MENTORS IN ORTHOPEDICS

THE KNEO POSTERIOR-STABILIZED IMPLANT FOR TKA: UNIVERSAL SURGICAL INSTRUMENTS FOR ALL KNEE SURGEONS

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SUMMARY

Background: Successful total knee arthroplasty (TKA) depends on the synergy between implant design and surgical instrumentation. While many systems dictate a specific operative philosophy, there is a clinical need for versatile instrumentation that accommodates diverse surgical preferences, including varying alignment strategies and referencing methods, to address complex primary cases and revisions.

Objective: This article describes the design rationale, technical specifications, and surgical application of the KNEO posterior-stabilized, fixed-bearing total knee prosthesis and its associated universal instrumentation system.

Key Points: The KNEO system features 11 femoral and tibial sizes with asymmetric anatomical tibial components to optimize cortical coverage and rotational positioning. The instrumentation is modular, supporting both intramedullary and extramedullary alignment, as well as measured resection or gap-balancing techniques. Key surgical steps include a distal femoral cut adjustable from -2mm to +5mm, four distinct configurations for the proximal tibial resection, and a 4-in-1 femoral cutting block that allows for anterior or posterior referencing. The system incorporates multifunctional "multitools" to streamline the surgical tray. Preparation of the intercondylar box is performed using the trial implant, facilitating intraoperative assessment of patellar tracking and kinematics prior to final component fixation.

Conclusion: The KNEO system provides a flexible surgical platform that allows practitioners to maintain their preferred operative philosophy. By integrating universal instruments compatible with multiple alignment and referencing strategies, the system aims to simplify the technical execution of TKA while accommodating anthropomorphic variations and complex joint deformities.

KEYWORDS

Arthroplasty, Replacement, Knee; Knee Prosthesis; Osteoarthritis, Knee; Prosthesis Design; Instrumentation

1. RATIONALE OF KNEO DESIGN

When designing a total knee arthroplasty (TKA), there are two factors that will determine the success of the procedure: implant design and instrumentation. Both dictate the surgical technique, but not all instruments allow any surgical philosophy to be used. The KNEO Group has listed 10 key points for the design of a modern TKA and the choices made when developing the KNEO posterior-stabilized implant (Groupe Lépine, Genay, France).1 Based on these key considerations, the KNEO Group has now developed its own posterior-stabilized fixed-bearing total knee prosthesis (Figure 1) and universal instruments, which allow the surgeon to perform his own technique and surgical philosophy.

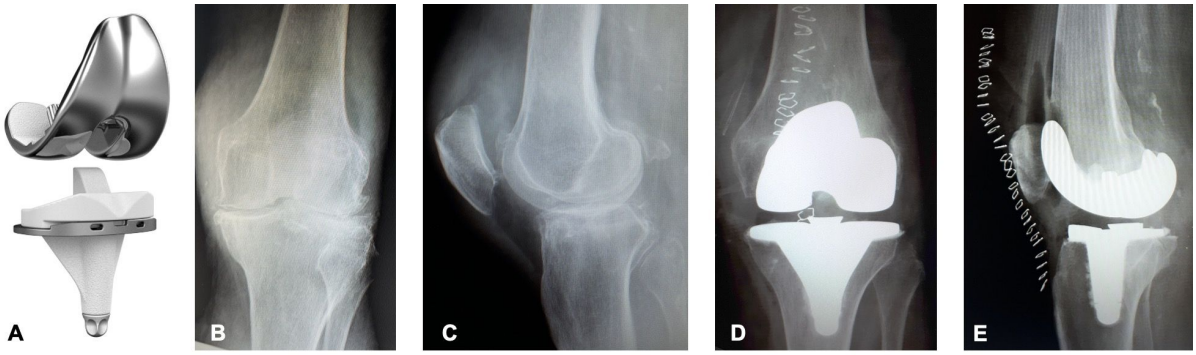

Figure 1 A. KNEO posterior-stabilized fixed-bearing total knee prosthesis (Groupe Lépine, Genay, France). B & C. Preoperative frontal and lateral x-rays. D & E. Postoperative frontal and lateral x-rays with KNEO TKA.

The KNEO system comprises 11 sizes of femoral and 11 sizes of tibial components and six heights of polyethylene insert. Each insert is compatible with 5 tibial sizes (nominal size ± two sizes). For the tibial component, the decision was taken to produce an asymmetric anatomical implant that would not only offer the benefits of positioning the implant in external rotation, but also allows for anthropomorphic variations in size ratio between proximal tibia and distal femur on an international market. The femoral trochlea is anatomically shaped, meaning it is sufficiently concave for use without patellar resurfacing, whilst also providing an effective guide for a prosthetic patella. The prosthetic trochlea has a physiological trochlear angle with a raised lateral rim. For patellar resurfacing procedures, the patellar component is fixed using three cemented pegs. In profile, the patellar implant is shaped somewhere between a dome and a 'Mexican hat', which does not only create an effective (contactless) guide in the trochlear notch but also to form a wide support base between the trochlear rims and the broad periphery of the patellar implant. The aim of this paper to describe in more details the surgical options and tips and tricks for the universal KNEO instruments.

2. INDICATION

The KNEO TKA is suitable for both osteoarthritis of the knee and inflammatory joint disease. A tibial stem can be added if the bone quality is poor (osteoporosis or rheumatoid arthritis), for obese patients and when revising a partial knee replacement (UKA) (provided there is no excessive loss of bone stock). The ligament balancing system can also treat complex cases such as reducible deformities, especially in valgus. Epiphyseal deformities (TKA after

a former tibial osteotomy) and TKA secondary to malunion can also be treated thanks to the extramedullary alignment system.

3. SURGICAL TECHNIQUE

Modern operating instruments should allow the surgeon to perform his own surgical philosophy, rather than force the surgeon to adapt his philosophy to the instrumentation. The KNEO surgical instruments are universal and do not impose a particular order for the bone cuts, which can be executed in whatever order the surgeon chooses. The KNEO instrumentation system is compatible with both standard and minimally invasive approaches to the knee. It is also modular and allows for different choice of alignment configuration, cutting techniques (gap balancing or measured resection) and anterior or posterior referencing, based on what's the surgeon preference. KNEO tools are also multifunctional in order to streamline the procedure, reduce the number of instruments required and the necessary storage space, and optimise the sterilisation process (Figure 2).

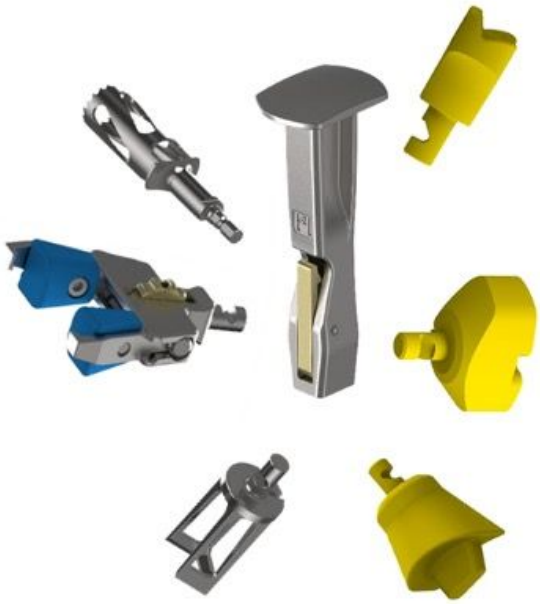

Figure 2. The KNEO multitools limit the size and complexity of the instrumentation set. They are ergonomically designed.

3.1 Preoperative planning

During planning, the surgeon should evaluate the existing bone stock, potential ligament instability and any femoral valgus (angle between anatomical axis and mechanical axis) to ensure that the distal femoral cut is perpendicular to the mechanical axis. The correct component size can be estimated using templates.

3.2 Distal femoral cut

After creating the intramedullary entry point, the intramedullary rod is inserted into the femoral canal up to the score line, using the impactor handle. The measured femoral valgus (0°–10°) is adjusted through simple traction, using the dial. The distal femoral cutting guide is then slid onto the template, right down to femur (Figure 3).

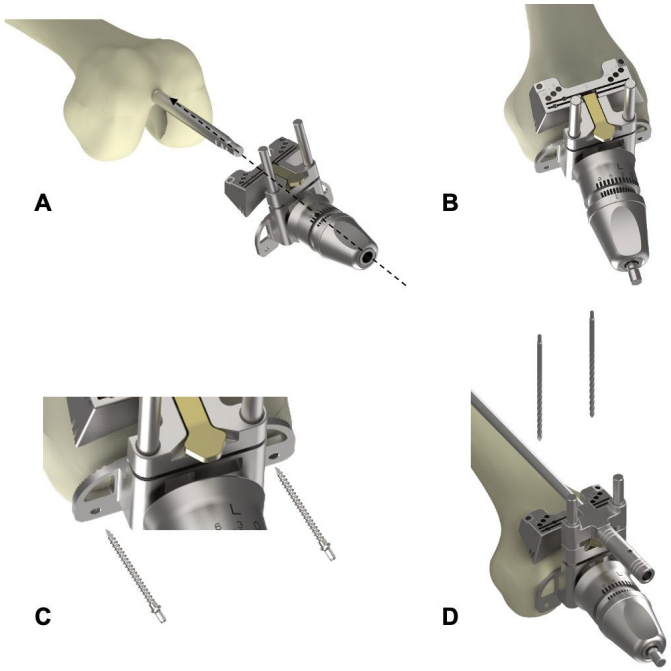

Figure 3 A. Placing the distal femoral cutting guide on the intramedullary rod. Femoral valgus can be adjusted to within a millimetre using the dial. B. Once touching the femur, the guide can be stabilized in rotation, using two pins with depth stops (C). The cutting guide is then secured using two long pins (D).

Extramedullary verification is possible. The cutting guide is then stabilized against femur using two long pins. It can be detached from the main body of the tool by pressing the gold release button, and the intramedullary rod can be withdrawn (Figure 4).

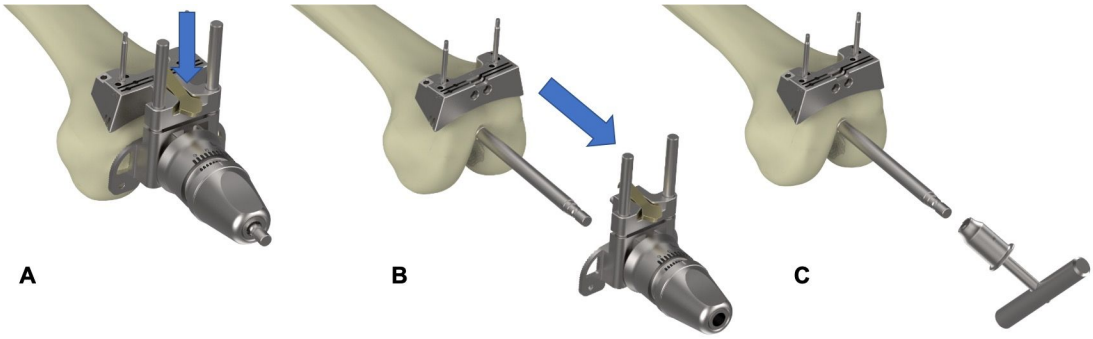

Figure 4. A. The gold button detaches the cutting guide from the body of the tool (B). C. The intramedullary rod can then be removed using the extractor handle.

Cut height is assessed using a test plate. Depending on the desired thickness of the distal femoral cut, the instrumentation offers three possibilities: (i) 0 mm cut in the distal slot (for an 8 mm implant); (ii) +3mm cut in the proximal slot (e.g. for flexion contractures); or (iii) the entire guide can be repositioned on the pins, allowing for ± 2mm readjustment (Figure 5). With this system, the cut can be adjusted from -2mm to +5mm. The distal femoral cut is then made after the cutting guide has been secured laterally using two short threaded pins with depth stop.

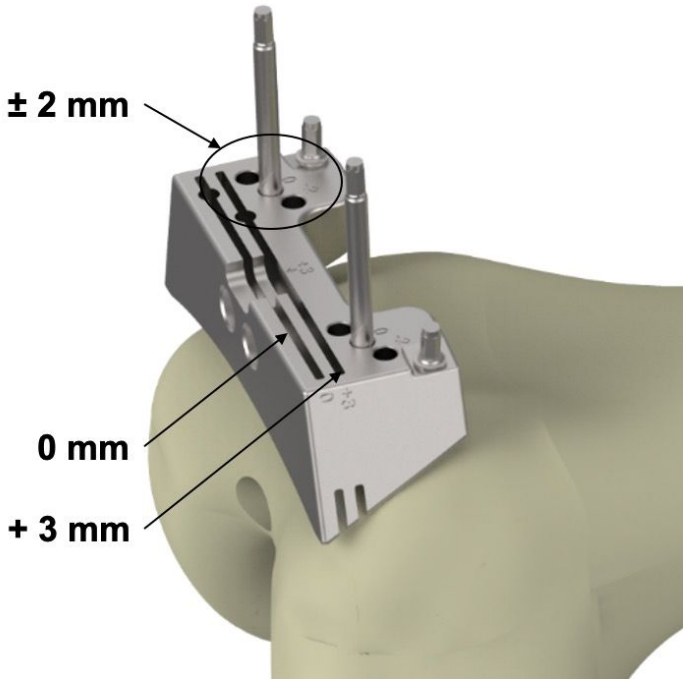

Figure 5. The cutting guide offers three options, depending on the desired femoral resection height: (i) 0 mm cut in the distal slot (for an 8mm implant); (ii) +3mm cut (e.g. for flexion contractures); or (iii) the entire guide can be repositioned on the pins, allowing for ±2mm readjustment.

3.3 Proximal Tibial Cut

The instrumentation can be configured in four different ways for making the tibial cut: extramedullary, extramedullary supported by the tibial eminence, extramedullary on an intramedullary stem, or intramedullary with extramedullary verification (Figure 6).

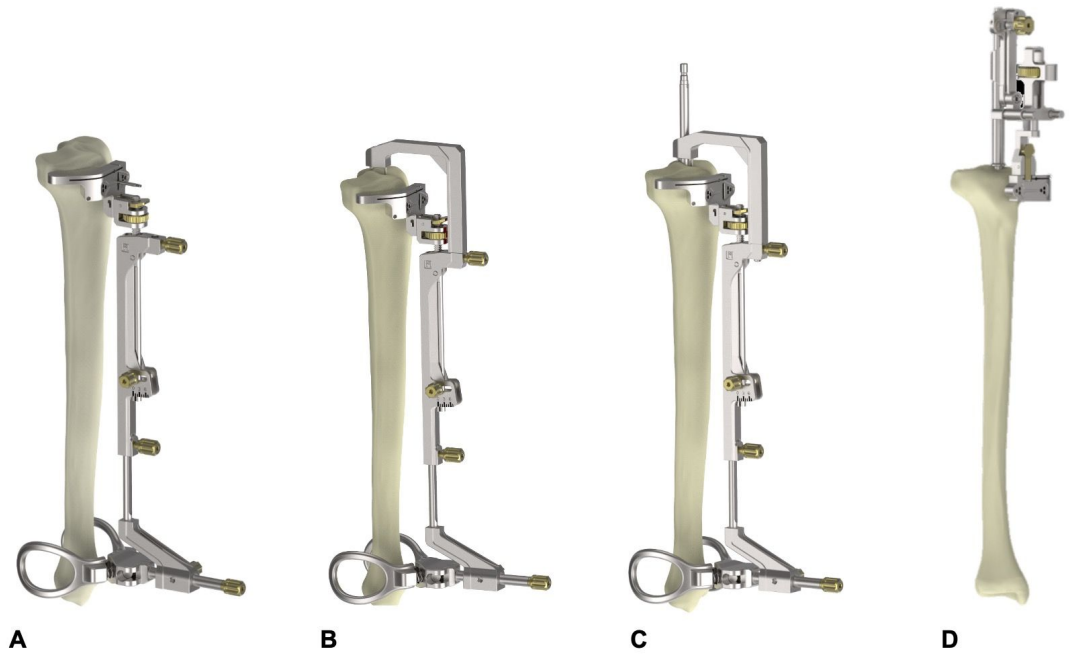

Figure 6. The tibial cutting guide can be used in four different configurations: a. Extramedullary (left); b. Extramedullary supported by the tibial eminence (centre); c. Extramedullary on an intramedullary rod; and d. Intramedullary with extramedullary verification.

Method 1: Extramedullary configuration (Figure 6A):

The cutting guide is placed on the proximal tibia, aligning the groove with the junction between the medial third and lateral two-thirds of the anterior tibial tuberosity (ATT) (Figure 7A). It is temporarily secured, proximally using a long nail and distally using the ankle clamp (Figure 7B). This configuration is especially useful in cases of bone deformity (former tibial osteotomy or malunion).

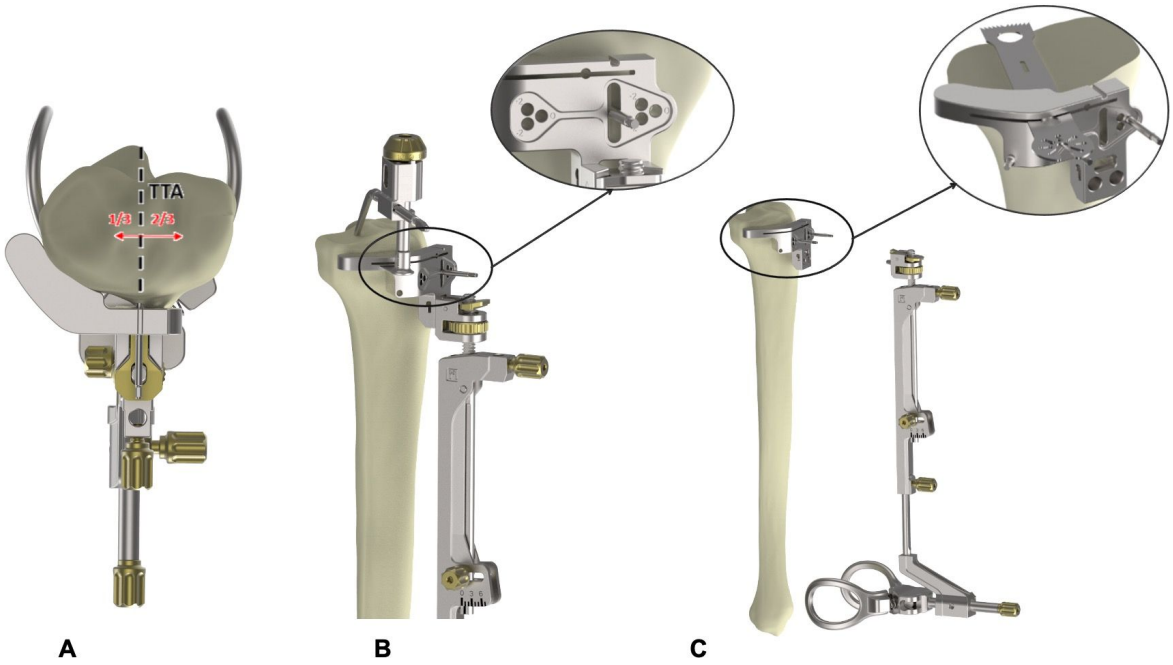

Figure 7. Tibial cut: Extramedullary configuration (method 1). A. The cutting guide is placed on the proximal tibia, aligning it with the junction between the medial third and lateral two-thirds of the anterior tibial tuberosity (ATT). B. It is temporarily fixed in place, proximally using a headless pin and distally using the ankle clamp. Resection height and tibial slope can be adjusted. C. The guide is then easily detached by pressing the gold release button. The tibial resection height can be adjusted by ±2mm.

Method 2: Extramedullary configuration supported by the tibial eminence (Figure 6B): Proximally, the pins on the guide are impacted into the tibial eminence, and distally the guide is stabilized using the ankle clamp (Figure 8B).

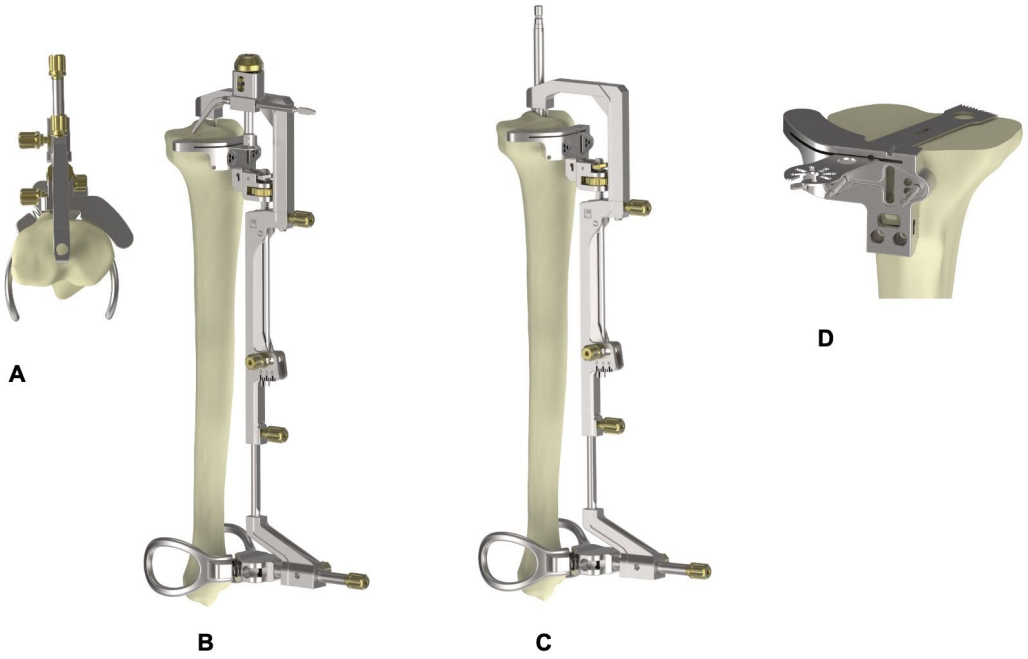

Figure 8. Tibial cut: Extramedullary configuration supported by the tibial eminence (method 2). The guide is fixed proximally by impacting the spike into the tibial eminence (A), and distally using the ankle clamp (B). C. Extramedullary configuration with intramedullary rod (method 3). The guide is inserted onto the intramedullary rod, and the spikes are impacted into the tibial eminence for proximal fixation. D. The cutting guide is secured using pins. The guide is then easily detached by pressing the button. The tibial resection height can be adjusted by ±2mm.

Method 3: Extramedullary configuration with intramedullary rod (Figure 6C):

After creating the intramedullary entry point, the intramedullary rod is inserted into the tibial canal up to the score line, using the impactor handle. The guide is then placed over the intramedullary rod, and the pins are impacted into the tibial eminence for proximal fixation (Figure 8C). The guide is stabilized distally using the ankle clamp.

Method 4: Intramedullary configuration with extramedullary verification (Figure 6 & 9 A):

After creating the intramedullary entry point, the intramedullary rod is inserted into the tibial canal up to the score line, using the impactor handle. The alignment guide is then placed onto the intramedullary rod. The intra- and extramedullary rods can be disconnected in order to adjust proximal tibial valgus/varus, centred over the ankle or second metatarsal.

For all four options, the tibial stylus is then inserted into the slot on the guide. Using this system, resection height and tibial slope can be finely adjusted using the dials. The instruments can be easily removed by pressing the release button (Figure 7C, Figure 9B). The tibial resection height can then be adjusted by ±2mm.

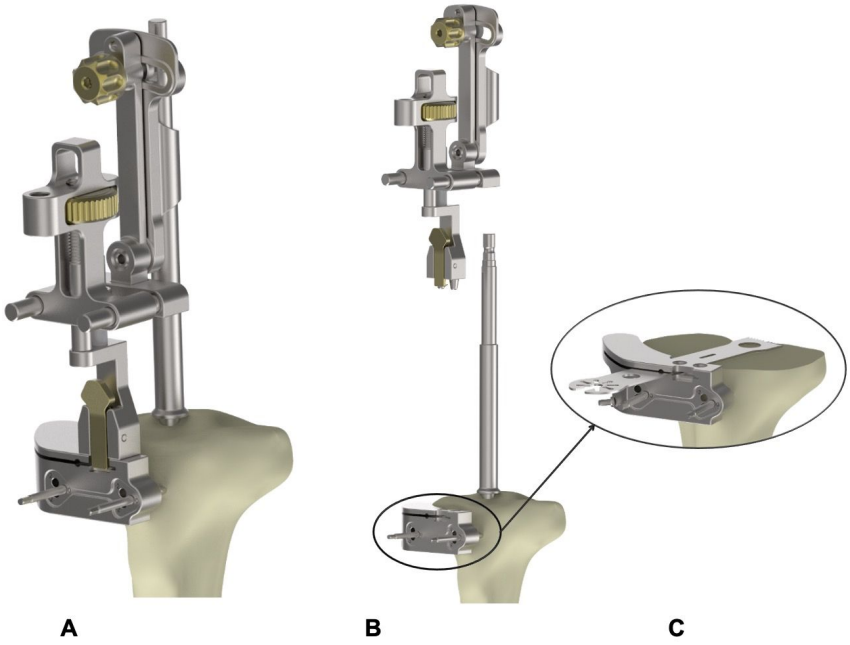

Figure 9. A. Tibial cut: Intramedullary configuration with extramedullary verification (method 4). The intra- and extramedullary rods can be disconnected in order to adjust proximal tibial valgus/varus, centred over the ankle or second metatarsal. B. The guide is then easily removed by pressing the release button. C. The tibial resection height can be adjusted by ±2mm.

3.3 Gap assessment and ligament balancing in extension

After the proximal tibia cut has been performed the leg is placed in full extension and a spacer block is inserted in the resulting quadrangular gap. The spacer represents the total final implant (femur component + insert + tibial baseplate). Alignment can be checked by placing the alignment stems against the spacer (Figure 10A). If the gap is not balanced, a further bone cut and/or soft tissue release can be performed (Figure 10B).

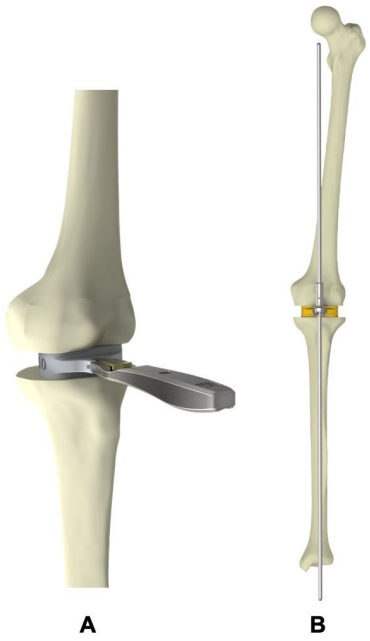

Figure 10. A. Checking ligament balance in extension. B. Alignment can be checked by placing alignment rods into the spacer.

3.4 Measuring and adjusting femoral rotation

The KNEO instrumentation system can be used with either an anterior or posterior reference system (Figure 11). The A/P femoral sizer is placed on the distal femoral cut, resting on the posterior condyles (Figure 11). For a valgus deformity, a wedge may be placed on the posterior lateral condyle to fill the defect. A/P size is adjusted by placing the stylus on the anterior femoral cortex, slightly laterally. The size is read in line with the grooves on the sizer, and then transferred to the stylus to determine the saw blade exit point. Remember, every femoral component size is compatible with five different tibial component sizes (nominal size ±2 sizes).

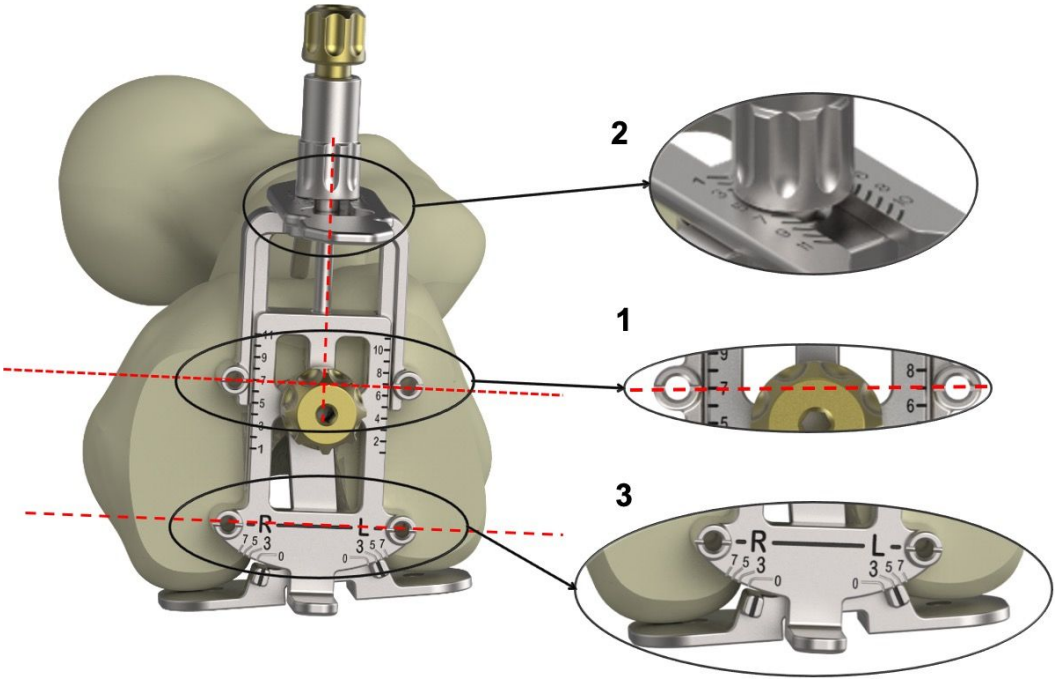

Figure 11. The anteroposterior (A/P) femoral sizer is placed on the distal femoral cut. A/P size is adjusted by placing the stylus on the anterior femoral cortex, slightly laterally. The size is read in line with the grooves on the sizer (1), and then transferred to the stylus (2) to determine the saw blade exit point. The reference point can be anterior (2) or posterior (3). The angle of external rotation is read from the guide (3).

Option 1: Measured resection:

The degree of external rotation is adjusted according to anatomical landmarks (parallel to the transepicondylar axis and perpendicular to Whiteside's line) by turning the gold knob. The angle is read from the instrument (Figure 11).

Option 2: Gap balancing:

The gold knob is loosened, then a hemispacer is slid between the femoral sizer and tibia, with the knee flexed at 90° (Figure 12). Ligament balancing is automatic and the degree of external rotation is fixed by tightening the gold knob.

Once the rotation is set, two pins are inserted, either into the upper holes (for an anterior reference point) or the lower holes (for a posterior reference point).

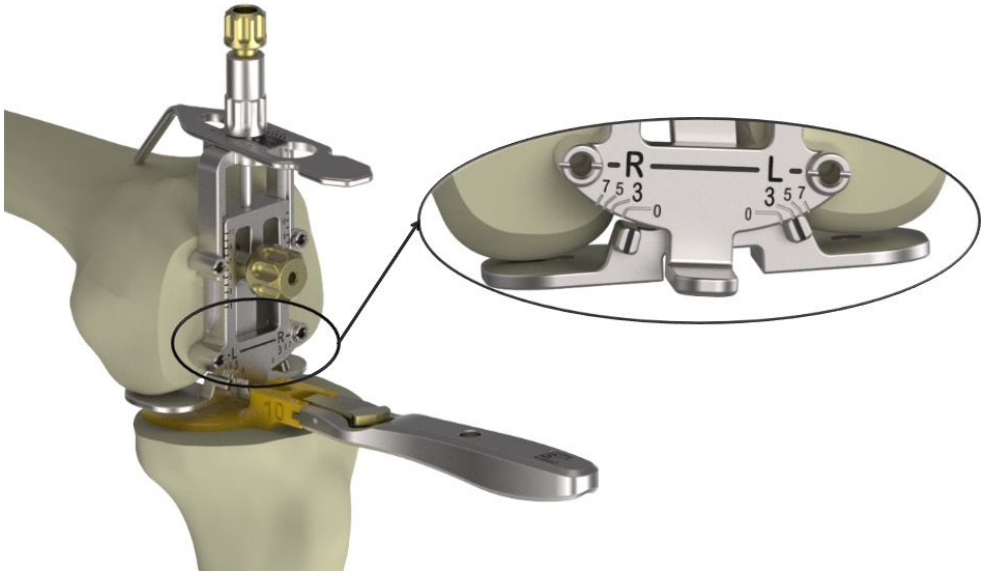

Figure 12. Loosen the gold knob, then slide a hemispacer between the femoral sizer and tibia, with the knee flexed at 90°. Ligament balancing is automatic and the degree of external rotation is fixed by tightening the gold knob.

3.5 Femur Preparation

After removing the A/P femoral sizer, the correct 4-in-1 femoral cutting block for the measured size is then placed against the distal femoral cut (Figure 13). The 4-in-1 block represents the mediolateral (M/L) size provided by the final implant. The A/P femoral sizes increase in increments of 2.5mm. Three sets of nail holes spaced ±1mm apart allow the surgeon to adjust the A/P position of the cutting block by 1.5mm anteriorly or posteriorly. The 4-in-1 cutting guide can be fixed using two lateral converging threaded long pins, with depth stop. Once the A/P pins have been removed, the anterior, posterior and chamfer cuts can be made.

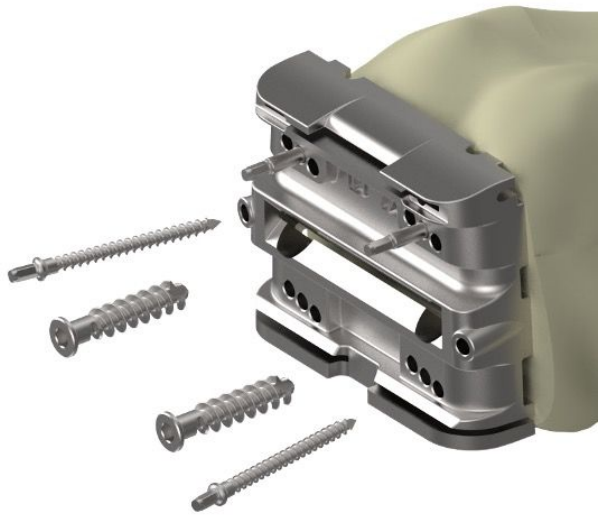

Figure 13. The correct 4-in-1 femoral cutting block for the measured size is then placed against the distal femoral cut. It can be secured using two lateral converging pins or two cancellous bone screws.

3.6 Preparing the intercondylar box

The box cut is made using the trial implant which saves time because the tests can be performed using the trial tibial component. It also makes it quick and easy to assess patellar tracking, knee kinematics and spontaneous tibial rotation during flexion and extension of the knee (Figure 14A). At this stage, the tibia baseplate with the insert without the peg is not fixed to the bone and the femur component can be still placed medially/laterally before preparing the posterior stabilization box. Before removing the trial tibial insert, the two femoral holes are created using a drill bit with a depth stopper (Figure 15). The trial femur is stabilized with screws and the PS box cut can be prepared using a hole saw bit and extractor (Figure 15C& D). After inserting the femur box and the tibia PS peg a new test using the posterior stabilization insert can now be performed (Figure 14B & D).

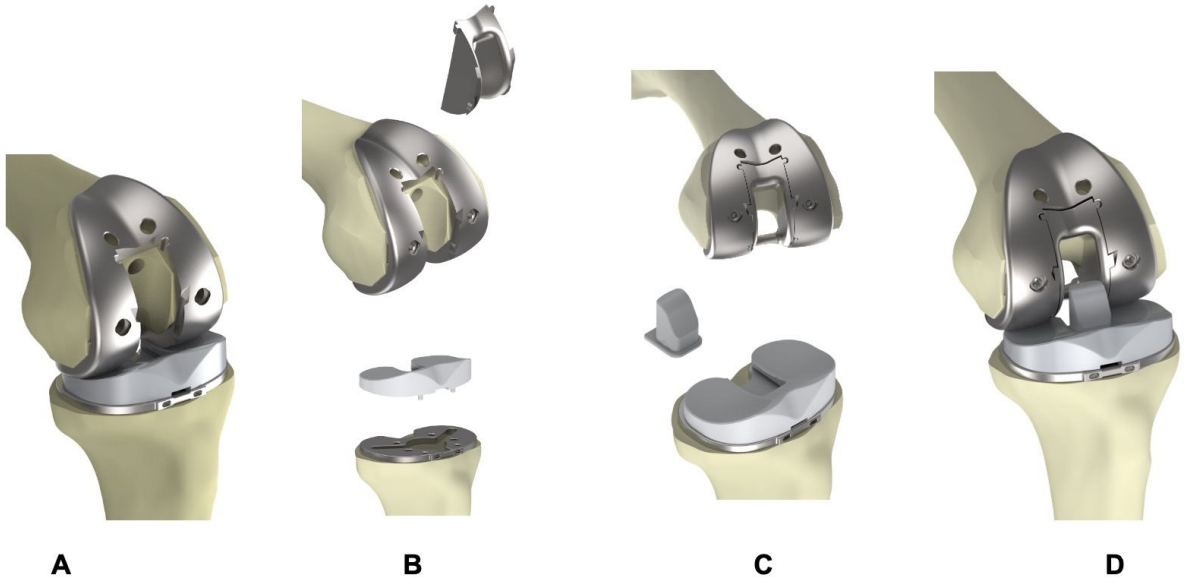

Figure 14. A. The tibial component can be tested with the tibial insert without the tibia peg to assess patellar tracking, knee kinematics and spontaneous tibial rotation during flexion and extension of the knee. B. After the box cut a further test with the PS insert can be performed after insertion of the femur box and fixing the PS peg at the tibia insert.

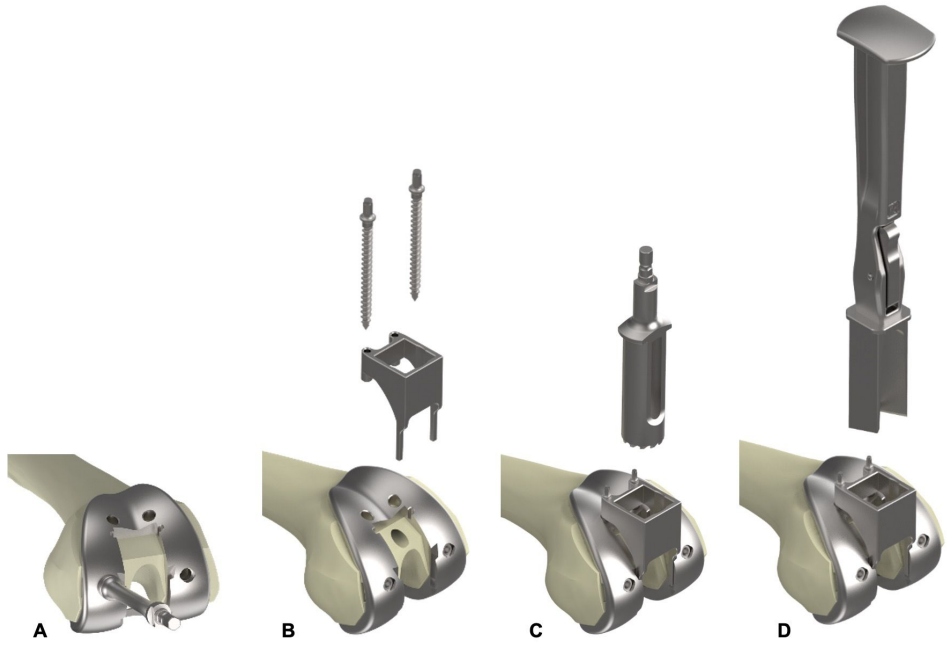

Figure 15. A. After removing the trial tibial insert, the two femoral holes are created using a drill bit with a depth stopper. The trial femoral component is stabilized with screws and the posterior stabilization box cut (B) is made using a hole saw bit (C) and extractor D).

3.7 Preparation of tibia and tibial stem

The anatomical tibial baseplate is positioned to give maximum coverage, without overlap, whilst ensuring it is centred over the middle third of the ATT (Figure 16A). It is secured using two short threaded pins with depth stops. Remember, every femoral component size is compatible with five different tibial component sizes (nominal size ±2 sizes).

The conical burr and tibial impactor of the correct size, are then inserted up to the mechanical stop (Figure 16B & C). A long tibial stem can be used in cases of poor bone quality (osteoporosis or rheumatoid arthritis), obesity or a UKA revision. The reamer must be inserted to the desired length through a centring ring.

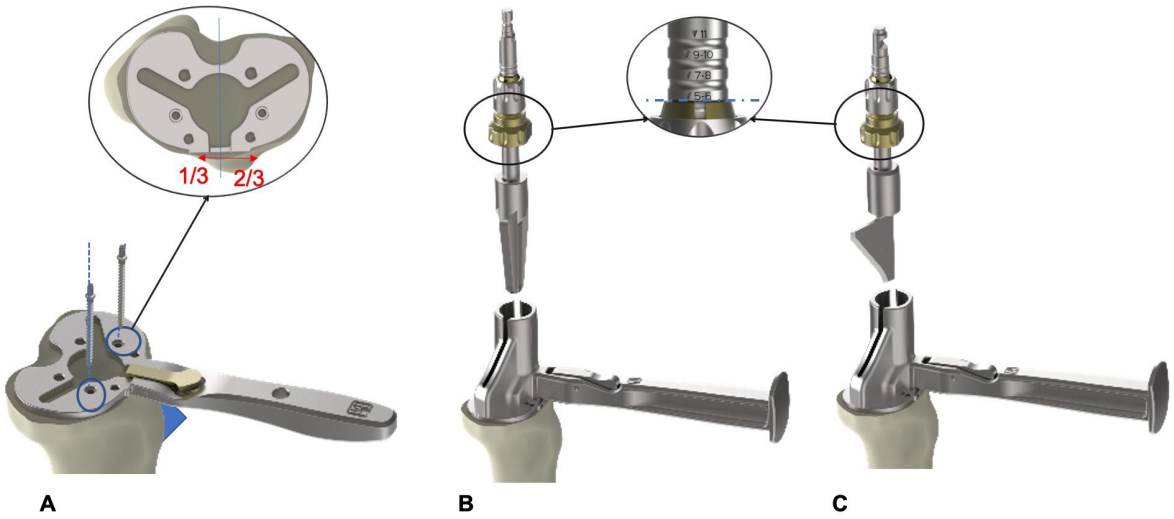

Figure 16. A. The anatomical tibial baseplate is positioned to give the maximum coverage, without overlap, whilst ensuring it is centred over the middle third of the ATT. It is fixed using two pins. The conical burr (B) and tibial impactor (C), both preset to the correct size, are inserted up to the mechanical stop.

3.8 Patellar preparation and resection

Patellar resurfacing is possible. The instrumentation set can be used to measure the height of the patellar cut between the patellar crest and disk; it also guides the cut. Three pegs are inserted using a perforator and drill bit with depth stop.

3.9 Fixing the final implants

First the tibia followed by femur is finally fixed. The poly tibial insert is slid in horizontally and impacted, ensuring an angle of 30° off the tibial plateau in order to help position it with the posterior dovetail on the baseplate (Figure 17A). The shape of the impactor tip should naturally create this angle. Warning: The polyethylene implant should be the same size as the femoral component. The position of the insert is verified using the anterior perforations on the baseplate (Figure 17A). If the patella is being resurfaced, the patellar component is held in place using a clamp during fixation (Figure 17B). This tool has a removable sleeve so that the surgeon can continue working whilst the patellar is being fixed, without being hampered by the instrumentation.

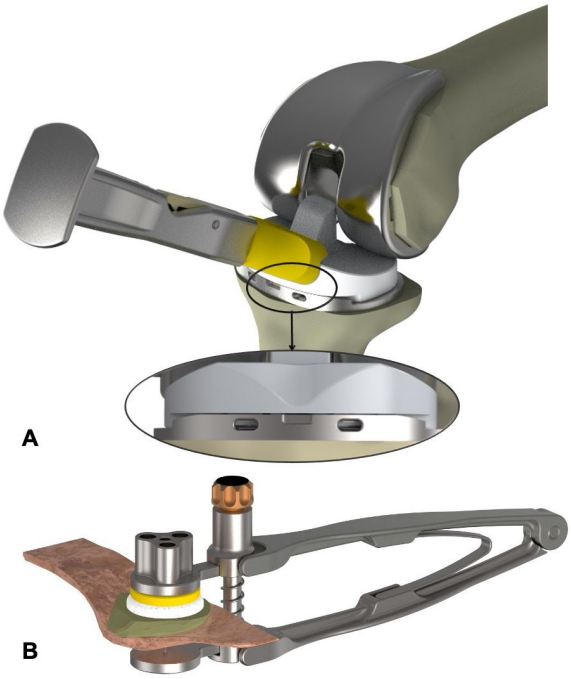

Figure 17. A. The tibial insert is slid in horizontally and impacted, ensuring an angle of 30° off the tibial plateau in order to help position it with the posterior dovetail on the baseplate. The position of the insert is verified using the anterior perforations on the baseplate. B. Patellar clamp during fixation (a removable sleeve allows the surgeon to continue working whilst the patellar is being fixed, without being hampered by the instrumentation).

CONCLUSION

The instrumentation supplied with the KNEO fixed-bearing TKA does not force the surgeon to change his or her usual methods, since it is compatible with both anterior and posterior referencing, gap balancing and measured resection, intramedullary and extramedullary alignment, with or without patellar resurfacing. The mission of the KNEO Group is to make it easier for every surgeon to perform knee arthroplasties, whilst making the instrumentation easier to use and more streamlined. At six months after the first procedures, the technical choices have all been validated in the short term. Longitudinal monitoring is now needed to validate these choices in the long term.

REFERENCE

1. **Le groupe KNEO.** Les 10 points clés de la conception d'une prothèse totale du genou (PTG) moderne. Maîtrise Orthopédique. 2018;276: 44-48.