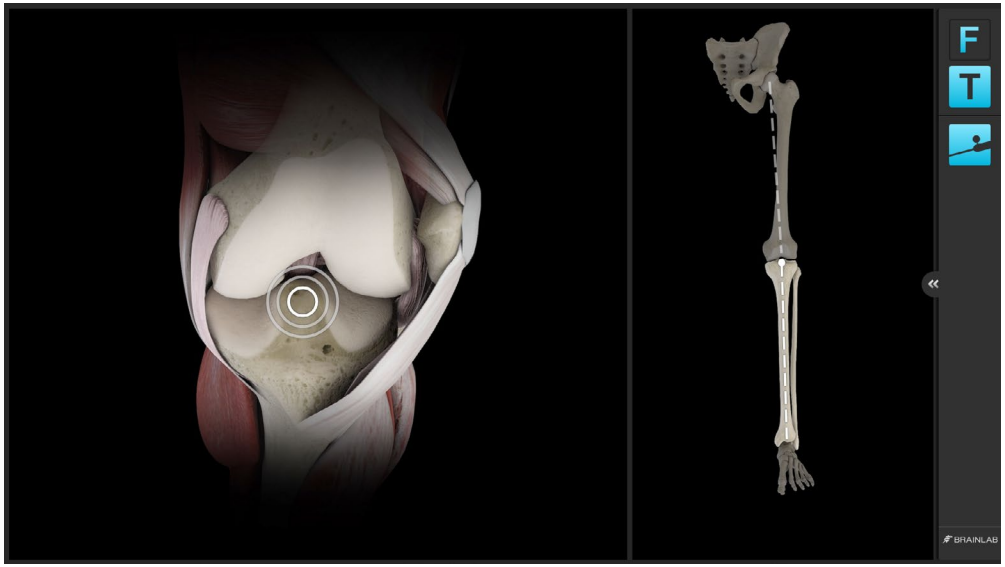
Place the tip of the pointer on the medial malleolus and pivot the pointer. Once the system has registered the medial malleolar points, the lateral malleolar point can be registered in the same way. Acquiring the malleoli defines the most distal point of the axis.

PROXIMAL TIBIAL MECHANICAL AXIS POINT

The proximal point on the tibial mechanical axis is defined by acquiring the posterior aspect of the ACL tibial insertion point.

This is indicated by the circle on the screen. Additionally the intersection of the mid-coronal and mid-sagittal planes can be used for the identification of this point.

The definition of the mechanical axis is the basis for all further calculations and should be acquired as accurate as possible. Final implant position will be referenced to the mechanical axis.

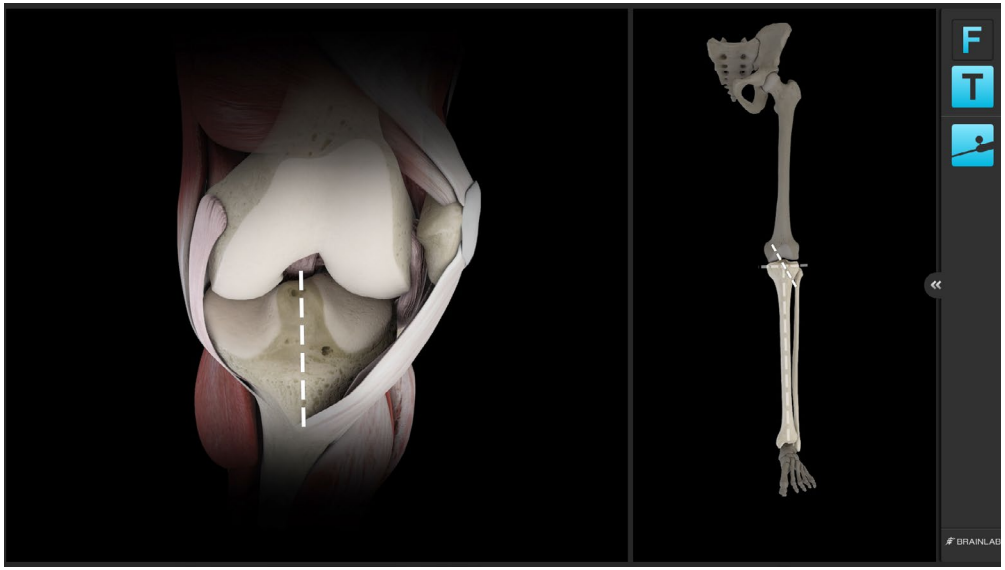


TIBIAL A/P DIRECTION

The pointer is placed horizontally in the A/P direction, so that it lies on the tibial eminence. The handle should be in line with the medial third of the tibial tubercle. The pointer is held in place for a few seconds to allow the system to calculate the direction.

The system determines the direction the tibia is facing and the direction of any intended slope which may need to be cut. The rationale behind this is to avoid a compound tibial slope (oblique tibial slope). Accurate acquisition of the A/P direction will help to avoid an oblique tibial slope in the anteromedial to posterolateral direction or anterolateral to postero-medial direction.

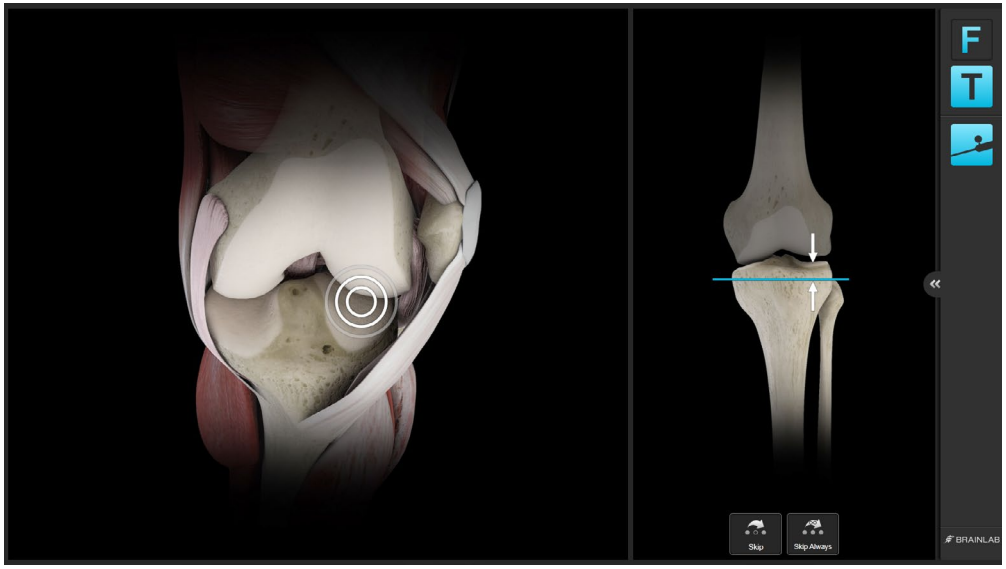
Compound slope can put the tibial component into varus or valgus and lead to poor tibial/femoral contact. This can lead to malalignment.

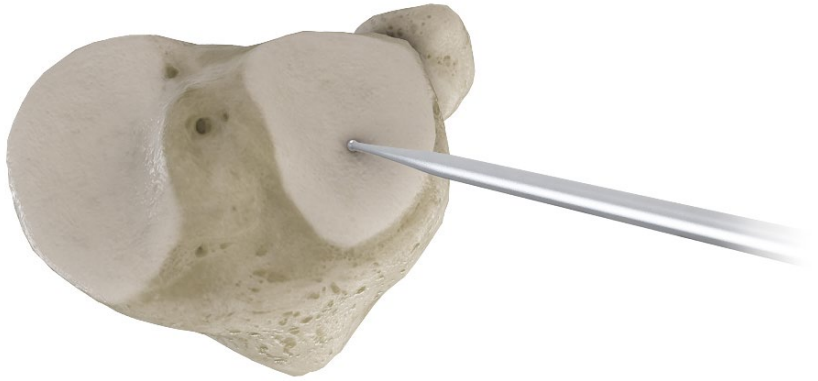


TIBIAL PLATEAU

A single point on each plateau is used to calculate the tibial resection level. Careful consideration should be given if bone defect is present. The software will show resection height numbers from this reference point.

Note: Registration of one or both tibia plateau points can be skipped, if for example in a revision from a partial to a total knee replacement one condyle is missing. A skipped condyle will result in no resection levels being displayed on the respective side during navigation and planning. All other functionalities, including gap calculations, are not affected.





Surgical Techniques

SEQUENCE OF RESECTIONS

Knee3 does not use predefined workflows leading the surgeon in a particular sequence of resections. The software instead simply follows the sequence of steps performed surgically. Nevertheless, depending on the sequence of resection, surgical considerations at each step might be slightly different, due to the available options for cutting block positioning.

FEMUR FIRST TECHNIQUE

Femur first techniques are probably the most common technique for total knee replacement. Note that in contrast to conventional femur first techniques, using computer navigation with Knee3, the final implant stability effect of the tibial resection, while not being performed, can still be anticipated during the femoral resection steps, potentially enabling the surgeon to use that information to alter the femoral component position slightly to accommodate for potential unbalanced gaps.

An extension gap first balancing technique, with tibial resection performed after the distal femoral resection, does enable the surgeon to use a fixed spacer block to balance the knee joint in extension and subsequently adjust the flexion gap to the established extension gap during positioning of the anterior resection.

TIBIA FIRST TECHNIQUE

In contrast to the femur first techniques, the tibia first technique allows access to the back of the joint and at least partial removal of osteophytes for balancing, before any compromises have been made on the femoral cuts. Therefore, this technique offers the most options to achieve balanced gaps in extension and flexion using the desired implant size.

If no other surgical considerations stand against this approach, this sequence of steps is recommended.

ADAPTIVE WORKFLOWS

Brainlab Knee follows the user. It automatically identifies the current treatment step and displays the matching content on the screen. E.g. when the tibia cutting block with the Plane Tool is positioned on the tibia cortex, the software displays tibia cut navigation values.

The following navigation steps are available:

- Tibia cut navigation
- Distal femur cut navigation
- Anterior femur cut navigation

Use the Plane Tool for navigation or the pointer for measurements and the software will automatically display the according information.

Note: The order of cuts can be chosen by the user and is not predefined in the software.

When no tool (Plane Tool, pointer) is used, the software displays the leg alignment screen. It allows evaluating leg axis and flexion range, as well as joint stability.

When the software detects that a cutting block is positioned on the bone, it displays all relevant information for the respective resection. All values are calculated relative to bone references.

Blue lines show the current cut position relative to bone landmarks. Yellow lines represent the planned or verified cut.

Note: All values are referenced to bone landmarks. If you want to navigate to your planned resections you can use the yellow lines as a visual guide.

Femur First Technique

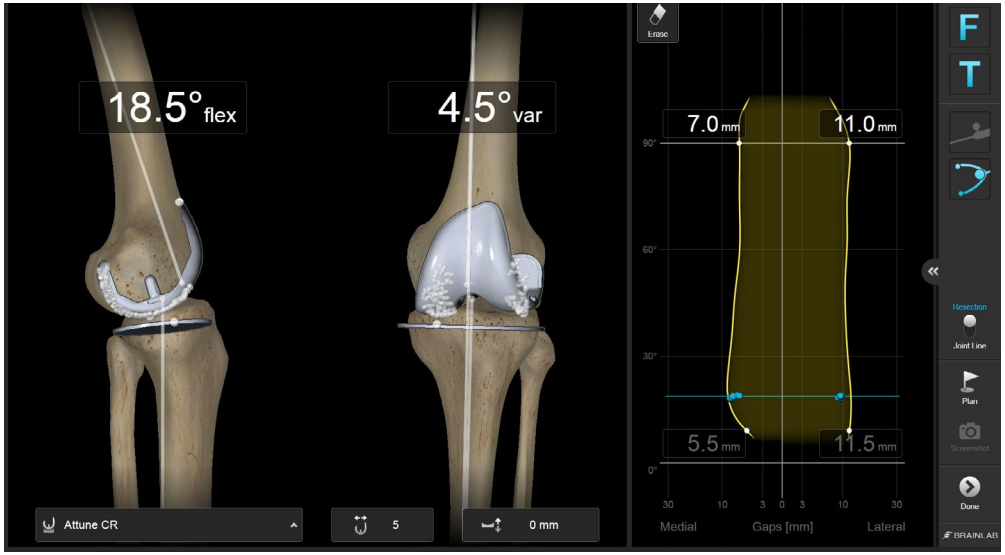
INITIAL LEG ALIGNMENT – SCREEN LAYOUT

After registration is finished, the screen is basically split into two parts.

The left hand side shows the current bony anatomical situation and measurements regarding the implant position; the right hand side shows the stability of the knee joint after implantation, even if no resection has been done. All calculations are based referencing a final implant positioning, therefore at any time in the procedure, the numbers denote the same values.

Initially, the implant is placed based on the measured resection principle. As the surgeon makes changes to the planned implant position throughout the procedure, the implant position is updated accordingly.

Note: At this step, tibial AP registration can be cross-checked kinematically. At 90° flexion, the tibial mechanical axis should not deviate significantly from the long leg mechanical axis. A significant deviation either denotes excessive tibial rotation or an erroneously registered tibial AP direction.

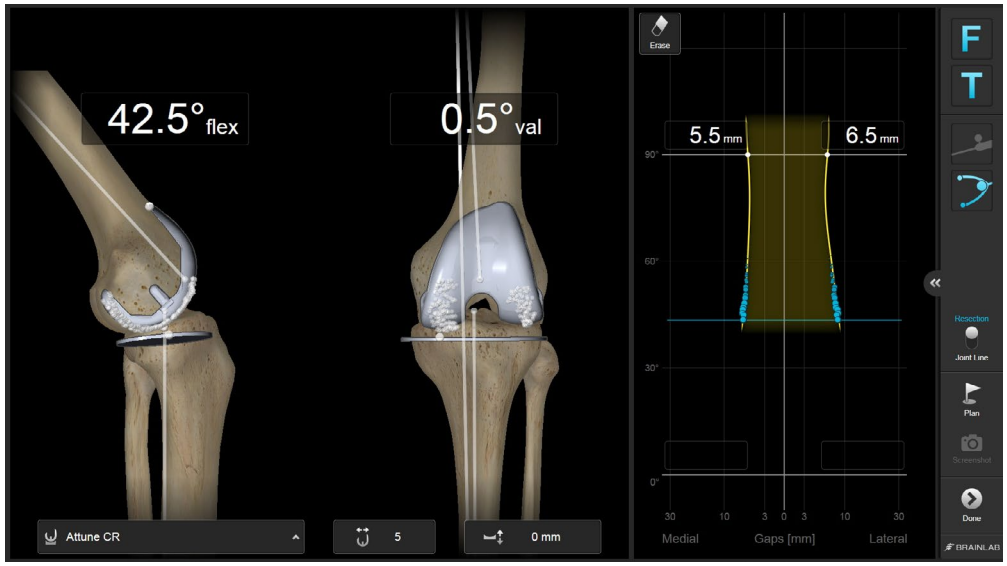


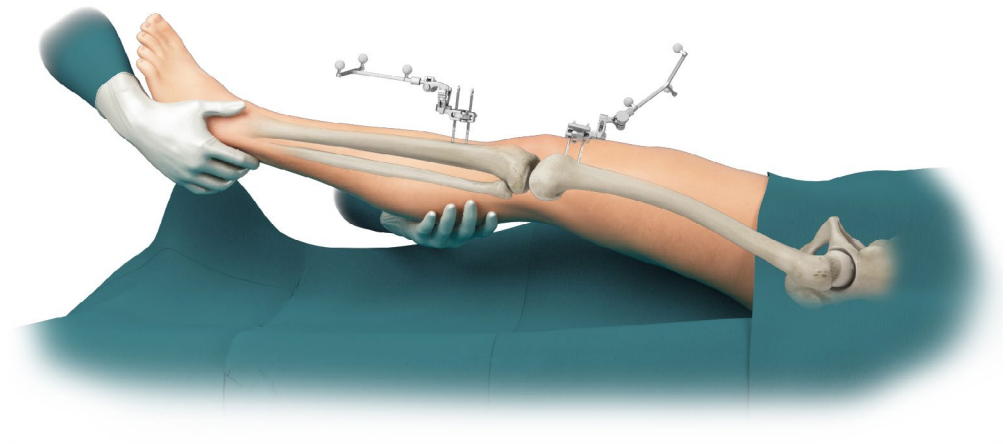
VARUS/VALGUS STRESS TESTING

Bring the leg into full extension and apply varus and valgus stress to test stability and check for fixed flexion or other deformities. Bring the leg into maximum flexion, applying varus and valgus stress during the movement. The stability graph on the right now shows the calculated implant stability assuming the implant position on the left.

The implant position on the left is initially based on a measured resection philosophy, with no joint line shift, neutral femoral flexion and coronal alignment, and femoral rotation based 3° external to the posterior condyles (or another rotation reference if selected).

At this stage, based on the stability information, decisions might be already derived regarding potential necessary releases or corrections of the implant position. Gaps from resected tibia to femoral implant are shown over the full range of motion as an interpolated line, while at 0° and 90° the actual numerical values are shown. In case of fixed flexion deformities, full extension might not yet be reached; however the lines already give an indication of what might be happening later after addressing the deformity.





DISTAL FEMORAL RESECTION

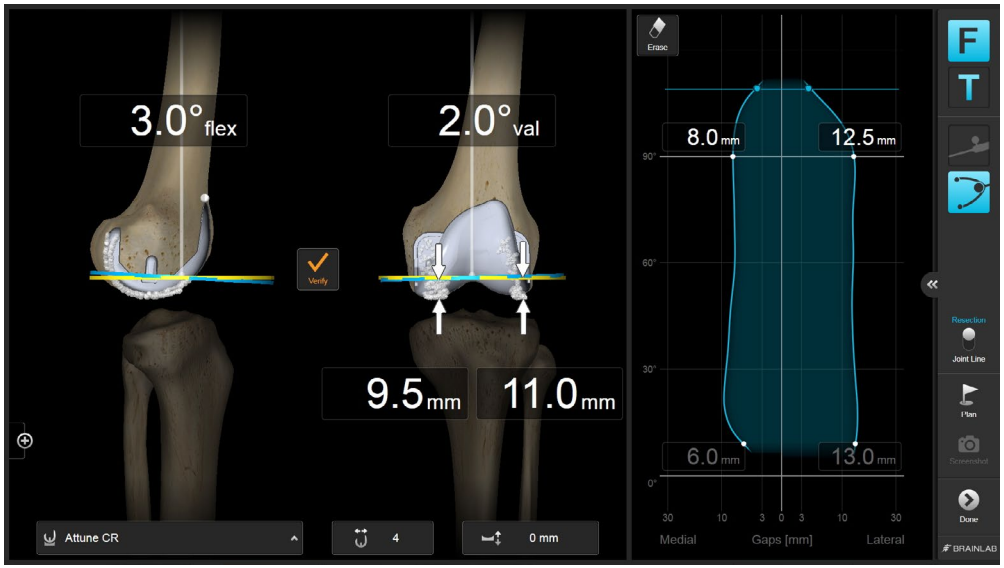
During a femur first technique, the next step is the distal femoral resection. Attach the navigation plane tool to the distal cutting block for your implant. You may use optional adjustable distal cutting block as well for this step, refer to the user manual guide for details.

The software automatically switches to the distal femoral navigation information as soon as the resection block with the plane tool is close to the right position. The current position of the cutting plane is shown as a blue plane.

Art. no. 53202 *Knee Plane Tool – Cutting Block Adapter*
Art. no. 53201 *Knee Plane Tool – Tracking Array*

Initially, the plan for the femoral component is placed according to manufacturer specifications following a measured resection philosophy. Femoral sizing is based on the AP dimensions of the registered femur. All measured numbers are shown in relation to the corresponding femoral landmarks.

Note that femoral component flexion is shown in relation to the femoral mechanical axis, while conventional instrumentation is uses anatomical axes. Depending on the type of intramedullary rod, a neutral component flexion is based either on the distal anatomical axis, or the femoral mid-shaft axis. Depending on your particular patient population, this axis might be in 3°-5° of flexion to the mechanical axis.

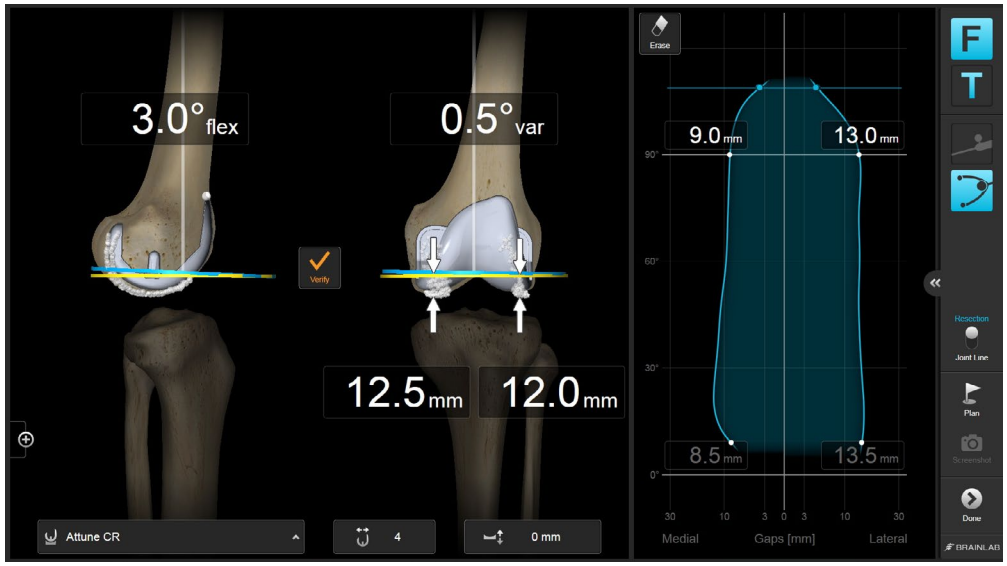


STABILITY INFORMATION

While navigating the distal femoral cutting block to the desired location, the stability graph on the right shows in real time the effect of the current cutting block position on the final result. Increasing resection height opens up the gap in extension; adding more flexion to the implant closes the gap in flexion.

Make sure at this point the software is reflects the same femoral size you are planning to use for this patient. If not, change it on the bottom of the screen. Compare the relative difference between the gaps in flexion and extension. With the correct implant size chosen, flexion and extension gaps should be brought into the same range, up to a few millimeters difference. Note that equality of the medial and lateral gaps in flexion is not influenced by this step and will be addressed with the anterior resection later. In order to compare flexion and extension gap values, during this step use the sum of medial and lateral gap in flexion, and compare it to the sum of gaps in extension.

Additionally, note that in particular in cases with fixed flexion deformities, gaps in extension might still increase due to releases after getting access to the back of the joint.



PLACEMENT OF CUTTING BLOCK & RESECTION

Once the cutting block is at the correct position, place one pin for the cutting block, while constantly checking for changes in alignment during drilling. Place the second pin, correcting for any alignment deviations from the first pins. If necessary, fix with additional pins and perform resection.

CUT VERIFICATION

After performing the resection, always verify the resected surface. Verifying distal resection will show the effect of potential deviations from the desired position immediately, making it easy to judge if the deviation can be accepted or need reassessment of the cut.

Note that verification of a resected surface will adjust the plan accordingly for the subsequent steps, therefore showing the yellow plane at the same location as the blue plane. Cross-check the result of the resection using the displayed numbers with respect to the bone landmarks as well as with respect to the calculated final stability outcome.

Art. no. 53203 *Knee Plane Tool – Bone Verification Plate*
Art. no. 53201 *Knee Plane Tool – Tracking Array*

ANTERIOR FEMORAL RESECTION

Following the distal femoral resection, femoral implant rotation is defined by the anterior femoral resection. Attach the navigation plane tool to the 4-in-1 cutting block for your appropriate implant size, and place the resection block on the resected distal femur. The software will automatically show the information required for anterior resection navigation.

The software presents the yellow target line for the implant already placed according to the selected rotation reference (indicated by the icon next to the main rotation reference). The other two rotation references can be shown by pressing the (+) sign next to the selected main rotation reference. By selecting either of the two other rotation references, this landmark will be used as the main rotation reference moving forward.

Rotate the cutting block, such that the desired rotation to your main rotation reference is achieved. Cross-check with the other two rotation references if necessary. Place the cutting block at the appropriate AP position by looking at the shift from the registered anterior cortex point, or simply verify the position using a conventional tool to avoid notching.

By looking at the calculated post-operative gap values on the right-hand side, you may alter that position in case of substantial gap inequality. However, always consider if osteophyte removal could still be incomplete, and changes to the soft tissue envelope might still happen during the subsequent resection steps. To make sure the software is using the most up-to-date information about the ligament situation, you may want to use some tensioning device in flexion before that step.

Apply tension to the joint while both tibial and femoral reference arrays are visible to the computer to update that information.

Once you are happy with the position of the block, pin it securely in place and perform the resection.

CUT VERIFICATION

After performing the resection, always verify the resected surface.

Art. no. 53203 *Knee Plane Tool – Bone Verification Plate*
Art. no. 53201 *Knee Plane Tool – Tracking Array*

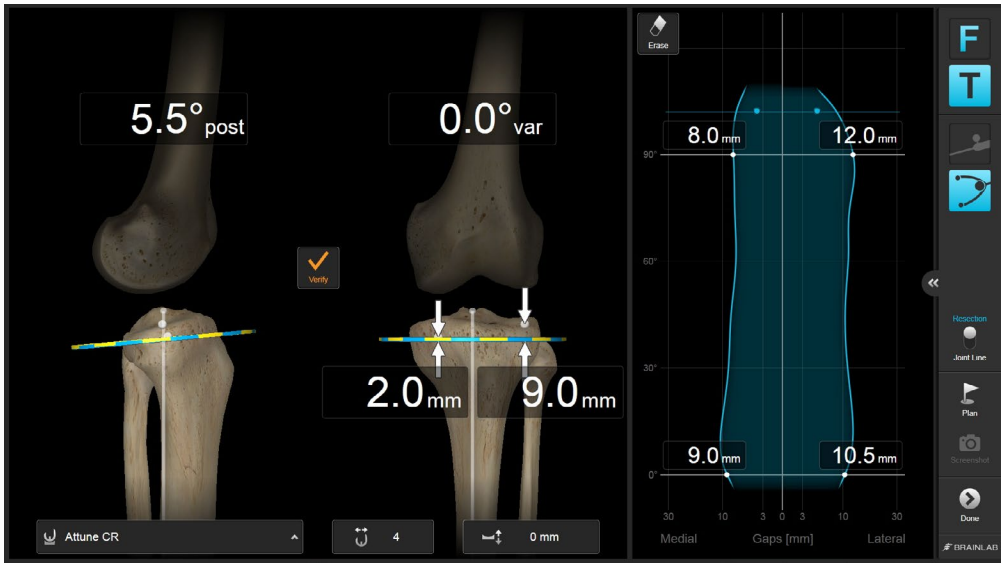
TIBIAL RESECTION

While in a full femur first technique the anterior resection follows directly after the distal femoral resection, it is recommended to perform tibial resection before the anterior femoral resection. This will allow better removal of osteophytes and balancing of the leg in extension using a fixed spacer block.

The software automatically switches to the tibial navigation information as soon as the resection block with the plane tools is close to the right position. The current position of the cutting plane is shown as a blue plane. The standard plan based on implant manufacturer specifications is shown as a yellow plane, however always adjust the resection to the specific patient anatomy. In particular, tibial resection height is based on measurements from the cutting plane to the registered tibial plateau points. Due to bone defects, the anatomy of the tibial plateau, and in particular natural tibial slope, this reference point might or might not lead to the right resection height. You can cross-check resection height using the conventional stylus, or using the pointer from registration. Slide the pointer tip over the tibial plateau surface to check resection height at any point of the plateau.

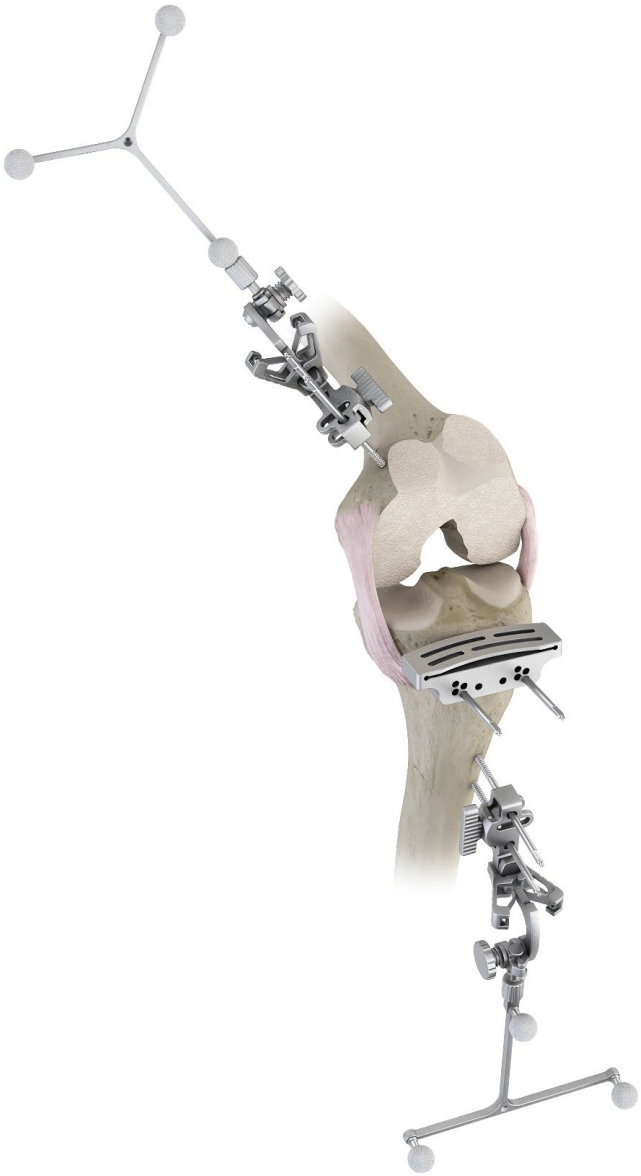
For the femoral rotation with the anterior resection, soft tissue considerations can then be taken into account to cross-check the rotation based on the anatomical landmarks, potentially reducing the necessity of ligament releases at a later time.

Art. no. 53202 *Knee Plane Tool – Cutting Block Adapter*
Art. no. 53201 *Knee Plane Tool – Tracking Array*



PLACEMENT OF CUTTING BLOCK & RESECTION

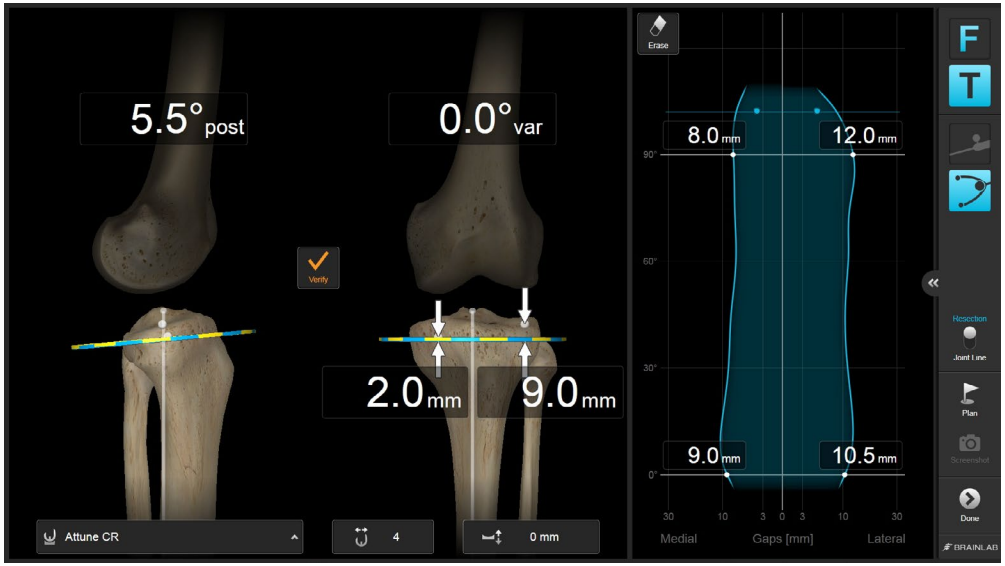
Once the cutting block is at the correct position, place one pin for the cutting block, while constantly checking for changes in alignment during drilling. Place the second pin, correcting for any alignment deviations from the first pins. If necessary, fix with additional pins and perform resection.



CUT VERIFICATION

After performing the resection, always verify the resected surface.

Art. no. 53203 *Knee Plane Tool – Bone Verification Plate*
Art. no. 53201 *Knee Plane Tool – Tracking Array*



After cut verification please continue with chapter Trialing.

Tibia First Technique

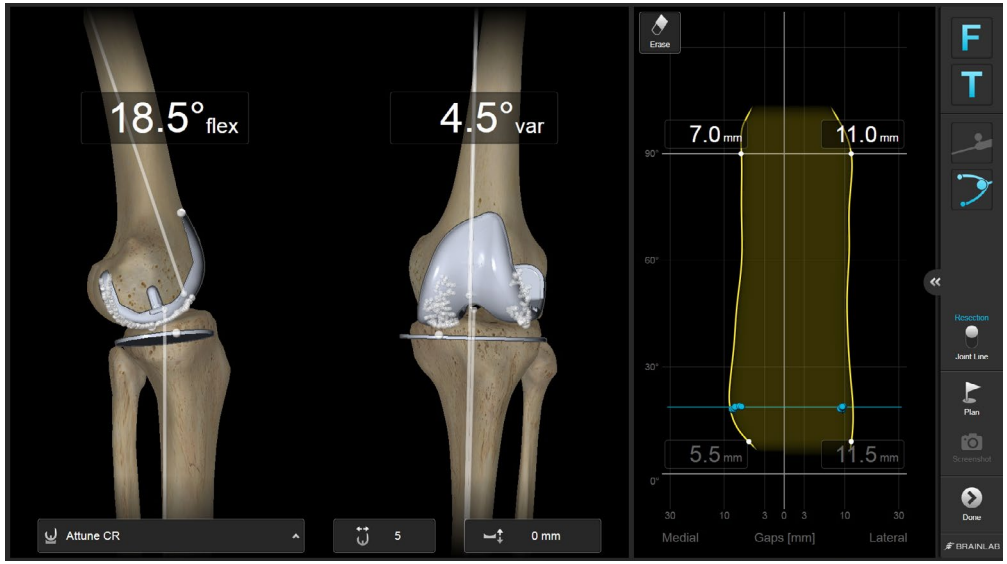
INITIAL LEG ALIGNMENT – SCREEN LAYOUT

After registration is finished, the screen is basically split into two parts.

The left-hand side shows the current bony anatomical situation and measurements regarding the implant position. The right-hand side shows the stability of the knee joint after implantation, even if no resection has been done. All calculations are based referencing a final implant positioning, therefore at any time in the procedure, the numbers denote the same values.

Initially, the implant is placed based on measured resection principle and the default values coming from the implant manufacturer. Any changes applied to the planned implant position throughout the procedure result in an updated implant position.

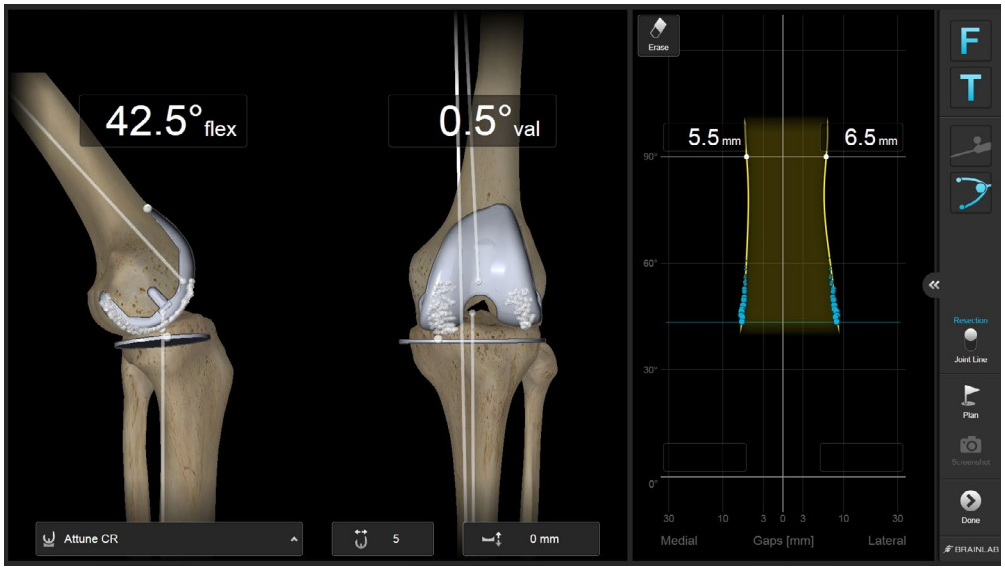
Note: At this step, tibial AP registration can be cross-checked kinematically. At 90° flexion, the tibial mechanical axis should not deviate significantly from the long leg mechanical axis. A significant deviation either denotes excessive tibial rotation or an erroneously registered tibial AP direction.



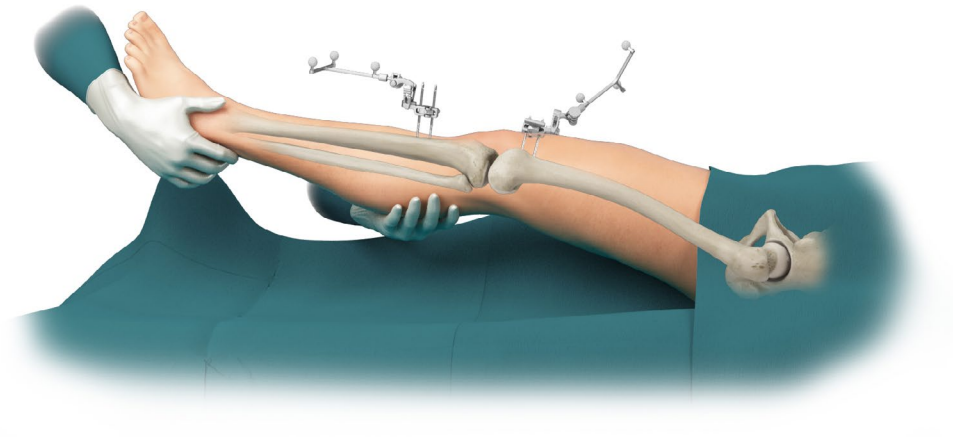
VARUS/VALGUS STRESS TESTING

Bring the leg into full extension and apply varus and valgus stress to test stability and check for fixed flexion or other deformities. Bring the leg into maximum flexion, again applying varus and valgus stress during the movement. The stability graph on the right now shows the calculated implant stability assuming the implant position on the left.

The implant position on the left is initially based on a measured resection philosophy, with no joint line shift, neutral femoral flexion and coronal alignment, and femoral rotation based 3° external to the posterior condyles (or another rotation reference if selected).



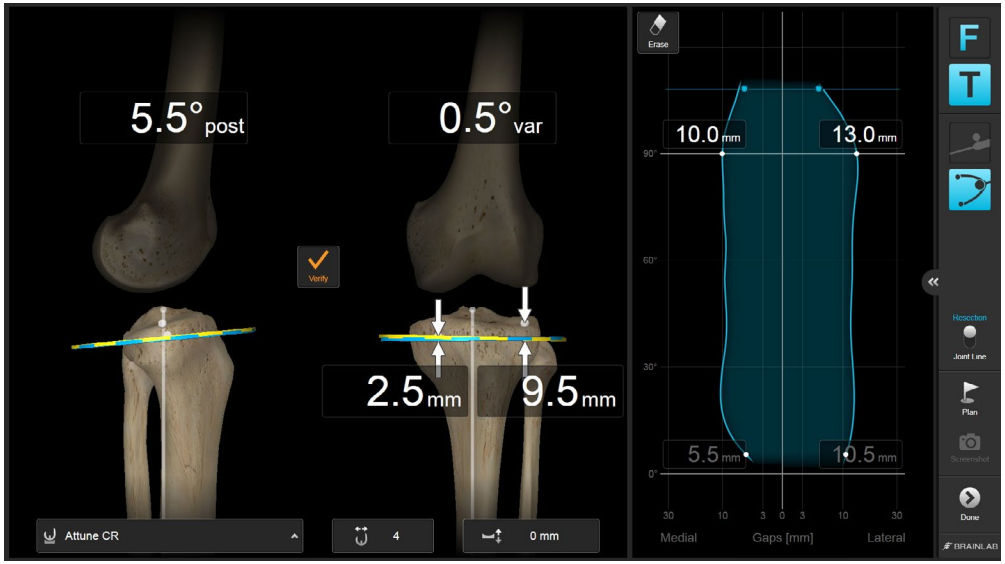
At this stage, based on the stability information, decisions might be already derived regarding potential necessary releases or corrections of the implant position. Gaps from resected tibia to femoral implant are shown over the full range of motion as an interpolated line, while at 0° and 90° the actual numerical values are shown. In case of fixed flexion deformities, full extension might not yet be reached; however the lines already give an indication of what might be happening later after addressing the deformity.

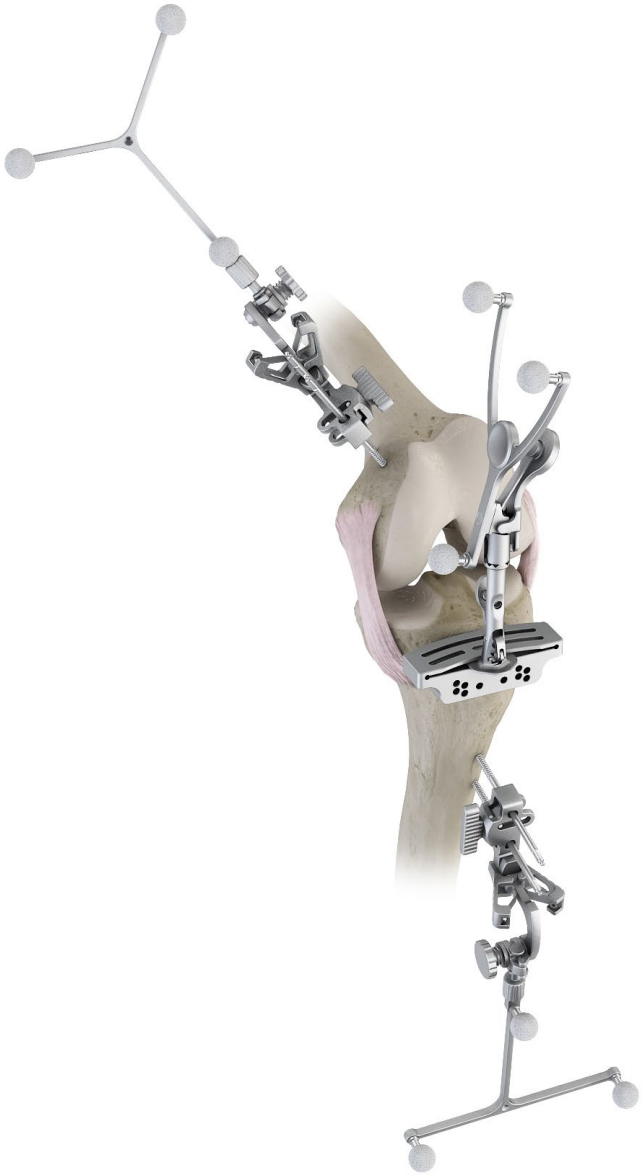


TIBIAL RESECTION

In a tibia first technique, next step is the tibial resection. Attach the navigation plane tool to the tibial cutting block for your implant. You may use the conventional extramedullary alignment tools, or simply the block alone. The software automatically switches to the tibial navigation information, as soon as the resection block with the plane tools is close to the right position. The current position of the cutting plane is shown as a blue plane.

Art. no. 53202 *Knee Plane Tool – Cutting Block Adapter*
Art. no. 53201 *Knee Plane Tool – Tracking Array*





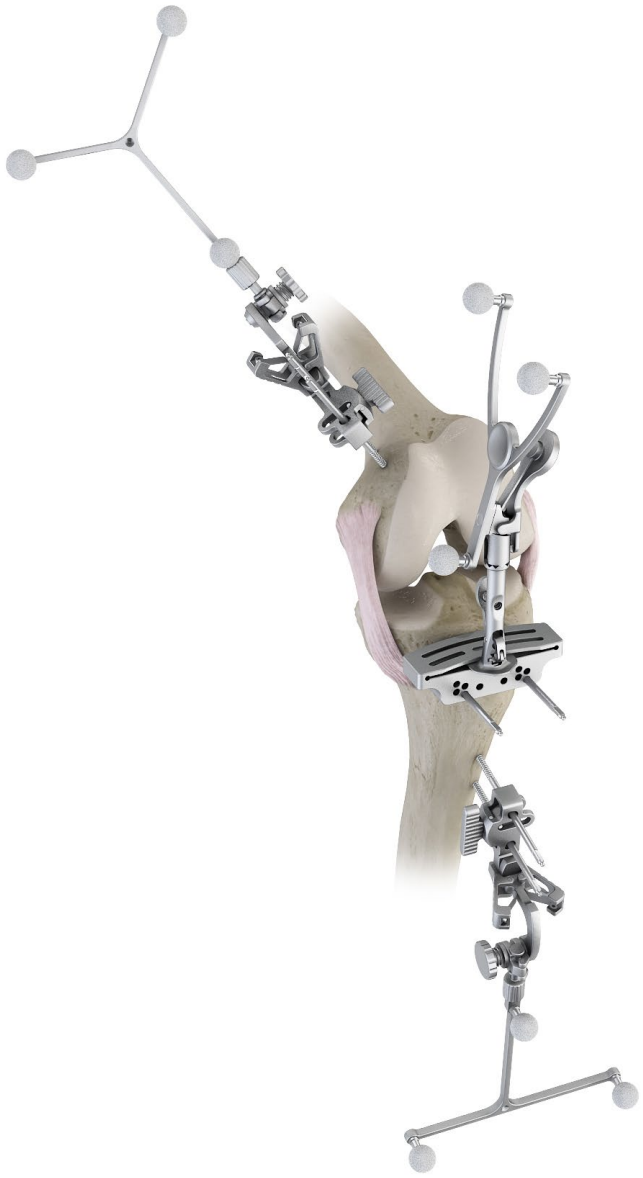
PLACEMENT OF CUTTING BLOCK

Once the cutting block is at the correct position, place one pin for the cutting block, while constantly checking for changes in alignment during drilling. Place the second pin, correcting for any alignment deviations from the first pins. If necessary, fix with additional pins and perform resection.

The standard plan based on implant manufacturer specifications is shown as a yellow plane, however always adjust the resection to the specific patient anatomy. In particular, tibial resection height is based on measurements from the cutting plane to the registered tibial plateau points. Due to bone defects, the anatomy of the tibial plateau, and in particular natural tibial slope, this reference point might or might not lead to the right resection height. You can cross-check resection height using the conventional stylus or the pointer from registration. Slide the pointer tip over the tibial plateau surface to check resection height at any point of the plateau.

RESECTION

Once the cutting block is at the correct position, place one pin for the cutting block, while constantly checking for changes in alignment during drilling. Place the second pin, correcting for any alignment deviations from the first pins. If necessary, fix with additional pins and perform resection.

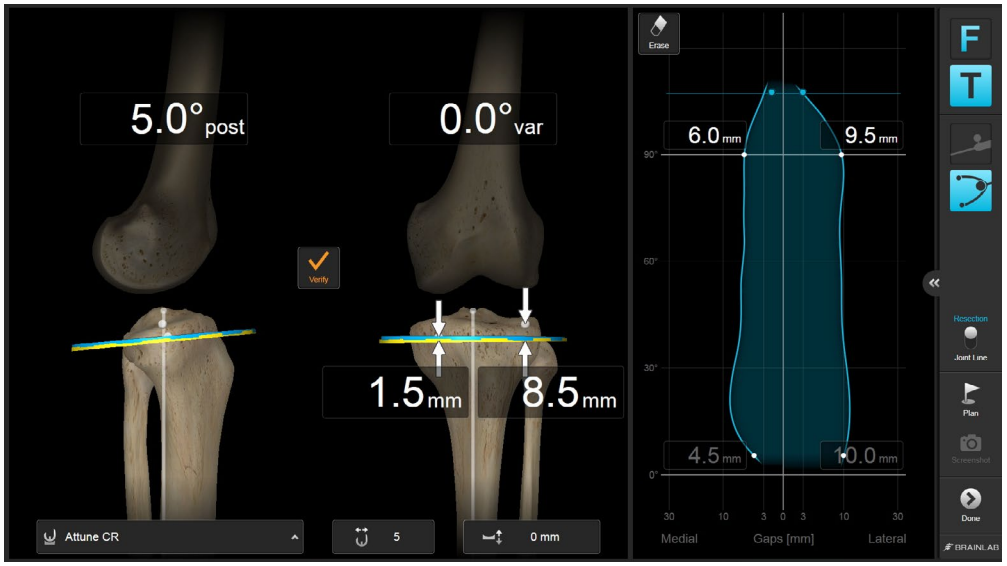


STABILITY INFORMATION

While navigating the tibial cutting block to the desired location, the stability graph on the right shows in real time the effect of the current cutting block position on the final result. Increasing resection height is opening the gaps, decreasing resection height is closing the gaps, simultaneously in extension and flexion. To indicate live navigated values, the stability lines change to the blue color.

With flexion instabilities that might already be apparent at that stage, this information can be used to potentially decide for more or less conservative tibial resections.

Note that the flexion gap is heavily affected by femoral sizing. This is a good time to cross-check the femoral size the software has selected based on AP dimensions of the registered bones is the correct size according to preoperative planning and intraoperative visual inspection of the femur. If the software is measuring a different femoral component size, change it by pressing the size button at the bottom of the screen.

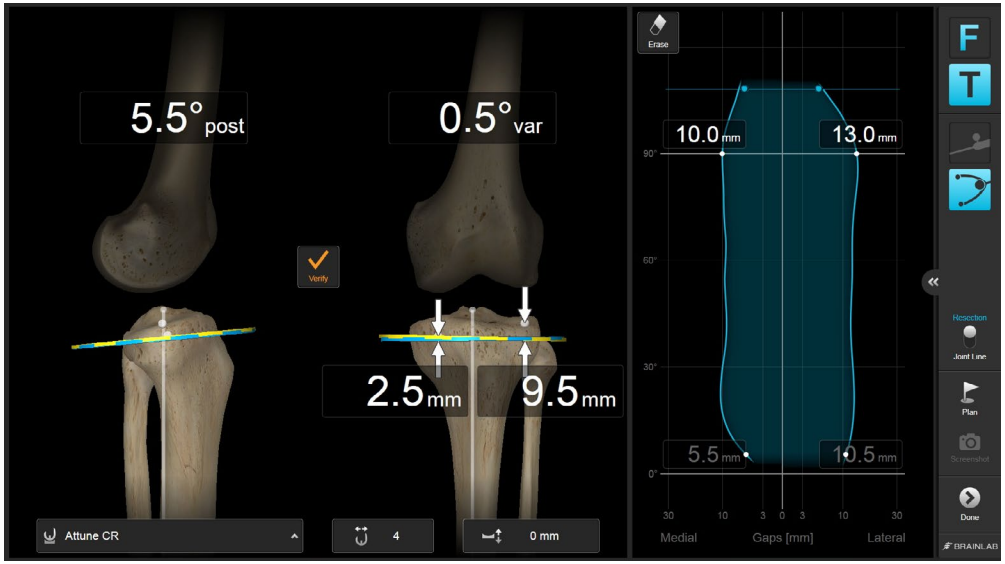


CUT VERIFICATION

After resection and clean-up of the resected surface, place the plane tool with bone verification plate on the resected surface. Inaccuracies introduced by saw blade deformation or cutting block movement can easily be detected. The software recognizes the verification step and automatically stores the position, as soon as the tool is held still for two seconds. Alternatively, the 'Verify' button on the screen or the blue footswitch pedal can be used to store the verified resection.

In case of deviations from the initial plan, the stability graph immediately shows the effect on final stability. This makes it easy to judge the influence of deviations on the final result, helping the decision if changes to the resection might be necessary, or deviations can be accepted.

Art. no. 53203 *Knee Plane Tool – Bone Verification Plate*
Art. no. 53201 *Knee Plane Tool – Tracking Array*

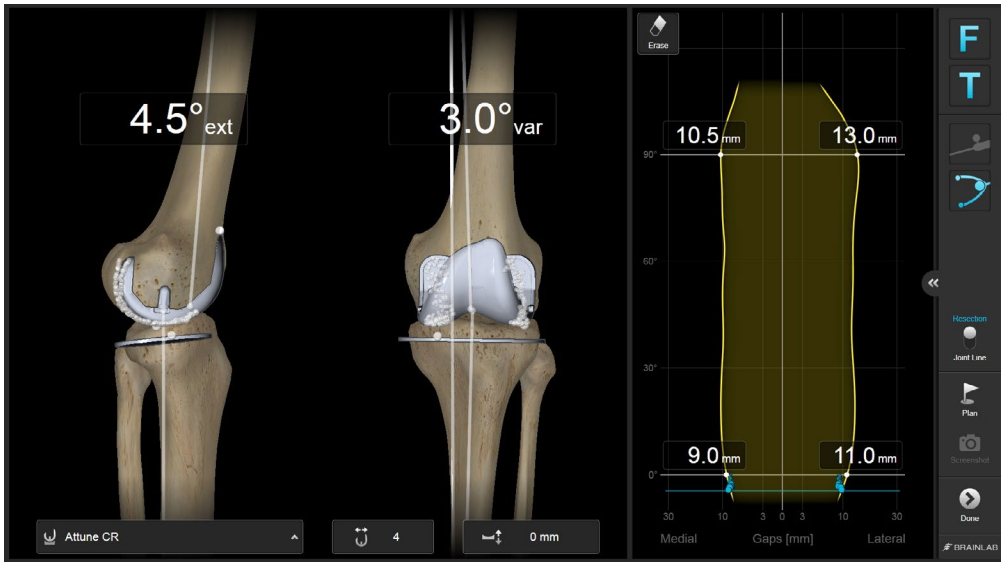


Note that verification of a resected surface will adjust the plan accordingly for the subsequent steps, therefore showing the yellow plane at the same location as the blue plane. Cross-check the result of the resection using the displayed numbers with respect to the bone landmarks, as well as with respect to the calculated final stability outcome.

RANGE OF MOTION

After tibial resection, clean-up remaining osteophytes and start addressing potential fixed flexion deformities. The effect of these releases can immediately be visualized by applying medial or lateral stress in the respective flexion range. This can be performed either by lamina spreaders, tibial trial components or any spreading device.

It is recommended to use a spring loaded tensioner, which allows easy movement of the leg throughout range of motion, while constantly keeping the gaps at maximum tension. In full extension, check medial and lateral gaps for symmetric stability. In case of asymmetry, use additional osteophyte removal or whatever additional release might be necessary to achieve symmetry. Alternatively, consider undercorrecting the preoperative deformity, or deliberately accepting slight remaining instability. Note that in case of fixed flexion deformities, or posterior condylar osteophytes, the knee joint might at that point be able to reach full extension by compressing the anterior part of the gaps. On the stability graph, this will be visible by converging lines when getting close to full extension. In such case, you might want to temporarily leave the imbalance for to address it at a later stage when better access to the posterior part of the joint is possible.



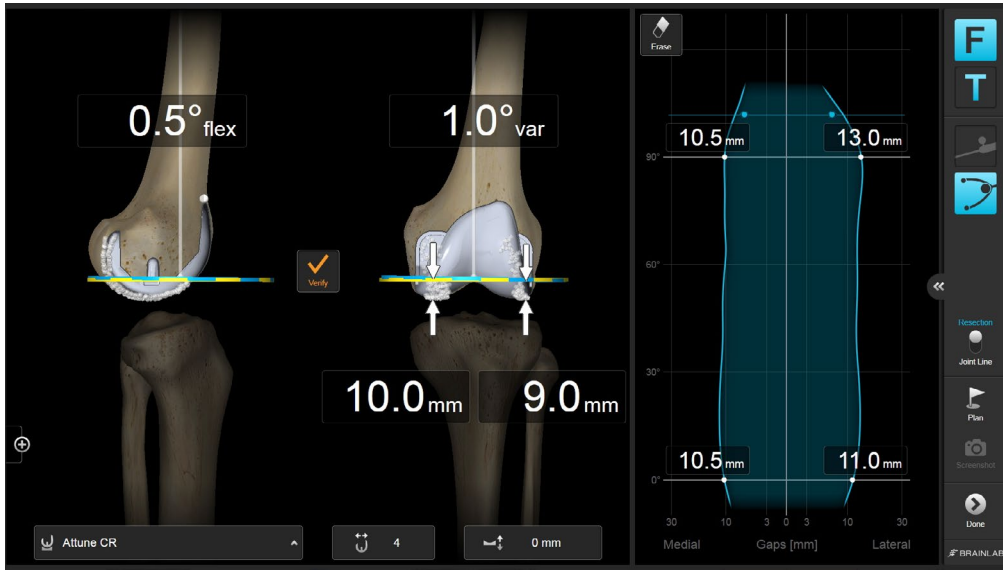
DISTAL FEMORAL RESECTION

FEMORAL SIZING

Initially, the plan for the femoral component is placed according to manufacturer specifications following a measured resection philosophy.

Femoral sizing is based on the AP dimensions of the registered femur. Make sure at this point the software is using the same femoral size you are planning to use for this patient. If not, change it on the bottom of the screen.

All measured numbers are shown in relation to the corresponding femoral landmarks. Note that femoral component flexion is shown in relation to the femoral mechanical axis, while conventional instrumentation is using anatomical axes instead. Depending on the type of intramedullary rod, a neutral component flexion is based either on the distal anatomical axis, or the femoral mid-shaft axis. Depending on your particular patient population, this axis might be in 3°-5° of flexion to the mechanical axis.



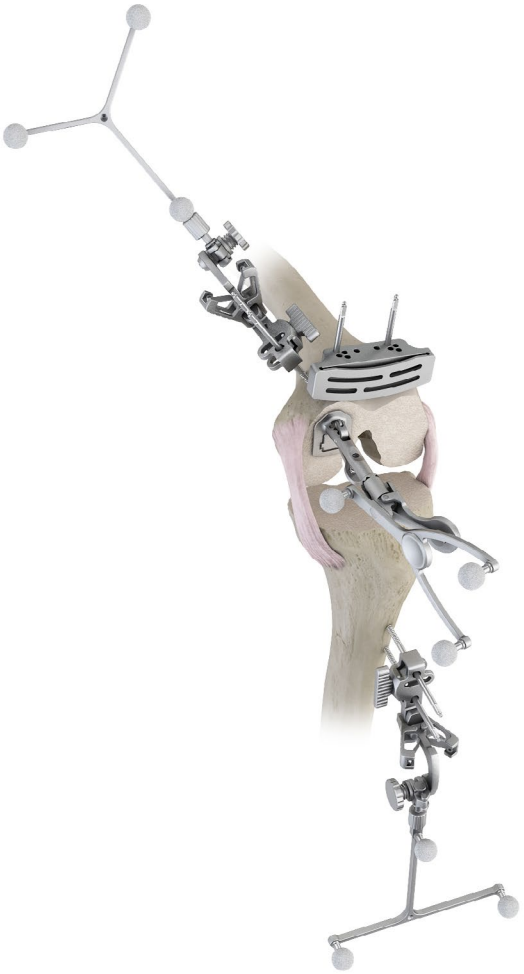
PLACEMENT OF CUTTING BLOCK & RESECTION

Once the cutting block is at the correct position, place one pin for the cutting block, while constantly checking for changes in alignment during drilling. Place the second pin, correcting for any alignment deviations from the first pins. If necessary, fix with additional pins and perform resection.

CUT VERIFICATION

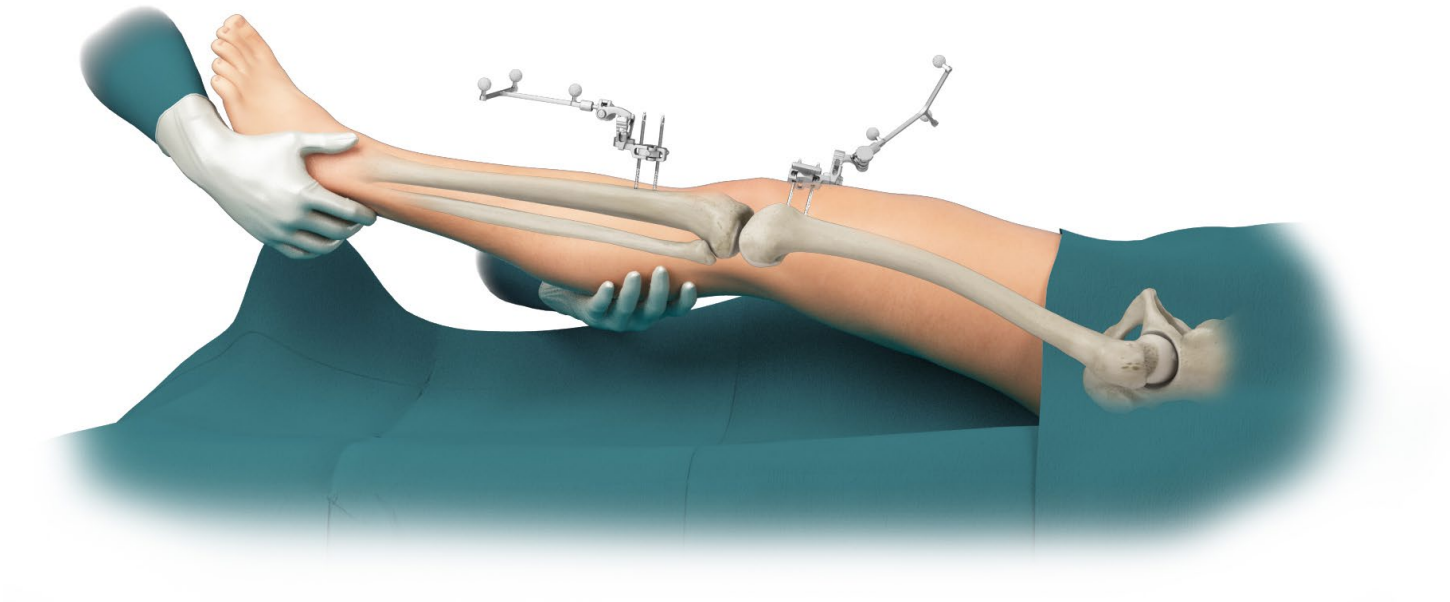
After performing the resection, always verify the resected surface.

Art. no. 53203 *Knee Plane Tool – Bone Verification Plate*
Art. no. 53201 *Knee Plane Tool – Tracking Array*



BALANCING IN EXTENSION

After performing and verifying the distal resection, bring the leg in full extension again. Use the spacer block to assess long leg alignment and extension stability again.



BALANCING IN FLEXION – ANTERIOR/POSTERIOR RESECTIONS

Place 4-in-1 block in rotation so that medial and lateral flexion gaps are equal. Cross-check anatomical rotation references to see if that it is acceptable rotation.

Shift cutting block slightly posteriorly, if flexion gap is larger than extension gap.

Consider downsizing if flexion gap is smaller than extension gap; consider upsizing femoral component if flexion gap can't be made equal to extension gap.

FULL PLANNING MODE

All steps of the algorithm can be performed instantly and on the fly while placing the cutting block to the relative resection positions.

In cases with larger deformities, where the solution might not be directly obvious, switch to full planning mode. Here you can plan all resections simultaneously on one screen to find the best solution.

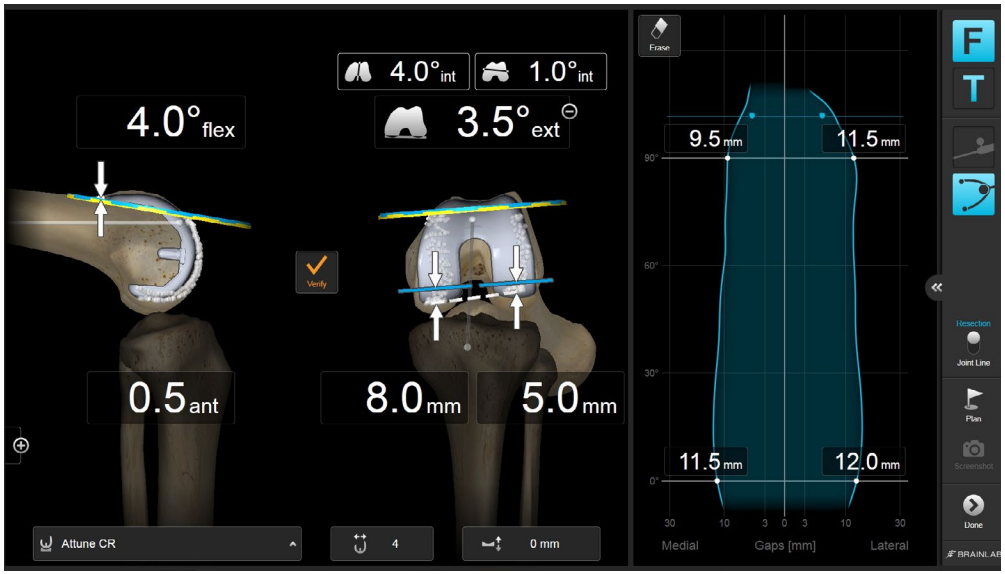
Always keep in mind that imbalance on the screen might denote incomplete releases or incomplete storing of maximum gaps, especially after performing releases. Therefore, if in doubt, always cross-check the ligament situation by applying medial or lateral tension to see if the number on screen matches with the actual ligament situation.

CUT VERIFICATION

After performing distal or anterior resection, always verify the resection. Verifying distal resection will show the effect of potential deviations from the desired position immediately, making it easy to judge if the deviation can be accepted or if the cut needs reassessment.

Verifying anterior resections makes sure the software has correct information for the final balancing step as well as for documentation in the patient report. The verification of the anterior resection is easily missed, since it is the final step before making all remaining cuts and placing the trial implant.

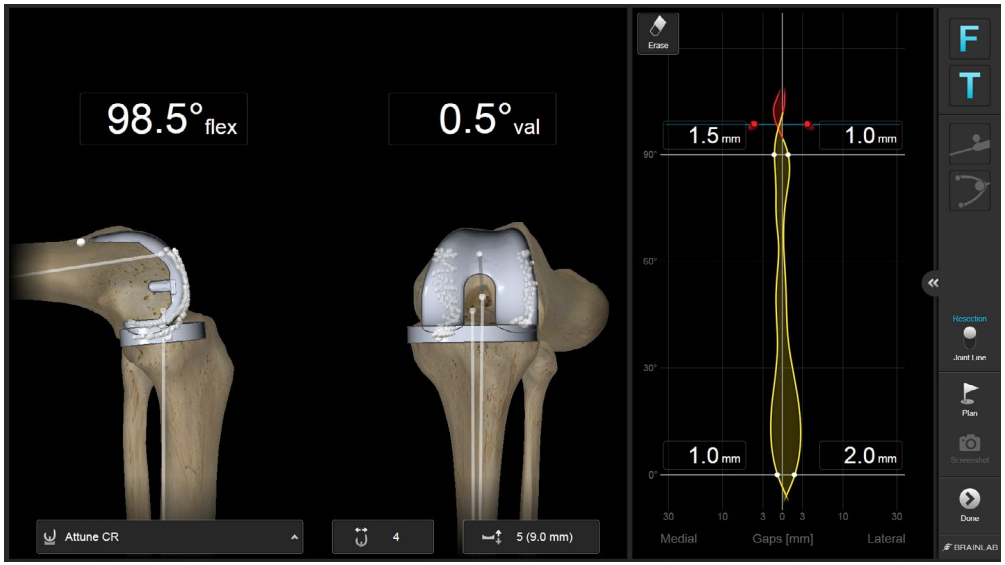
Art. no. 53203 *Knee Plane Tool – Bone Verification Plate*
Art. no. 53201 *Knee Plane Tool – Tracking Array*



Trialing & Closure

After insertion of the trial components, clear the information in the stability graph and record the actual stability and alignment situation for final documentation. You may want to select the correct tibial insert thickness to make the graph reflect the actual situation.

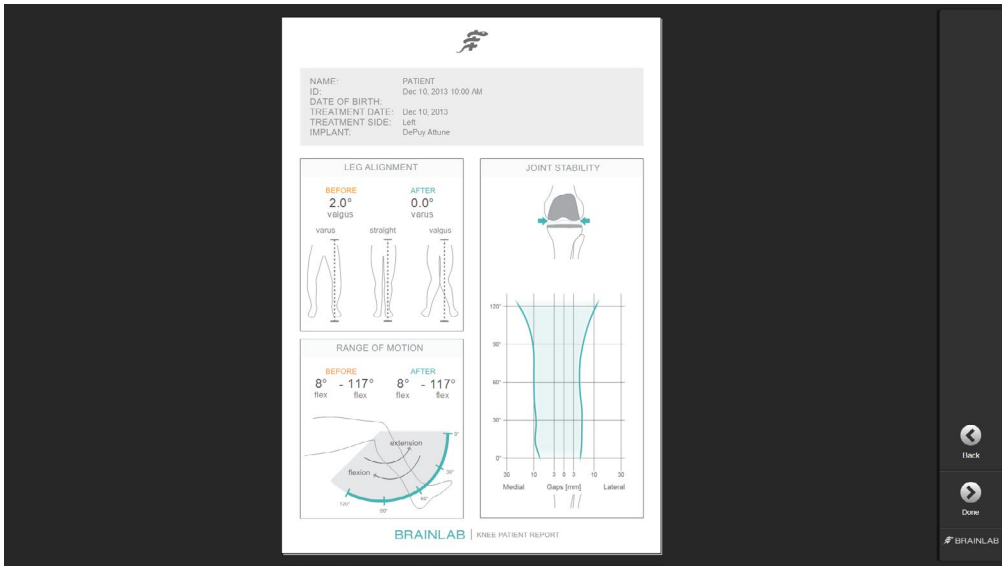
Close the knee in layers using the surgeon's preferred technique.

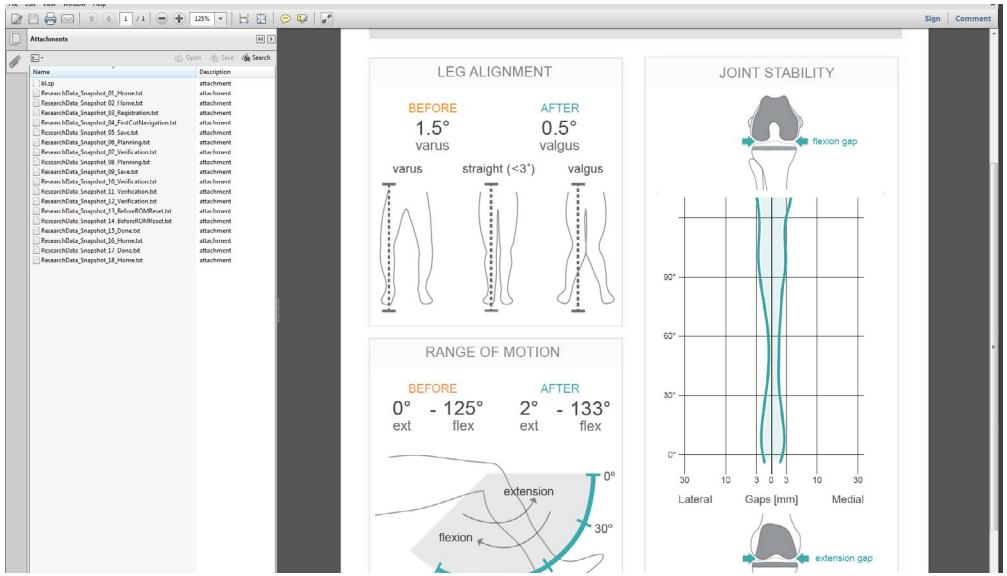


Patient Therapy Report

After finishing the procedure, press the 'Done' button to access the patient report. This report contains information in a simplified language for the patient.

Additional data, in particular for research purpose, can found in the PDF attachment which can be accessed via the paperclip in the PDF file.





Appendix

JOINT LINE MODE

By pressing the 'Joint Line' button you can switch to joint line mode for femoral resections. Instead of resection heights the software displays the joint line shift for the selected implant component during femur navigation.

Note: Resections are calculated perpendicular to the cuts. Joint line values are the distance between the most distal implant point to the most distal condyle surface point in femur axis direction.

When the femur component is flexed resection plus distal implant thickness may not equal the joint line shift!

SETTINGS

Some application settings, including sound volume controls, can be accessed from the menu drawer on the right part of the screen.

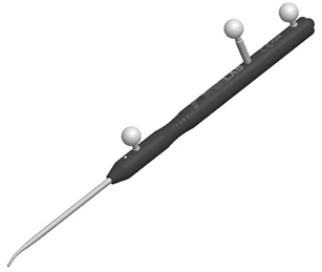
CLIP-ON REMOTE

The use of the optional disposable clip-on on remote control can be enabled for registration of the anatomic landmarks in Settings. When turned on, hold the tip to the indicated landmark and press the 'Control' button. The remote control reacts upon pressing the button, not upon releasing. If the tip moves during registration, the point is not acquired.

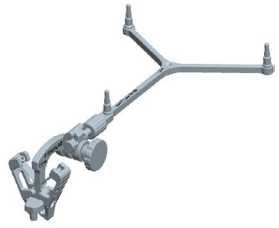
Art. no. 53153 *Disposable Clip-On Remote Control (20 pcs)*

ARTICLE LIST

Pointer

Article Number	*Article Name*	
53101	*Pointer Angled For Hip/Knee*	

Arrays and Fixation

Article Number	*Article Name*	
52410	*Reference Array T-Geometry X-Press*	
52411	*Reference Array Y-Geometry X-Press*	

Article Number	Article Name	
41866-77	Universal Cutting Block Adapter	
52429	Bone Fixator 2-Pin, Flip Flop, X-Press	
54932	Pindriver Adapter For AO Coupling	
52421/52422/52423	Bone Fixator 1-Pin Size S/M/L	

Plane Tool

Article Number	*Article Name*	
53201	*Knee Plane Tool – Tracking Array*	
53202	*Knee Plane Tool – Cutting Block Adapter*	
53203	*Knee Plane Tool – Bone Verification Plate*	

Disposables

Article Number	*Article Name*	
54922	*Disposable Schanz Screw 3.2 mm x 100mm (10 pcs)*	
54922	*Disposable Schanz Screw 4.0 mm x 125mm (10 pcs)*	
54909	*Disposable Schanz Screw (AO) 5mm x 175mm (10 pcs)*	
18071-50	*Disposable Sterile Monitor Drapes (40 pcs)*	
41774 or 41773	*Disposable Marker Spheres (270 pcs or 90 pcs)*	

Clip-On Remote Control & Footswitch

Alternatively to pointer tip pivoting the Clip-On Remote Control or the Footswitch can be used to trigger landmark acquisition.

Article Number	*Article Name*	
18460	*Footswitch*	
53153	*Disposable Clip-On Remote Control (20 pcs)*	

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