KNEE3

SURGICAL TECHNIQUE – MOTION

Tibia First
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.
KNEE3 MOTION

Tibia First Technique

A software guided surgery for total knee replacement
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OR 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 KNEE3 Motion Workflow by pressing the corresponding icon on screen. Enter the patient name and ID or select a patient from the patient list. Press “Done” to proceed. To start the knee application, press the “KNEE3 Motion” icon. Select the implant and the treatment side.

The default resection settings are based on the manufacturer specifications, e.g. 3° of posterior tibia slope. Femoral component flexion is set to 3° by default.

**NOTE:** Femoral component flexion in KNEE3 is shown relative to the femoral mechanical axis. Conventional instrumentation uses either the distal anatomical axis or the femoral mid-shaft axis instead. Thus, depending on the patient population, neutral anatomical flexion corresponds to 3°-5° of flexion relative to the mechanical axis.

These parameters can be changed according to the surgeon’s preference and are linked to the selected implant and user.

To proceed, press “Navigate”.

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[Image of software interface with highlighted icons and settings]

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**BRAINLAB**
Instrument Preparation

At the scrub table, prepare instruments with marker spheres. 12 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 on the tibia. During navigation they define the position of the bones.

- Art. no. 52410 Reference Array T-Geometry, X-Press
- Art. no. 52411 Reference Array Y-Geometry, X-Press

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. 53109 Pointer Straight
- Art. no. 53101 Pointer Angled (optional)

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
Incision & Exposure

Incision and exposure to the knee joints should be performed based on the surgeons’ choice of technique. Brainlab knee navigation instruments support all standard approaches.

The incision must allow good exposure of the compartment to be resurfaced.

After initial exposure, assess the extent of arthritic damage and the ligaments including the ACL and remove all prominent osteophytes from the medial (or lateral) edges of femur and tibia and in the intercondylar notch.

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 surgeons’ 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
Art. no. 54908 Disposable Schanz Screw (AO) 4mm x 125mm

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, extra medullary 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 degree 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 at in-between positions, the mechanism might snap into one of the predefined positions during the procedure, and thus losing the fixed reference.

Art. no. 52410 Reference Array T-Geometry, X-Press
**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 intra-operatively. 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.

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

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 Reference Array Y-Geometry, 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

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
Art. no. 5242x Bone Fixator 1-Pin Size S/M/L
Registration

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

Femur

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 Cortex

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.

Furthermore 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) and pivot the pointer.

The acquisition of this point along with the femoral head center completes the femoral mechanical axis.
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. Furthermore 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. Align the pointer along the line marked and hold the pointer still for two seconds to register.

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 need to be collected. The software will proceed once all sectors are covered.

Note: Registration of one or both condyles can be skipped, in particular 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 Cortex

A number of points along the surface of the anterior cortex are acquired using the pointer. To register, put the pointer tip on the anterior femoral cortex and pivot the pointer to start the acquisition. Slide the pointer over the bone surface to “paint” the surface of the cortex. Points should be acquired on the lateral side of the anterior femoral cortex, until the superior border of the femoral implant.

The anterior cortex is used as a reference for the exit of the anterior cut plane and determines the femoral components AP position and sizing.
Tibia
On the tibial side, the following bone landmarks are registered:

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

Malleoli
The malleoli can usually be located by palpating 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 and registered accurately.

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 AP Direction

The pointer is placed horizontally in the AP 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 AP direction will help to avoid an oblique tibial slope in the anteromedial to posterolateral direction or anterolateral to posteromedial direction.

Compound slope can put the tibial component into varus or valgus and lead to poor tibial/femoral contact. This can in turn 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 there is bone defect present. The software will show resection height numbers from this reference point.

Note: Registration of one or both tibia plateau points can be skipped, in particular if for example in a revision from a partial to a total knee replacement one plateau 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 Technique Overview

This document describes a tibia first technique; however KNEE3 Motion 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.

For a detailed description of the Femur First sequence refer to the dedicated Brainlab KNEE3 Motion Femur First Surgical Technique.
Adaptive Workflows
Brainlab KNEE3 follows the user. It automatically identifies the current treatment step and displays the matching content on the screen. If for example 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
• Anterior femur cut navigation
• Distal femur cut navigation

Simply 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. White lines represent the planned and yellow lines the 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 visual guide.
Tibia First Technique

Initial Leg Alignment - Screen Layout
After registration is finished, the screen is basically split into two parts:

The left hand side of the screen shows the current bony anatomical situation and measurements regarding the implant position, the right hand side shows the expected stability of the knee joint after implantation, even if no resections have been done yet. The software uses the planned, the current or the verified resection plane position to calculate the predicted stability. All calculations are based on a virtual implantation; therefore at any time in the procedure, the numbers denote the same values.

Initially, the implant is placed based on measured resection principle 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), and the standard values defined by the implant manufacturer. As the surgeon makes changes to the planned implant position throughout the procedure, the implant position and the stability graph is updated accordingly.
**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 screen side.

At this stage, based on the alignment information, decisions might be already derived regarding potentially necessary releases. In case of fixed flexion deformities, full extension might not yet be reached.

**Storing Pre-operative Alignment**

To store the pre-operative alignment, bring the leg in full extension without applying stress, then lift the fully extended leg approximately 10 cm. The software will interpret the lifting gesture and store the alignment.

Alternatively, pressing the “Store” button on screen will also store the alignment.

Note: At this step, tibial AP registration can be crosschecked 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.
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
Stability Information
To indicate live navigated values, the stability graph changes to blue color while navigating the tibial cutting block to the desired location. The stability graph on the right shows the effect of the current cutting block position on the final result in real time.

Increasing the tibial resection height will open flexion and extension gaps equally, while decreasing the resection height will close both, the flexion and extension gaps.

In particular 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. Crosscheck the femoral size selected by the software with the preoperatively planned. In case the software selected a different femoral component size, change it using the sizing button at the bottom of the screen.
Placement of Cutting Block & Resection

Once the cutting block is at the desired position, put the first pin fixing the cutting block, while constantly checking for changes in alignment during drilling. Place the second pin, focusing on varus/valgus position and correct possible alignment deviations. If necessary, put additional oblique pins and perform resection.

Cut Verification

After resection and cleanup 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 and updates the stability information as soon as the tool is held still for two seconds. Alternatively, the “Verify” Button on 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 allows assessing the influence of cut deviations on the final result, helping to decide if changes to the resection will be necessary, or if the deviations can be accepted.

Crosscheck 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.

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.
Range of Motion & Extension Balancing
After tibial resection, clean up remaining osteophytes and start addressing potential fixed flexion deformities.

In full extension, check the medial and lateral gaps for symmetry and stability. In case of asymmetry, consider additional osteophyte removal or additional releases to achieve symmetry. The effect of releases can immediately be visualized by applying medial or lateral stress in the according flexion range. This can be performed either by using 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.

Note: In particular in case of fixed flexion deformities, or posterior condylar osteophytes, the knee joint might at that stage be able to reach full extension only while compressing the extension gap. In this case remaining posterior osteophytes tend to tighten the posterior capsule such that the anterior aspects of the extension gaps collapse while the leg is extended.

On the stability graph, this will be visible by converging lines when getting close to full extension (see figure below). In such case, you might want to leave the flexion-extension imbalance for now to address it at a later stage when the posterior part of the joint is accessible.

Watch out for effects on the posterior capsule only. Converging lines before reaching full extension denote stability from the posterior capsule, which might be resolved later.
**Femoral Sizing**

Initially, the plan for the femoral component is based on the manufacturer specifications following a measured resection philosophy. Femoral sizing is based on the AP dimensions of the registered femur. Resection height values are based on the registered femoral landmarks.

Make sure that the software is using the same femoral component size you have planned to use for this patient. If the femoral component size deviates from the pre-operatively planned size, change it using the controls on the bottom of the screen.

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.
**Distal Femoral Resection**

Place the cutting block adapter in the saw slot of the distal femoral cutting block. When placing the cutting block near the distal femoral condyles, the software will automatically enter navigation mode.

At this point a potential inequality of extension and flexion gap can already be addressed by altering the cutting block position. The extension gap can be decreased or increased by shifting the cutting block more distally or proximally. The flexion gap can be decreased by slightly flexing the distal cut and therefore the femoral component. Make sure the gap values are in the same range (fine tuning gaps is still possible with the next resections).

Note: Alternatively, consider under correcting the preoperative deformity, or deliberately accept slight remaining instability. Asymmetry of the extension gap can be addressed by either additional soft tissue releases or by considering anatomical alignment by positioning the femoral component in slight varus.

The effect of the current cutting plane position on the postoperative outcome will be shown in real time in the stability graph.

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

Art. no. 53204 Knee Plane Tool – Cutting Block Adapter
Art. no. 53201 Knee Plane Tool – Tracking Array
**Distal Cut Verification**

After the resection has been performed, verify the cut using the plane tool. Verifying the resection will immediately show the effect of potential deviations from the desired position, making it easy to judge if the deviation can be accepted or need reassessment of the cut.

Place the plane tool on the cut surface and hold it still for two seconds to record the position and to update the joint stability graph.

Art. no. 53204 Knee Plane Tool – Bone Verification Plate, Small
Art. no. 53201 Knee Plane Tool – Tracking Array
Balancing in Extension

After having performed and verified the distal resection, bring the leg in full extension again. Use a fixed spacer block to assess long leg alignment and extension stability while applying varus and valgus stress.

If the desired correction and stability in extension is achieved, continue with preparation of the anterior femoral resection.

Note: Make sure that both Tibia and Femur reference are visible to the camera, such that the navigation system can analyze the effect of releases.
Balancing in Flexion - Anterior/Posterior resections
Place the plane tool in the anterior cutting slot of the 4-in-1 block and place it on the distal femoral resection to enter navigation mode. At this point, the flexion gap can be modified to match the extension gap and to achieve a symmetric flexion space.

Shift the cutting block slightly posterior, if the flexion gap is larger than the extension gap. If the block is shifted posteriorly, crosscheck the AP position using conventional instrumentation to prevent notching. Consider downsizing the femoral component, if the flexion gap is much smaller, or upsizing, if the flexion gap is much larger than the extension gap.

For a given medial/lateral flexion gap mismatch, there are usually three options to achieve a balanced gap:

1) Adjust femoral component rotation:

Internal rotation of the 4-in-1 block will close the medial and open the lateral flexion space, while external rotation will open the medial and close the lateral compartment of the joint in flexion. Rotate the cutting block until medial and lateral flexion gaps are equalized.
Cross check the rotation with anatomical landmarks. Care should be taken to avoid excessive axial rotation, which is often associated with patellar maltracking. Assess the rotation values displayed on screen. If rotation exceeds the acceptable values, consider reducing rotation and accepting slight instability in flexion.

For complex cases, it might be helpful to enter the planning mode to adjust axial femoral component rotation. With increased navigation experience, the rotation might be adjusted directly on the navigation screen without entering the planning mode.

2) Perform additional soft tissue management:

An imbalance can be the sign for an incomplete release. In particular, make sure to remove all osteophytes. Always consider the effect of the particular release for the extension gap as well to avoid over releasing.

3) Accept a remaining instability:

Natural knees commonly tend to have a laxer lateral compartment, particularly in flexion. Thus a slight lateral instability can be accepted in order to avoid excessive rotation.

Altogether, the best solution for a particular patient might be a combination of all three possibilities, rather than a single one.

Art. no. 53204 Knee Plane Tool – Cutting Block Adapter
Art. no. 53201 Knee Plane Tool – Tracking Array

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, in particular 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 match with the actual ligament situation.
Anterior Cut Verification
After performing the anterior resection, verify the cut. Verifying the resection will update the software with the current cut position information for the final balancing step as well as for documentation in the patient report. In particular 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.

Place the plane tool on the cut surface and hold it still for two seconds to record the position.

Art. no. 53202 Knee Plane Tool – Cutting Block Adapter
Art. no. 53204 Knee Plane Tool – Bone Verification Plate, Small
Art. no. 53201 Knee Plane Tool – Tracking Array
**Trialing & Closure**

After insertion of the trial components and the insert, clear the information in the stability graph by pressing the “erase” button. Record the final stability and alignment situation for case documentation.

To store the alignment, bring the leg in full extension without applying stress, then lift the fully extended leg approximately 10 cm. The software will interpret the lifting gesture and store the alignment.

Alternatively, pressing the “Store” button on screen.

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

You may want to select the tibial insert thickness currently used to make the graph reflect the actual situation.
Patient Report

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

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

## Tibia First Balanced Technique Overview

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Perform tibial and femoral registration</td>
</tr>
<tr>
<td>2</td>
<td>Perform initial stability and alignment assessment using the Joint Stability Graph</td>
</tr>
</tbody>
</table>
| 3 | Use the plane tool with the tibial block to position the tibial cutting block  
- Watch out for potential fixed flexion deformities. Converging lines in the graph in extension might indicate tight posterior capsule. Consider conservative tibial resection if full extension cannot be reached before tibial resection  
- Pin the block and perform resection |
| 4 | Verify tibial resection |
| 5 | Use spring tensor on tibial cut to record stability over full range of motion while applying varus/valgus stress |
| 6 | Use the plane tool with the distal cutting block to position the distal cutting block  
- Adjust femoral flexion angle.  
  a. Femoral Flexion should be between 0° and 3° depending on patient anatomy  
  b. If flexion gap is too large, try to increase femoral flexion angle, which closes the flexions gap.  
- Adjust distal resection level to make extension gap equal to flexion gap. Increase resection to open extension gap. Decrease resection to close extension gap  
- Pin the block and perform resection |
| 7 | Verify distal femoral resection |
| 8 | Place the cutting block adapter in the anterior cutting slot of AP resection block and navigate the block using the onscreen data  
- Crosscheck for correct implant sizing with anatomical situation (conventional sizing guide). Change size suggested by the software if necessary  
- Adjust femoral rotation  
  a. Femoral rotation should be adjusted to equalize medial and lateral gaps. Crosscheck that rotation is not too far from what anatomic landmarks suggest (3-5° int/ext. rotation max) |
| 9 | Verify anterior resection |
| 10 | Perform implant trialing  
- Erase the stability graph  
- Re-record the stability graph with the trial implants in the joint  
- Adjust insert thickness if necessary |

b. If in anatomically neutral rotation the medial and lateral gaps are unequal, basically there are three options:  
- Adjust bone cuts away from anatomical landmarks, towards what gaps dictate. Consider patellar tracking.  
- Apply (additional) soft tissue releases. Make sure to remove all osteophytes. Consider the effect of the particular release for the extension gap – do not over release!  
- Accept a certain remaining instability. In particular on the lateral side, a slightly larger gap is common in natural knees  
In most cases, it might be a combination of the three above mentioned options.
**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 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

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>53101</td>
<td>Pointer Angled For Hip/Knee</td>
<td><img src="image1" alt="Image" /></td>
</tr>
<tr>
<td>53109</td>
<td>Pointer Straight For Knee</td>
<td><img src="image2" alt="Image" /></td>
</tr>
</tbody>
</table>

#### Arrays and fixation

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Image</th>
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</thead>
<tbody>
<tr>
<td>52410</td>
<td>Reference Array T-Geometry X-Press</td>
<td><img src="image3" alt="Image" /></td>
</tr>
<tr>
<td>52411</td>
<td>Reference Array Y-Geometry X-Press</td>
<td><img src="image4" alt="Image" /></td>
</tr>
<tr>
<td>41866-77</td>
<td>Universal Cutting Block Adapter</td>
<td><img src="image5" alt="Image" /></td>
</tr>
<tr>
<td>52429</td>
<td>Bone Fixator 2-Pin, Flip Flop, X-Press</td>
<td><img src="image6" alt="Image" /></td>
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<tr>
<td>54932</td>
<td>Pindriver Adapter For AO Coupling</td>
<td><img src="image7" alt="Image" /></td>
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<tr>
<td>52421/52422/52423</td>
<td>Bone Fixator 1-Pin Size S/M/L</td>
<td><img src="image8" alt="Image" /></td>
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<tr>
<td>53201</td>
<td>Knee Plane Tool – Tracking Array</td>
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<tr>
<td>53202</td>
<td>Knee Plane Tool – Cutting Block Adapter</td>
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<tr>
<td>53203</td>
<td>Knee Plane Tool – Bone Verification Plate</td>
<td><img src="image3.png" alt="Image" /></td>
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<tr>
<td>53204</td>
<td>Knee Plane Tool – Bone Verification Plate Small</td>
<td><img src="image4.png" alt="Image" /></td>
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</tbody>
</table>

**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.

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Image</th>
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<tbody>
<tr>
<td>18460</td>
<td>Footswitch</td>
<td><img src="image5.png" alt="Image" /></td>
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<tr>
<td>53153</td>
<td>Disposable Clip-On Remote Control (20 pcs)</td>
<td><img src="image6.png" alt="Image" /></td>
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**Disposables**

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<td>Disposable Schanz Screw 3.2mm x 100mm (10pcs)</td>
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<td>54922</td>
<td>Disposable Schanz Screw 4mm x 125mm (10pcs)</td>
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<tr>
<td>54909</td>
<td>Disposable Schanz Screw (AO) 5mm x 175mm (10 pcs)</td>
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<td>18071-50</td>
<td>Disposable Sterile Monitor Drapes 40 pcs</td>
<td><img src="image10.png" alt="Image" /></td>
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<tr>
<td>41774/41773</td>
<td>Disposable Marker Spheres 270 pcs or 90 pcs</td>
<td><img src="image11.png" alt="Image" /></td>
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