Technical Note

Kirschner Wire Reference Technique in Open-Wedge High Tibial Osteotomy

Atichart Kwanyuang, Ph.D., Tanarat Boonriong, M.D., Wachiraphan Parinyakhup, M.D., and Chaiwat Chuaychoosakoon, M.D.

Abstract: Open-wedge high tibial osteotomy is a common procedure to treat young adult and adult patients with symptomatic varus malalignment. The purpose of the high tibial osteotomy is to shift the mechanical load from the medial compartment to the lateral compartment. There are several methods to determine the correct alignment, such as the cable method, the gap measurement method, the navigator system, or the patient-specific cutting guide method. The cable and gap measurement techniques are easy to use, but the results of these techniques are unpredictable. The navigator and patient-specific cutting guide methods have high accuracy in attaining the desired correction alignment, but they are quite costly. We propose a technique we call the Kirschner wire reference method, which is easy to use to achieve the desired alignment correction, without requiring specialized or expensive equipment.

The open-wedge high tibial osteotomy (HTO) is a common procedure to treat young adult and adult patients with symptomatic varus malalignment. The HTO is performed to shift the mechanical load of the knee joint from the medial compartment to the lateral compartment.[1] However, the operation requires precise alignment of correction, which can be difficult to attain. There are several methods to determine the correction alignment, such as the cable method, the gap-measurement method,[2,3] the navigator system,[4] and the patient-specific cutting guide method.[5] The cable and gap measurement methods are easy to use but the results are somewhat unpredictable due to the indirect measurements. The navigator and patient-specific cutting guide methods have high accuracy but they are also very costly and thus not practical in many institutions. Herein, we purpose the Kirschner wire (K-wire) reference technique for the HTO procedure, which is easy to perform, highly accurate, and does not require specialized equipment, so it can be performed in most hospitals.[6]

With this technique, the surgeon can determine the desired alignment of correction by measuring the degrees of 2 coronal K-wires before and after creating the gap opening with a modified goniometer. The difference between the 2 measurements in degrees of the 2 coronal K-wires in the coronal plane is the correct degree of alignment correction. The posterior tibial slope is determined by 2 parallel K-wires in the sagittal plane. To maintain the posterior tibial slope, the surgeon must keep these 2 sagittal K-wires parallel after creating the gap opening.[6,7] If the K-wires are not kept parallel, the posterior tibial slope will change and the angle of correction will also change.

Surgical Technique (With Video Illustration)

The patient is set and sterilely draped in the supine position. A tourniquet is applied at the right thigh and inflated to 250 mm Hg. A longitudinal incision is created along the anteromedial aspect of the proximal tibia between the tibial tubercle and the superficial medial collateral ligament, passing through the subcutaneous tissue. The sartorius fascia is incised in an oblique line above the gracilis tendon and then detached from the proximal tibia. The superficial medial collateral ligament is released and detached from the proximal tibia. Two 2.4-mm K-wires are inserted 3.5 cm below the medial joint line and

From the Institute of Biomedical Engineering (A.K.), and Department of Orthopedics (T.B., W.P., C.C.), Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand.

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Address correspondence to Chaiwat Chuaychoosakoon, M.D., Department of Orthopedics, Faculty of Medicine, Prince of Songkla University, 15 Karnjanavanich Road, Hat Yai, Songkhla 90110, Thailand. E-mail: psu.chaiwat@gmail.com or chaiwat.c@psu.ac.th

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Fig 1. Right knee in a supine position. Two parallel reference K-wires are inserted in the sagittal plane at the proximal fragment and the distal fragment.

extended to the tibiofibular joint. Then a biplanar osteotomy is done with an oscillating saw. The 2 K-wires are removed from the proximal tibia.

After the osteotomy, 2 other reference K-wires are inserted parallel to the sagittal plane, the first at the proximal fragment and the second at distal fragment (Fig 1). A TomoFix plate (Synthes, Zuchwil, Switzerland) is applied and temporarily held in place with another K-wire. Then, the 2 coronal K-wires are inserted through a modified goniometer. The first coronal K-wire is inserted parallel to the joint line from the medial side to the lateral side, beginning 1 cm below the

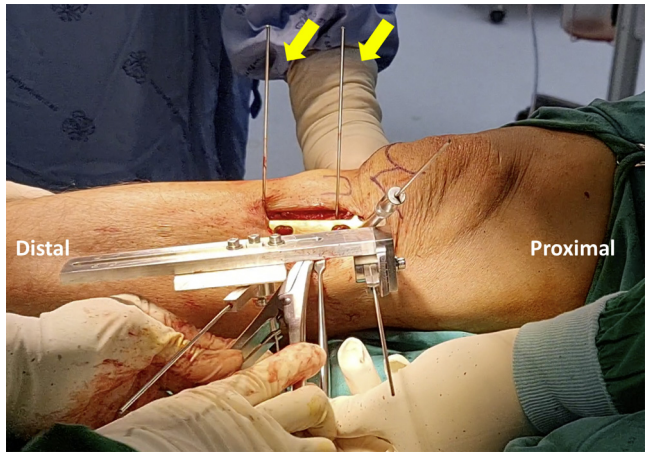

Fig 3. Right knee in a supine position. A lamina spreader is inserted at the posteromedial aspect of the osteotomy site to widen the gap until the desired alignment correction is achieved. To maintain the posterior tibial slope, these 2 sagittal K-wires (yellow arrows) must be parallel before and after the gap opening.

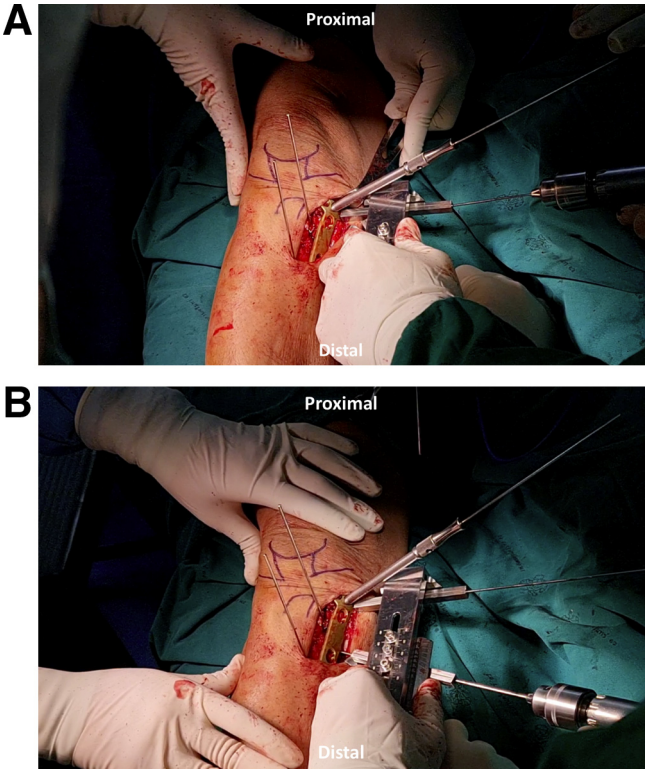

Fig 2. Right knee in a supine position. The steps of inserting the 2 coronal K-wires. (A) The first coronal K-wire is inserted parallel to the joint line from the medial side to the lateral side, starting 1 cm below the medial joint line. (B) The second coronal K-wire is inserted 1 cm below the osteotomy site to the tibiofibular joint.

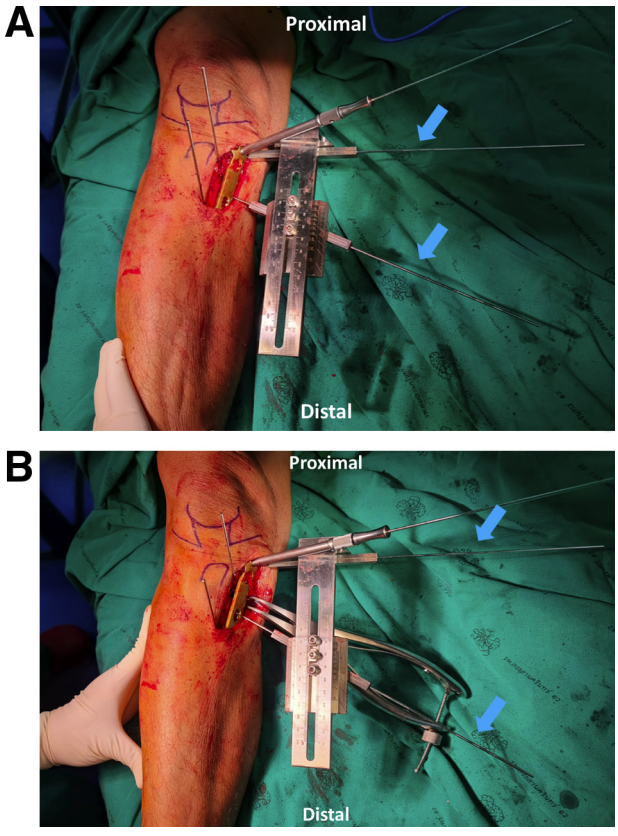

Fig 4. Right knee in a supine position. The angle of the 2 coronal K-wires (light blue arrows) is measured before (A) and after (B) the gap is created with a modified goniometer.

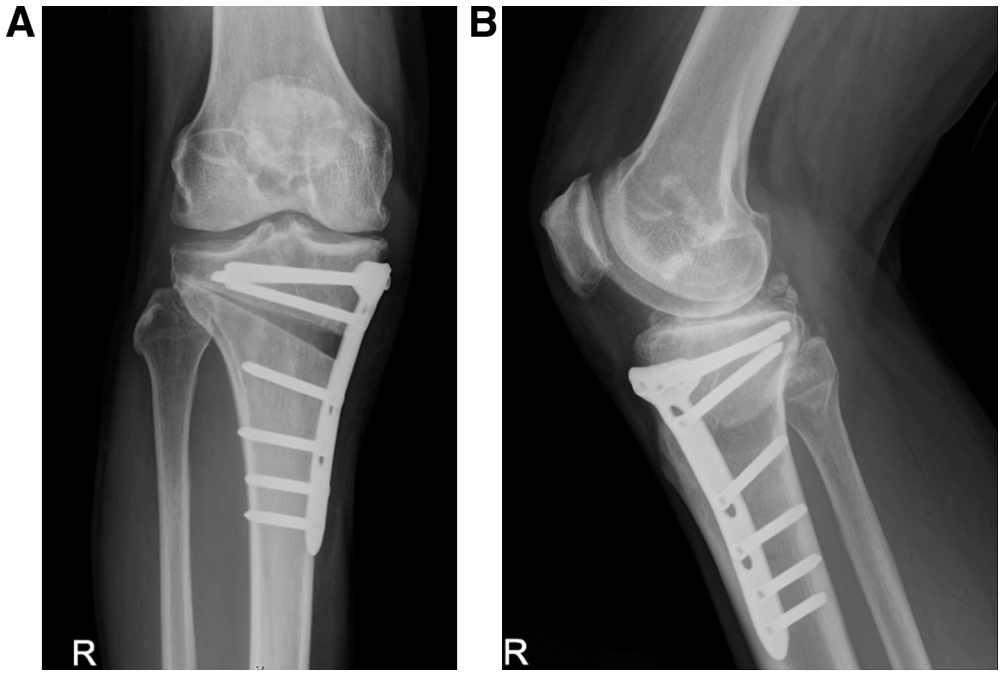

Fig 5. The postoperative radiographs in (A) the anteroposterior view and (B) the lateral view of right knee.

medial joint line (Fig 2A). The second coronal K-wire is inserted 1 cm below the osteotomy site and extending to the tibiofibular joint (Fig 2B). The angle of these 2 coronal K-wires is measured with the modified goniometer with a degree scale. Then, a lamina spreader is inserted at the posteromedial part of the osteotomy site and the bony gap increased until the desired alignment is achieved (Fig 3). To maintain the posterior tibial slope, these 2 sagittal K-wires (yellow arrows) must be parallel before and after the gap opening (Fig 3).

The difference in angles between the 2 coronal K-wires before (Fig 4A) and after (Fig 4B) the gap opening is the degree of correction. When the angle is correct, the TomoFix plate is fixed with locking screws. After the fixation, all K-wires are removed.

To finish the surgery, the superficial medial collateral ligament is repaired with VICRYL No. 1 suture and the satorius fascia is reapproximated to cover the implant. Finally, the subcutaneous tissue is closed by a VICRYL 3-0 suture and the skin is sutured with nylon 3-0 using simple sutures.

Postoperative anteroposterior and lateral view radiographs from K-wire reference technique are shown in Figure 5 A and B, respectively. A video of an entire procedure is provided in Video 1, with audio narration. Tables 1 and 2 present pearls, pitfalls, advantages, and disadvantages of using this technique.

Table 1. Pearls and Pitfalls

Pearls
A laminar spreader should be inserted at the posteromedial aspect of the osteotomy site and opened slowly and carefully to decrease the risk of iatrogenic fracture.
All reference K-wires must be inserted after the osteotomy.
The 2 coronal K-wires must be inserted parallel to the operative table.
The difference in the degree between the 2 coronal K-wires before and after the gap opening is the degree of correction.
After opening the gap, the 2 sagittal K-wires must be kept parallel to ensure the same tibial slope is retained after the procedure.
Pitfalls
There is a chance of measurement error if the surgeon uses too-small K-wires.

Discussion

The open-wedge HTO is the treatment of choice in young adults and adults with symptomatic varus malalignment. This procedure transmits the load of the knee joint from the medial compartment to the lateral compartment. Many studies have reported high success rates for the HTO. The most important factor in achieving a good outcome is correct alignment of HTO. There are various methods currently used for the HTO, and some have problems in attaining the correct alignment, and those that have better accuracy are not available in many institutions.

There are many methods available for determining the alignment correction. First is the cable method, in

Table 2. Advantages and Disadvantages

Advantages
This technique is simple and easy to use.
K-wires are available in all hospitals.
The 2 coronal K-wires can show small changes in the degrees in the alignment correction.
Disadvantages
The operative field may be disturbed by the K-wires.

which an alignment rod or a cautery cord is applied, extending from the center of the femoral head to the mid-talar dome. The mechanical axis is the location of the alignment rod or the cautery cord at the knee joint using fluoroscopic visualization. Second is the gap measurement method, in which the corrected gap is measured and calculated preoperatively. There are many factors that can interfere with the accuracy of a gap measurement, including the particular device used and the location of the measurement bases. Third is the navigator system, which is a real-time measurement during the procedure and allows the surgeon to evaluate the alignment in all planes. There are several disadvantages to the navigator system, however, notably the longer operation time and the high cost of the required materials. Fourth is the patient-specific cutting guide, which is a specific patient instrumentation based on a preoperative computed tomography scan. This is available only in large hospitals.

For the K-wire reference technique herein proposed, all of these disadvantages in the traditional methods are overcome. K-wires are available in all hospitals. The surgeon can modify a standard goniometer to accurately measure the angle of the 2 coronal K-wires before and after the gap opening to ensure the desired alignment correction is achieved and maintained throughout the procedure. This method is easy to apply and can achieve the desired alignment correction with a high degree of accuracy, at essentially no additional cost.

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