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Kinematically Aligned Oxford Unicompartmental Knee Arthroplasty Using the Microplasty Instrumentation System

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This technical note demonstrates kinematically aligned Oxford unicompartmental knee arthroplasty using the Microplasty instrumentation system with custom-made devices. The medial joint line is evaluated preoperatively; if it is aligned and parallel with the lateral joint line, they are considered to comprise the coronal knee joint line (CJL). In this case, the coronal inclination of a spoon gauge inserted into the medial joint space indicates the CJL. Otherwise, an accessory spoon is inserted and connected to the medial spoon to refer to the posterior condylar line, which is considered the CJL. The tibial cutting block is then connected without changing the inclination of the spoon and the coronal tilt of the tibial extramedullary rod is adjusted, which is implemented with a custom-made ankle yoke. The remainder of the steps is then identical to the conventional Microplasty procedure. This technique can imitate the cutting line to the CJL, which might be considered ideal from mechanical and kinematic perspectives.

Keywords: *Knee, Arthroplasty, Oxford, Kinematic, Alignment, Joint line*

Oxford unicompartmental knee arthroplasty (OUKA; Zimmer Biomet, Warsaw, IN, USA) is characterized by its mobile bearing with low polyethylene wear and excellent long-term results.[1,2] It aims to restore pre-arthritic conditions, so the postoperative leg alignment resembles the patient's constitutional alignment.[3] Although OUKA is technically demanding, the recent sophisticated Microplasty instrumentation system (MP) enables accurate bone cutting and has reduced the rate of complications.[4] In terms of the component alignment, however, only mechanical implantation of the tibial component (wherein a tibial component is placed perpendicular to the mechanical axis) has been facilitated using the conventional tibial cutting instrument including the MP. Meanwhile, kinematically aligned OUKA (KA-OUKA) is a notable approach because it may restore the patient's joint line to be as close as possible to the native joint line. The OUKA is actually a KA-friendly component because the femoral components are partly spherical; a cylindrical axis can therefore be perfectly constructed. The KA-OUKA technique has been previously described,[5] but the reported procedure did not use the MP and there was arguably an overreliance upon the surgeon's perspectives and skills. We have therefore developed a novel KA-OUKA technique using the MP and custom-made devices.

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TECHNIQUES

This report has no patient data, and as a result, it does not require IRB approval and is not applicable for informed consent.

Preoperative Planning

A well-aligned preoperative anteroposterior radiography is necessary for preoperative planning. The patella must be located at the center of the distal femur and both tibial plateaus must have linear projection. The medial joint line (MJL) and the lateral joint line (LJL) are identified by ra-

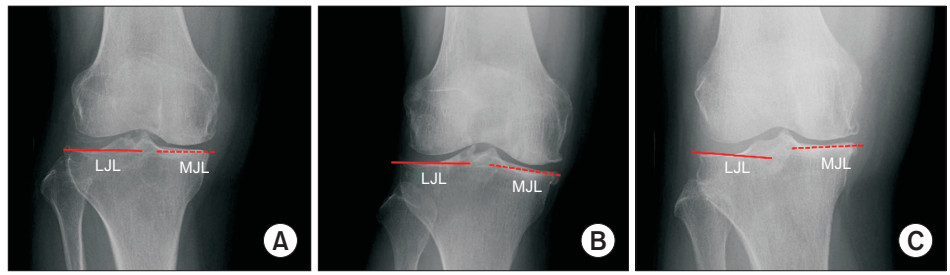

Fig. 1. Preoperative planning. (A) Leveled type: the lateral joint line (LJL) coincides with the medial joint line (MJL), where the MJL and LJL are considered the coronal joint line. The medial spoon technique is used for this type. (B) Convex type: the MJL does not coincide with the LJL, and they form an inverse "V" shape. (C) Concave type: the LJL inclines in varus and does not coincide with the MJL. The convex and concave types are classified as the uneven type. The double spoon technique referring to the posterior condylar axis is applied for this type.

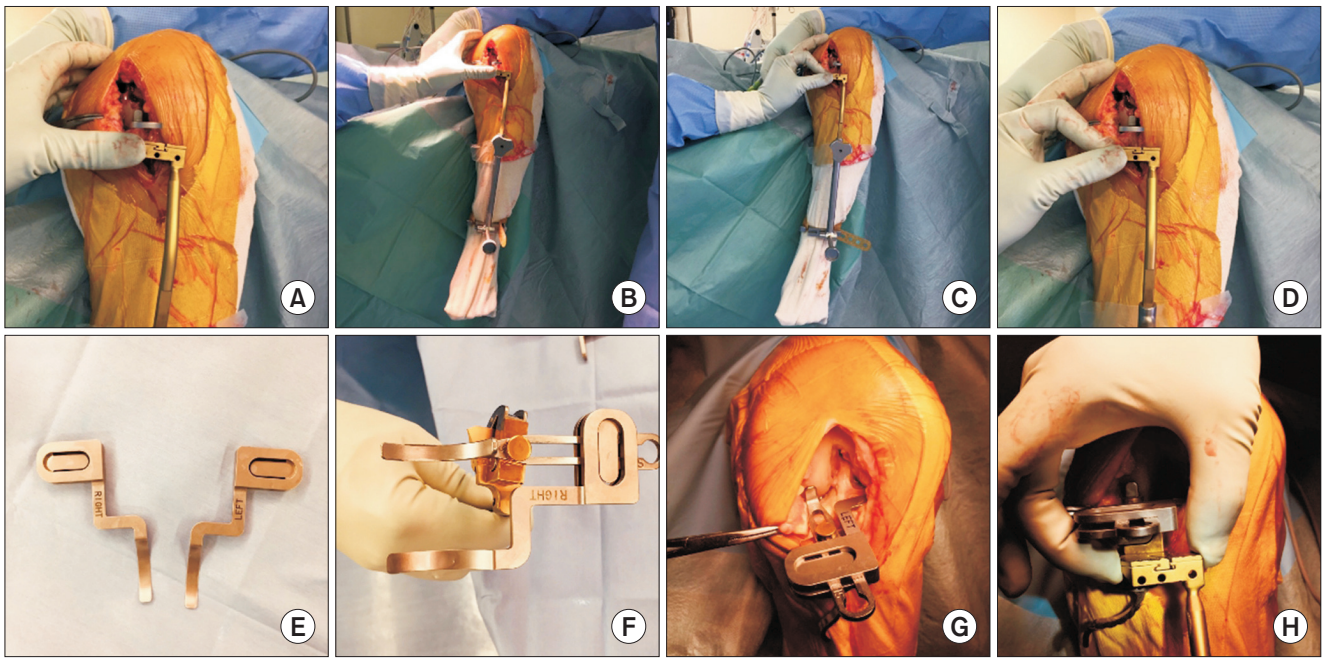

Fig. 2. Operation technique. Single spoon technique. Side-slidable ankle yoke. (A) The spoon is inserted into the medial joint space and represents the inclination of the joint line. (B) In most cases, the cutting block is not parallel to the spoon when the ankle yoke is placed at the center (mechanical alignment). (C) It is connected to the extramurally tibial rod instead of the original yoke and can slide medially/laterally to incline the tibial cutting block varus/valgus.[6] (D) Inclination of the tibial cutting block is adjusted to be parallel with the spoon, shifting the ankle yoke laterally. Double spoon technique. (E) The accessory spoons. (F) The accessory spoon is connected with the original spoon and then both spoons are set in the same level. (G) The accessory spoon is inserted under the lowest point of the opposite condyle and connects to the original spoon. (H) Similar to the single spoon technique, the inclination of the tibial cutting block is adjusted to be parallel with the spoon and clamped with the cutting block.

diography. In cases with both tibial plateaus on the same line (the leveled plateau type) (Fig. 1A), the MJL is considered to be the coronal knee joint line (CJL) and the medial spoon technique may be used. If the MJL and LJL are not on the same line (uneven plateau type) (Fig. 1B and C), the double spoon technique must be used.

Devices

The operation was performed following the original OUKA technique using the MP,[7] but making use of two custom-made devices (Zimmer Biomet). The first device is a side-slidable ankle yoke that is connected to the extramedullary tibial guide instead of the original yoke (Fig. 2C). It can slide laterally or medially for varus or valgus inclination of the tibial cutting block. The second device is an accessory spoon that is inserted into the lateral joint space and connects with the medial spoon (Fig. 2E and F). The bottoms of the spoons are at the same level, so their

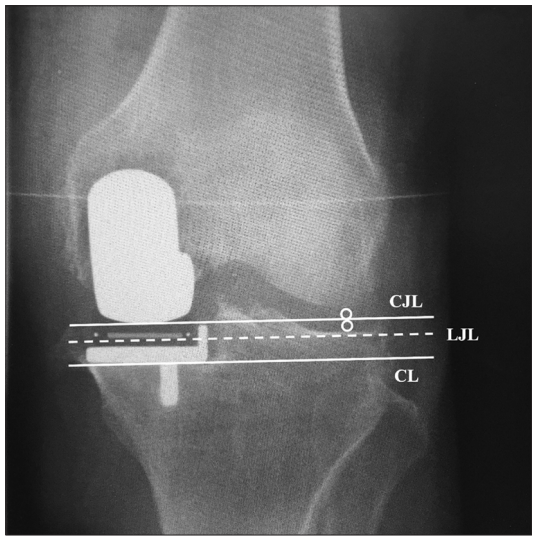

Fig. 3. Postoperative radiographic evaluation. The bone-cutting line (CL) is virtually parallel with the coronal knee joint line (CJL). Note that the lateral joint line (LJL) is also parallel with the CL and CJL.

inclination indicates the posterior condylar axis.

Setting and Joint Exposure

The leg hanging position using the manufacturer-provided leg holder (Zimmer Biomet) is set for surgery. Medial parapatellar incision is used for exposure. Although the mini-medial parapatellar or mid-vastus approach can be used, we prefer to use the modified under vastus approach to minimize operative invasiveness.[8] Osteophyte removal is facilitated after confirmation of functioning anterior cruciate ligament and intact lateral compartment cartilage. The next step (tibial horizontal cut) differs from the original Microplasty procedure, as described in the following "Single spoon technique" and "Double Spoon Technique" sections.

Single Spoon Technique

A sizing spoon is inserted beneath the lowest point of the medial femoral condyle. It is placed parallel to the MJL, so it represents the CJL because the MJL and CJL are parallel in the leveled plateau knee (Fig. 2A). The extramedullary rod is set and adjusted parallel with the anterior surface of the tibia. The ankle yoke slides laterally so that the cutting block and the spoons are parallel (Fig. 2B-D). The spoon and cutting block are then clamped with G-clamp and then horizontal followed by sagittal cuts are made. The remainder of the procedures are identical to those in the standard MP procedure.

Double Spoon Technique

An accessory spoon is inserted beneath the lowest point of the lateral condyle and captures the medial spoon (Fig. 2G). Both spoons are set at the same level, so their inclination indicates the posterior condylar axis. Similar to the medial spoon technique, the inclination of the cutting block is adjusted to be parallel with the spoon and then they are clamped with G-clamp (Fig. 2H). The subsequent steps are the same as the standard MP procedure.

Postoperative Evaluation

The postoperative joint line is between the lowest point of the femoral component and the midpoint of the lateral joint space. Ideally, the tibial cutting line is parallel with the joint line. In leveled plateau knees, it is also parallel with the LJL (Fig. 3).

DISCUSSION

Most importantly, the tibial cut is made in varus referring to the joint line. Although varus tibial cuts are a standard procedure in fixed-bearing unicompartmental knee arthroplasty, there are only two reports in which the tibia was cut in varus.[5,6] A similar cutting guide was reported by Hiranaka et al.,[6] but the varus angles were fixed at 3°. This should be labelled as an intentional varus cut rather than KA approach because the joint line inclination is not always 3° and it varies among patients. Riviere et al.[5] first reported the KA Oxford approach, but the bone cuts and component alignments were decided without using MP. In their procedure, the tibia is manually cut perpendicular to the flexion facet of the medial femoral condyle. The flexion facet is not always apparent, however, especially in cases of early osteoarthritis or osteonecrosis. Moreover, the tibia is cut manually without a saw cutting guide. Although the procedure is reasonable, the manual bone cut is not always easy, especially for inexperienced surgeons, because it relies upon their judgement and the need for delicate manipulation. Conversely, when the MP device is used for this procedure, the cutting level is decided by the tibial bone cut being made with the cutting block, so there is a reduction in errors. Moreover, a sophisticated and reproducible decision of the cutting level and femoral component alignment is possible.[4] Although custom-made devices are required, our procedure might be considered straightforward and surgeon-friendly.

There are some limitations of this technique. Firstly, the native articular surface cannot be perfectly replicated by Oxford components, especially in cases with uneven type tibia or in cases with significant bone loss because

the morphology is so simple that it is not identical to the original articular surface. However, this situation is similar to that in kinematic alignment TKA; the TKA component can also never perfectly replicate the original condylar shape.[9,10] Nevertheless, kinematic alignment has equivalent or even better reported clinical outcomes, patient satisfaction, and component survival.[11-13] We believe kinematically aligned implantation is also beneficial in UKA. In the bone and cartilage defect or uneven tibial cases, the posterior condylar axis would indicate the original joint line. Moreover, kinematic implantation results in varus placement of tibial components. This reduces the postoperative tibial fracture,[14] implying a mechanical advantage over orthogonal implantation. Although kinematic analysis as well as investigation of mid-to-long-term clinical outcomes are required, the kinematic Oxford is suggested beneficial, and it is important to clearly show how to implement it. As a second limitation, the slidable tibial guide and lateral spoon were custom-made and not routinely available. Their mechanisms are relatively simple to manufacture, however, so we strongly recommend that the device can be used everywhere. Thirdly, the tibial varus cutting angle is limited because of the limitation of the lateral slide length. The maximum varus cutting angle has been reported as approximately 4.5° against the mechanical line (a perpendicular line to the tibial axis).[6] The inclination of the tibial articular surface is sometimes very steep, however, especially in Asian patients.[15] Although a simulation study revealed that the mechanical property is superior up to 6°, avoiding an extreme varus angulation and restriction due to the distal sliding limit is likely safe.[16] A fourth limitation is that the posterior slope is fixed to 7° in all cases. This posterior slope has been recommended for use since the early days of OUKA and has acquired good long-term results. Although the tibial cutting plane in flexion can change due to the changed posterior slope, the impact is expected to be minimum. Lastly, clinical advantages of kinematic alignment have not been proven, although the KA approach is theoretically advantageous at least in the prevention of tibial fractures.

Despite the limitations, KA-OUKA using MP is a rational operation that can replicate the joint line. It is expected to achieve results close to native kinematics and mechanical stress on the bone. Greater availability of the slidable tibial rod and the lateral spoon devices is needed to facilitate this procedure. Further studies will investigate the accuracy of the technique with postoperative radiographs.

KA-OUKA can be facilitated using MP with some custom-made devices. The spoon inserted into the medial joint space indicates the CJL in leveled plateau knees, otherwise the double spoon technique is used to represent the CJL. The cutting block is set parallel with the spoon and the tibial cut and subsequent steps can then be performed.

CONFLICT OF INTEREST

The corresponding author (TH) is a paid presenter and instructor of Zimmer Biomet. No other potential conflicts of interest relevant to this article were reported.

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