

KNEE3

SURGICAL TECHNIQUE - UNIVERSAL

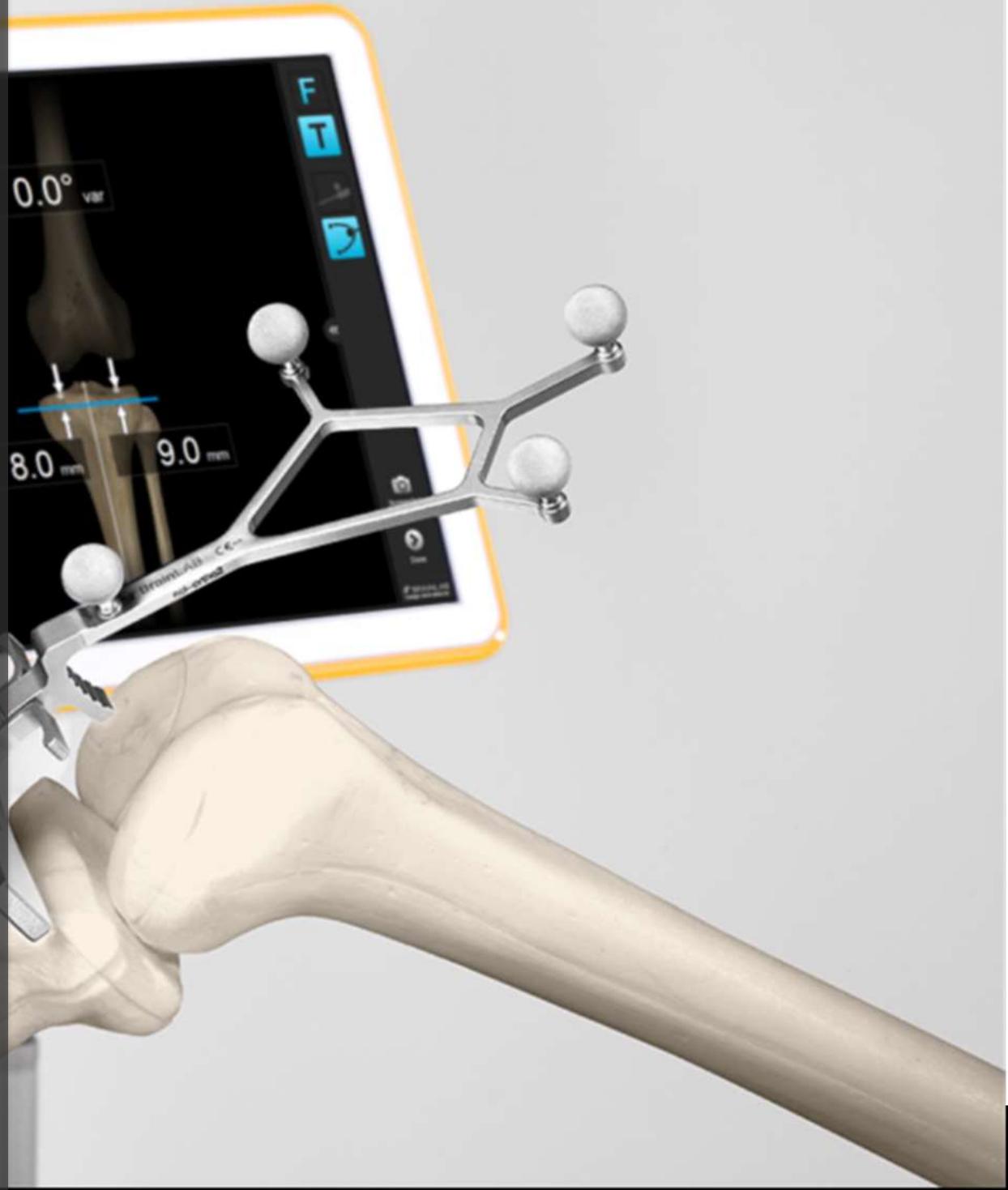
Purpose

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 UNIVERSAL

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A software guided surgery for
total knee replacement without
Implant information!



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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.

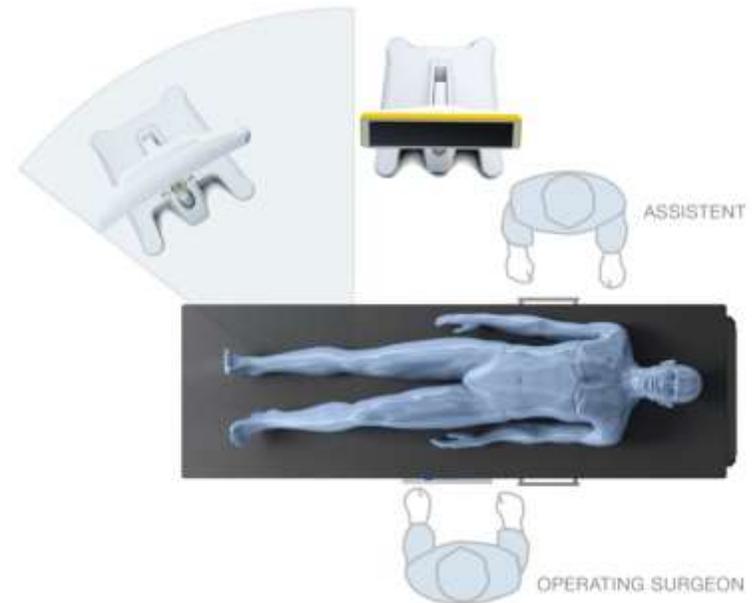
Screen Placement

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

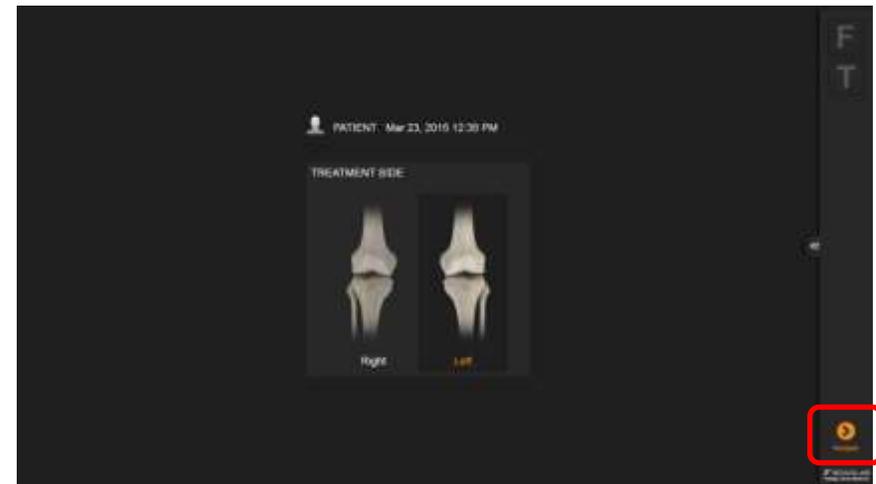
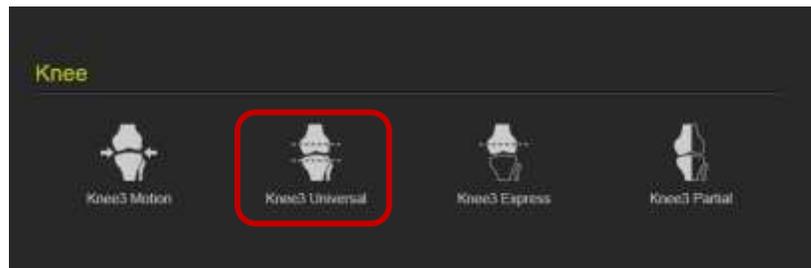
Art. no. 18071-50 Disposable Sterile Monitor Drapes 40 pcs



Software Start & Patient Selection

Start the KNEE3 Universal 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 Universal” icon. Select the treatment side.

To proceed, press “Navigate”.



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

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 (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 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 degree 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 (10 psc)

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
- Femoral Anteroposterior Axis (AP)
- Femoral Condyle Surface (medial or lateral)

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.

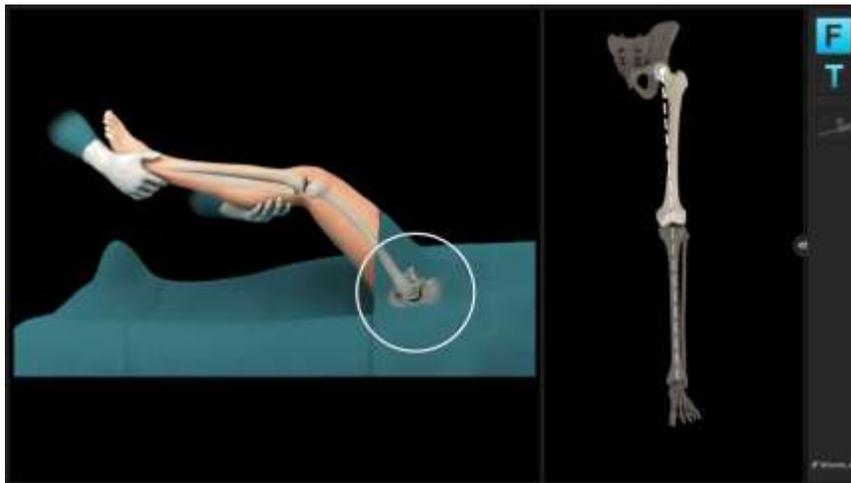
The system will produce a humming visibility sound (if turned on in Settings, see Appendix) while the femur reference is visible.

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.



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.



TIBIA

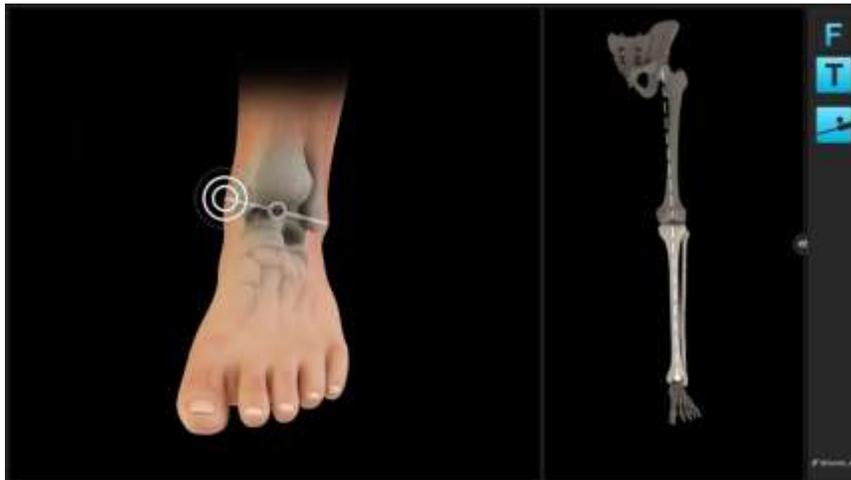
On the tibial side, the following bone landmarks are registered:

- 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.

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.

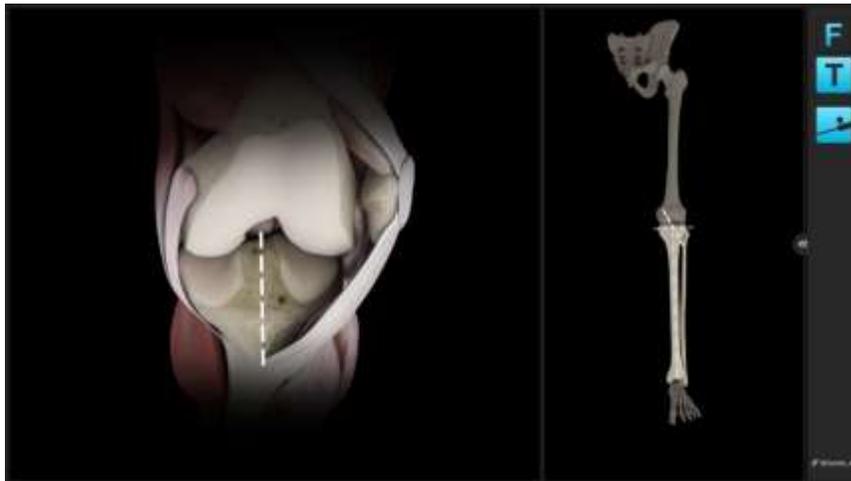


Tibial A/P Direction

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 posteromedial direction.

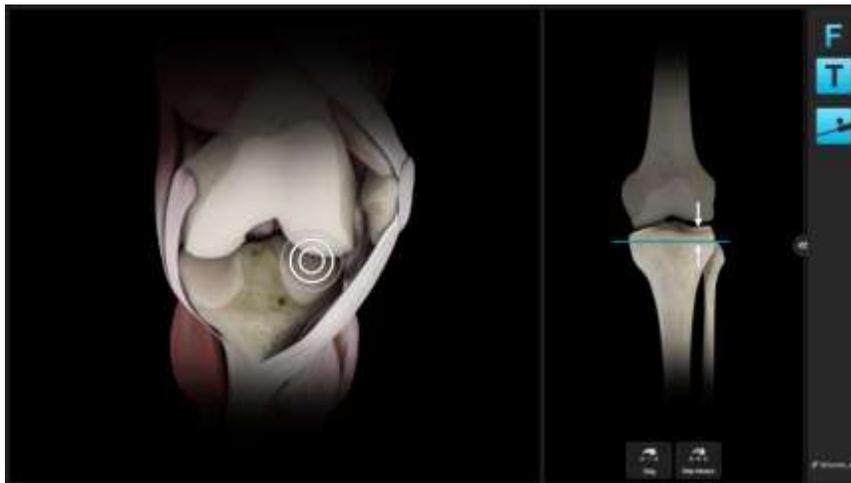
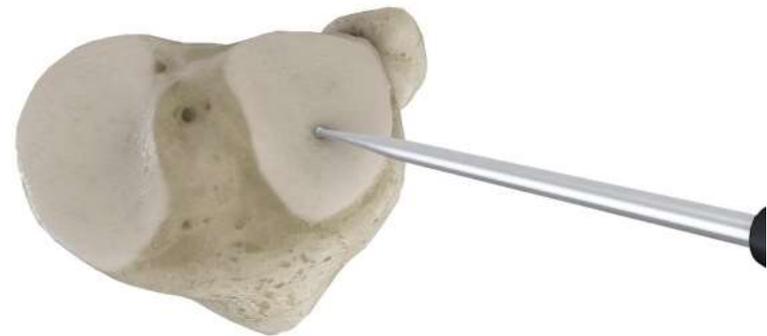
Compound slope can put the tibial component into varus or valgus and lead to poor tibial/femoral contact. This can in turn lead to malalignment.



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 condyle is missing. A skipped condyle will result in no resection levels being displayed on the respective side during navigation and planning.



Femur First Technique

KNEE3 Universal 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.

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
- 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 instrument (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.

Note: All values are referenced to bone landmarks.

Initial Leg Alignment - Screen Layout

After registration is finished, the alignment screen is shown. The screen shows the current bony anatomical situation and alignment of the joint throughout the whole range of motion.

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.

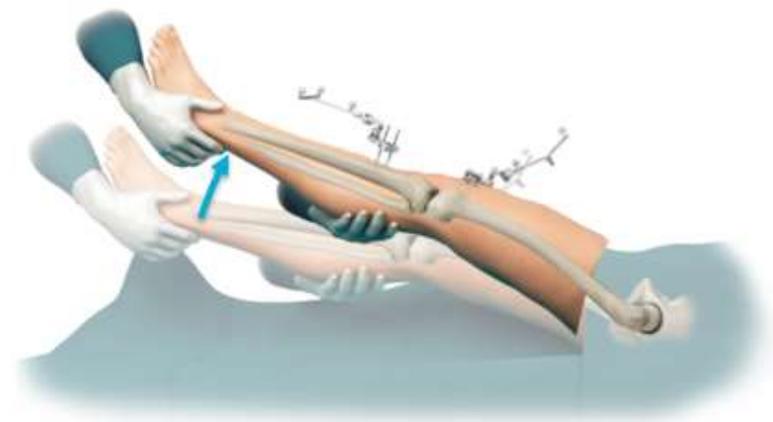
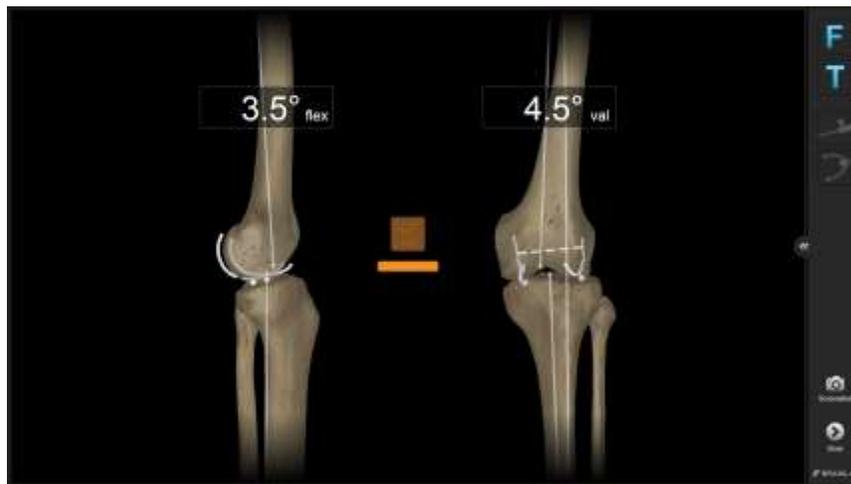
Storing Pre-operative Alignment

Bring the leg into full extension without applying varus or valgus stress. Assess the coronal alignment and check for fixed flexion or other deformities. Bring the leg into maximum flexion, again without applying varus and valgus stress during the movement.

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.

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.



Distal Femoral Resection

In 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 optionally the adjustable distal cutting block for this step, refer to the user manual guide for details.

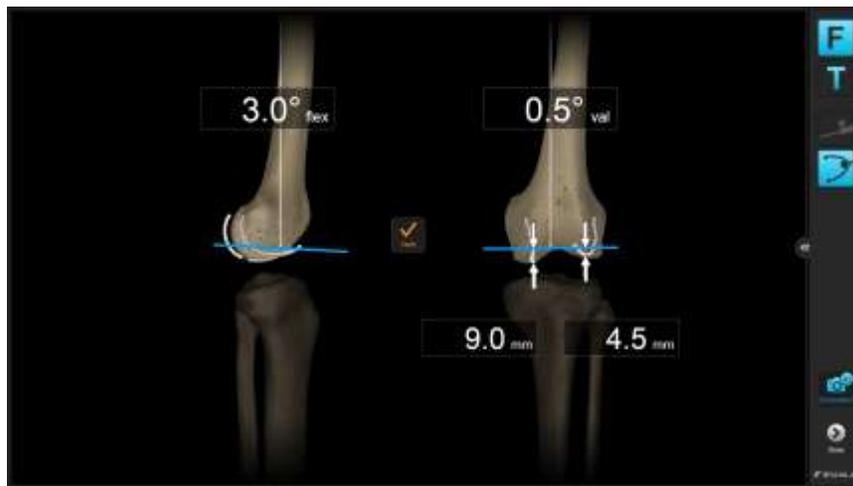
The software automatically switches to the distal femoral navigation information as soon as the resection block with the plane tool is close to the right position. The current position of the cutting plane is shown as a blue plane.

Art. no. 53202 Knee Plane Tool - Cutting Block Adapter

Art. no. 53201 Knee Plane Tool – Tracking Array

Adjust the position of the distal femoral cut according to the manufacturers' resection specification. 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 desired position, place the first pin fixing the cutting block. Constantly check for changes in alignment during drilling. Place the second pin, correcting for any alignment deviations from the first pins. If necessary, fix the block using additional oblique pins and perform resection.

Cut Verification

After performing the resection, place the Plane Tool on the resected bone surface to record the final cut position. The verified resection values (Varus/Valgus, Flexion/Extension, amount of resection) will be included in the automatically generated patient report.

Art. no. 53203 Knee Plane Tool – Bone Verification Plate

Art. no. 53204 Knee Plane Tool – Bone Verification Plate, Small

Art. no. 53201 Knee Plane Tool – Tracking Array

Final Femur Preparation

Use your conventional instruments to finish the femur preparation using the 4 in1 cutting block. Alternatively, the cutting block can be used with navigation.



Tibial Resection

While in a full femur first technique the anterior resection follows directly after the distal femoral resection, it is recommended to perform the tibial resection before the anterior femoral cut. 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 proximal tibia. The current position of the cutting plane is shown as a blue plane.

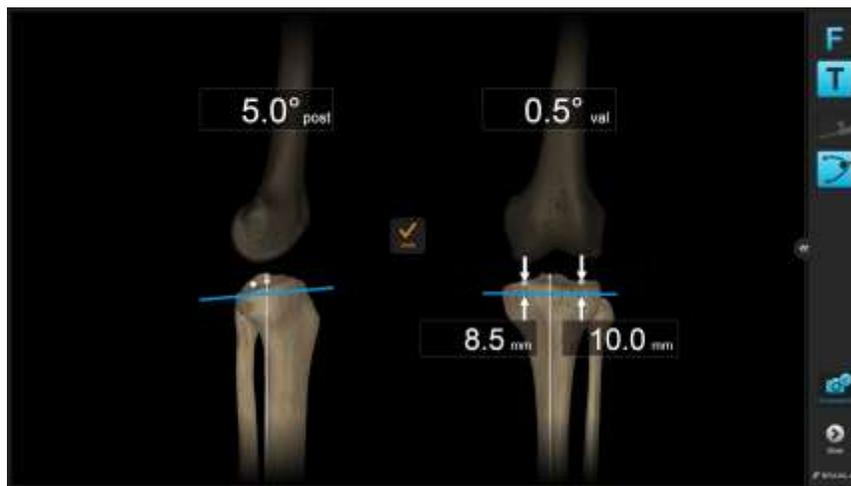
The tibial resection height displayed by the software is simply based on measurements from the cutting plane to the registered tibial plateau points.

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 crosscheck 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.

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.

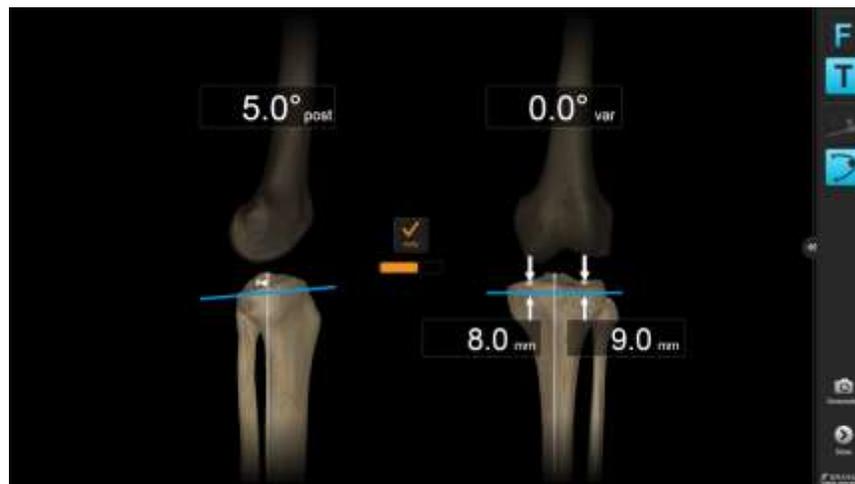
Cut Verification

After performing the resection, place the Plane Tool on the resected bone surface to record the final cut position. The verified resection values (Varus/Valgus, Slope, amount of resection) will be included in the automatically generated therapy report.

Art. no. 53203 Knee Plane Tool – Bone Verification Plate

Art. no. 53204 Knee Plane Tool – Verification Plate, Small

Art. no. 53201 Knee Plane Tool – Tracking Array



Trialing & Closure

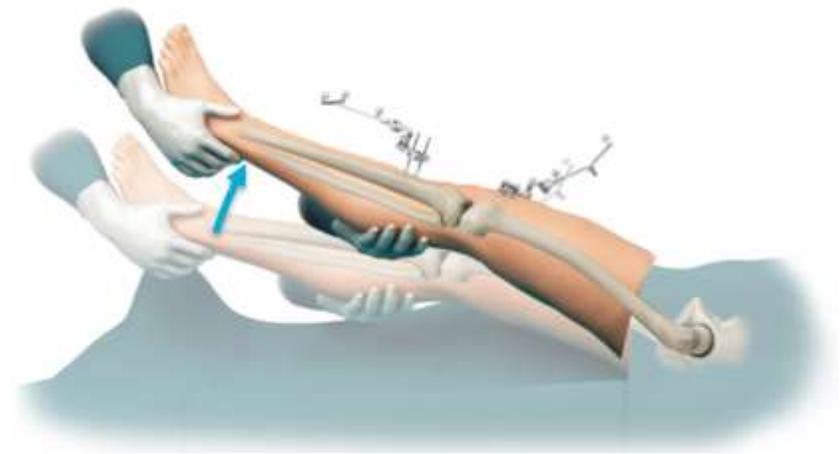
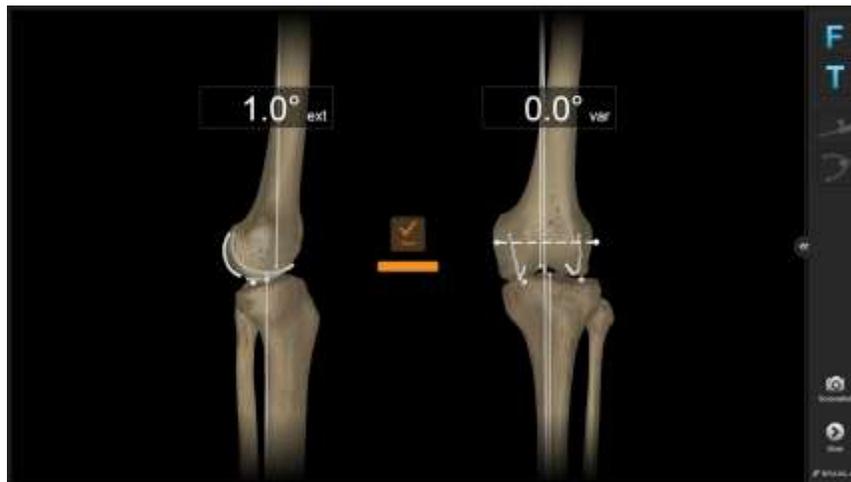
After insertion of the trial components, assess and record the coronal leg alignment situation for final documentation.

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.

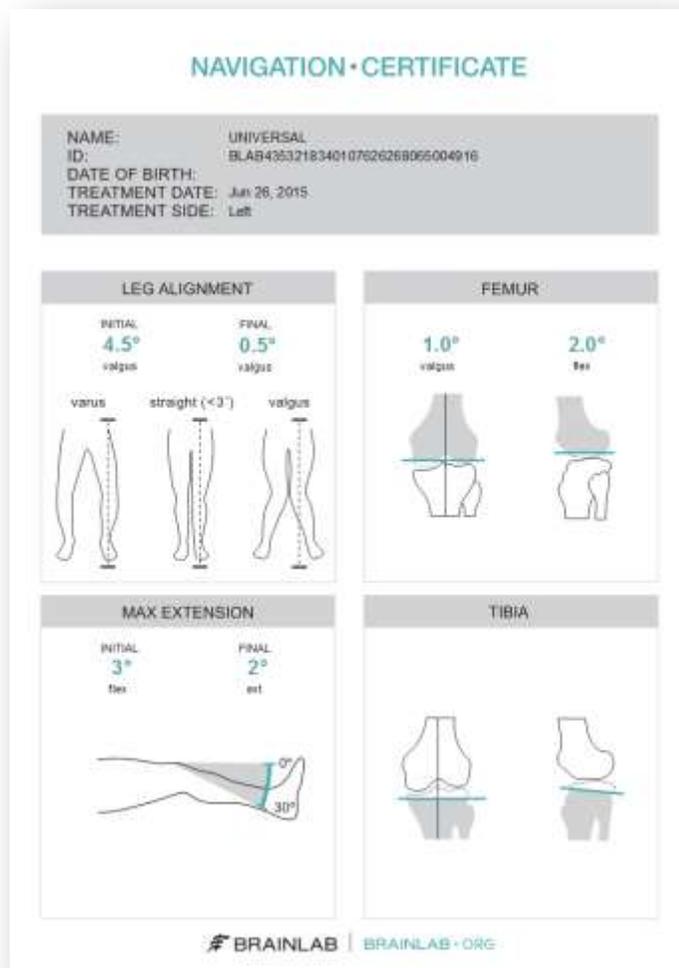
After confirming sufficient range of motion, sizing, soft tissue balance and the desired alignment correction, proceed with the preparation of tibia and femur component implantation as per conventional surgical technique.

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



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.



Appendix

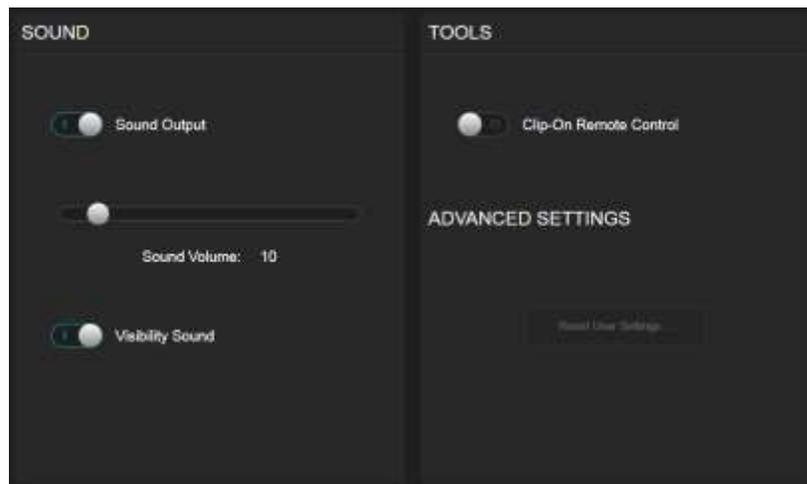
Settings

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

Number	Name	Image
53101	Pointer Angled For Hip/Knee	
53109	Pointer Straight For Knee	

Arrays and fixation

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

41866-77	Universal Cutting Block Adapter	
52429	Bone Fixator 2-Pin, Flip Flop, X-Press (for two pin fixation)	
54932	Pindriver Adapter For AO Coupling (for 3,2mm pins)	
52421/ 52422/ 52423	Bone Fixator 1-Pin Size S/M/L (for one pin fixation)	

Plane Tool

Number	Name	Image
53201	Knee Plane Tool – Tracking Array	
53202	Knee Plane Tool – Cutting Block Adapter	

53203	Knee Plane Tool – Bone Verification Plate	
53204	Knee Plane Tool – Bone Verification Plate Small	

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.

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

Disposables

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

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