

Use the Right Looking-Glass When You Do Calipered Kinematically Aligned TKA!

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‘Through the looking-glass’ refers to the Lewis Carroll novel (i.e., the sequel to Alice in Wonderland) where Alice crosses over into a ‘bizarre universe’ when she enters the flipped world on the other side of a mirror. The phrase implies unpredictable and strange happenings, a poignant metaphor for the mechanical alignment (MA) TKA surgeon’s initial confrontation with kinematic alignment (KA)!

Interest in calipered KA TKA is justifiably growing as most randomized trials show clinical outcomes are better and registry and case series analyses show implant survival is comparable or better than mechanical alignment (MA) with a negligible risk of varus tibial component failure and comparable risk of patellofemoral complications at 7 to 10-years. KA is ‘personalized’ and 3-dimensional; MA is ‘one-approach fits all’ in the coronal plane.

Calipered KA is defined as the setting of the femoral and tibial components to restore the patient's pre-arthritic joint lines without the release of ligaments, including the PCL. Resurfacing the knee co-aligns the components' axes with the three kinematic axes of the native (i.e., healthy) knee, thereby preserving the posterior cruciate, collateral, and retinacular ligaments' resting lengths, which reduces the risk of kinematic conflict between the components and soft-tissues.

The surgeon uses caliper measurements of bone resections to confirm the varus-valgus and internal-external orientations and proximal-distal and anterior-posterior positions of the femoral component are coincident within ± 0.5 mm of the pre-arthritic joint lines. The fine-tuning of the varus-valgus and posterior slope of the tibial cut to match the patient’s pre-arthritic slope creates a tight rectangular space in extension and balances the knee. These steps restore the tibial compartment forces of the native knee without ligament release, a target that compartment force studies of mechanical, functional, and restricted kinematic alignment have not achieved even after the release of healthy ligaments.

The MA surgeon learns to ‘see’ the knee differently operating in the ‘bizarre universe’ of KA. No longer are components set to the MA targets of the femoral head and ankle, the transepicondylar axis and Whiteside’s line, and a fixed posterior slope. The need for releasing ligaments disappears. Contracted and stretched ligaments are strikingly rare even in the most deformed knees. Correction of severe varus and valgus deformities become surprisingly straightforward, and flexion contractures readily resolve by releasing the posterior capsule.

The calipered KA surgeon incorporates the dentist's technique of assessing surface relationships inside the mouth to 3-dimensionally fit a crown on a worn tooth without referring to a pre-operative image. Similarly, the surgeon opens the knee, assesses the cartilage wear on the distal femur, sets the femoral resections' thickness compensating for cartilage loss at 0 and 90 degrees, cuts the tibia to restore a rectangular extension space, records the resection thicknesses in their operative note, and achieves a 'personalized' approach. They don't consider the tibial component is set in 'varus or valgus' because restoring the patient's pre-arthritis joint line is the target. The postoperative radiographic expectation is that component alignment matches the contralateral knee's joint lines and limb alignment when the paired femora and tibia are normal.

They gain confidence from those patients with a prior contralateral MA TKA that they treat with calipered KA. In studies of patients with bilateral TKA, the recovery of the KA TKA is more often less painful and faster, and the narcotic use is less. The Forgotten Joint Score is higher and comparable to a total hip replacement. Encouraging results and a surgery-free of morbidity from ligament release enable the transition from an overnight hospital stay to same-day discharge. Patients realize that self-administering motion exercises and forgoing formal physical therapy result in a less painful and faster recovery.

MA surgeons always ask the range of the varus, valgus, and posterior slope angles after calipered KA cuts the femur and tibia. This question is irrelevant and distracting to the calipered KA surgeon because they set no components in varus, valgus, or to a fixed posterior slope as the patient's pre-arthritis joint line is the target. Instead, imagine the MA surgeon switches things up and examines their bone resections through the KA looking-glass. They will realize that MA's one-approach fits all cuts 85% of distal femurs in varus and 70% of proximal tibias in valgus relative to the patient's pre-arthritis joint lines, and reduces the Q-angle in 70% of patients. The higher frequency of a varus cut of the femur than a valgus cut of the tibia explains why varus knee and limb alignment are more frequent after MA than KA. The low risk of patellofemoral complications with both alignments is explained by KA restoring the pre-arthritis Q-angle and not decreasing it like MA, which apparently off-sets KA's internal rotation of the femoral component relative to MA.

Any TKA surgery can be like a well-planned wedding, intended to come off without a hitch, yet something unintended occurs. Whether the surgeon performs KA with manual, patient-specific, navigation, or robotic instrumentation, it is best to double-check the femoral component resurfaces the femur by measuring resections with a caliper. Intraoperative recognition of an unexpected resection deviation of 1 mm or more from the patient's pre-arthritis joint lines provides an opportunity to correct component position and orientation before cementation and implantation.

Surgeons adopting KA go through a learning curve, and starting with patients with simple varus deformities eases concerns. It is better to use MA than calipered KA when the surgeon is uncomfortable fully restoring the pre-arthritis joint lines. Restricting correction can result in instability, high tibial compartment forces, and a limb alignment unnatural to the patient.

In conclusion, several implant designs are FDA and CE approved for use with calipered KA fostering a spirited competition between the KA and MA techniques. Surgeons considering the transition from MA to calipered KA need to appreciate the unresolvable conflict between the two alignment philosophies. As F. Scott Fitzgerald wrote: "The test of first rate intelligence is the ability to hold two opposed ideas in the mind at the same time, and still retain the ability to function." Those that blend the techniques experience frustration that compromises the

patient's result. It's best to follow all the principles and use the specific looking-glass for calipered KA and MA to set and assess component positions.

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