

## Case Report

# Uni-Condyle High Tibial Osteotomy for Malunion of Medial Plateau Fracture: Surgical Technique and Case Report

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High tibial osteotomy (HTO) is a surgical procedure to re-align varus or valgus mal-alignment of the knee. Medial opening wedge HTO is a surgical treatment of choice for knee varus mal-alignment with many advantages over lateral closing wedge HTO. However, the opening of the medial wedge alters the plane of the lateral tibial plateau, especially when the correction angle is large, which may be the cause of early arthritic changes of the lateral compartment. Many recent studies reported the changes in medial posterior slope after medial opening wedge HTO, which affected the biomechanics of the knee. This report presents uni-condyle HTO, a new surgical technique that corrects alignment of medial tibial plateau in both coronal and sagittal plane without affecting the plane of lateral tibial plateau.

**Keywords:** high tibial osteotomy, unicondyle, varus knee

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High tibial osteotomy (HTO) is known to orthopedic surgeons as an operative treatment of choice for varus or valgus mal-alignment of the knee<sup>(1-3)</sup>. The re-alignment helps to re-distribute the weight and prevents early uni-compartment osteoarthritis, and for early uni-compartment osteoarthritis, the osteotomy shifts compressive force from the arthritic part to a more normal compartment<sup>(4-6)</sup>.

High tibial osteotomy can be performed for patients with either valgus or varus knees. For varus knees, the osteotomy can be performed by closing the lateral wedge or opening the medial wedge. Lateral closing wedge HTO can be done at three different levels, above, behind, or below the tibial tuberosity. The above the tubercle technique is more popular and has many advantages<sup>(7,8)</sup> such as the allowance of larger correction, the high rate of healing due to large area of cancellous bone contact, and various cutting jigs<sup>(9,10)</sup> are available to guide the degree of correction. However, this above the tubercle lateral closing wedge technique can also cause some difficulties to surgeons<sup>(11)</sup>. For example, the thin proximal bone fragment usually limits the fixation options. Furthermore, an intra-articular fracture is possible. Avascular necrosis of the

tibial condyle is also of concern by some surgeons. The closing wedge results in lateral cortex step-off, create less stable osteotomy and might compromise future total knee arthroplasty. The Q-angle is increased and the lateral collateral ligament laxity can occur.

Following the development of many stable fixation devices for medial high tibia, the medial opening wedge HTO has been becoming more and more popular with many advantages<sup>(12)</sup>. The medial approach is easier, no fibular osteotomy is required, and the surgeon can correct deformities in multiple planes. This technique preserves bone stock and limb length, the deformity correction is more precise, and the opening of the wedge may increase the medial collateral ligament tension. The disadvantages of medial opening wedge osteotomy<sup>(11)</sup> are the need to fill the opening gap and fix with a stable fixation device, otherwise nonunion can occur. The posterior tibial slope can be changed after the osteotomy and the opening wedge moves the patella distally giving effects to the patello-femoral joint.

Either lateral closing wedge or medial opening wedge HTO alters the plane of both medial and lateral tibial plateau simultaneously, which is not desirable in some particular cases. This report presents an example case of knee mal-alignment, for which the classical lateral opening wedge or medial opening wedge HTO may not be the best surgical treatment. The uni-condyle HTO, a new surgical technique that enables correction

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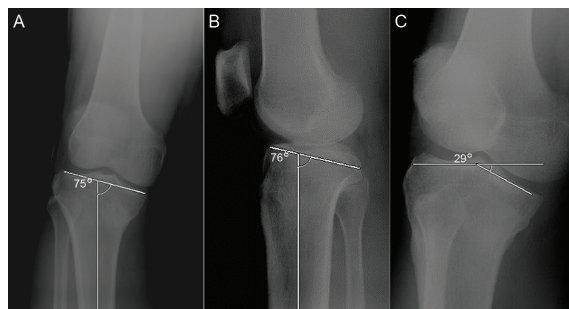
of medial tibial plateau plane or medial femoro-tibial alignment in both coronal and sagittal planes without affecting the plane of lateral tibial plateau is described, and a 2-year follow-up result is reported.

### Case Report

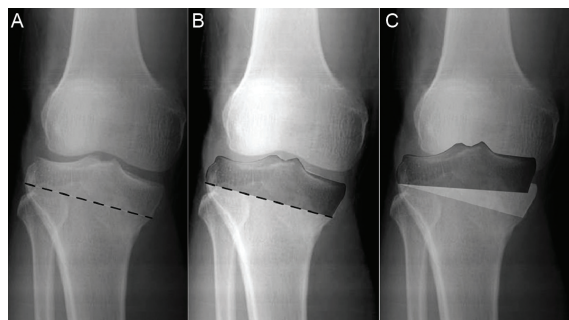
A 49-year male patient presented with right knee pain for six months. The knee had varus deformity. The varus stress test was positive. The knee had full range of motion. The radiographic measurement (Fig. 1) demonstrated that the varus was 15 degrees, the posterior slope of medial condyle was 14 degrees, and the oblique view showed 29 degrees of postero-medial inclination. With this radiograph, the varus was an extra-articular varus suspected to be a malunion of medial plateau fracture. Further history taking supported this suspicion since the patient could recall a motorcycle accident many months before the knee pain. If lateral closing wedge HTO were performed, it would have been difficult to correct the postero-medial slope. Medial opening wedge osteotomy would be a better choice. However, because the correction angle is about 15 degrees, which is a large-angle correction, it can affect the plane or alignment of the lateral tibio-femoral articulation. Most importantly, it is difficult to correct the medial posterior tibial slope independently. Simulation of the osteotomy line of conventional medial opening wedge is shown in Fig. 2. The illustration demonstrates how the lateral tibio-femoral articulation would be affected when the wedge is open. The author proposes uni-condyle high tibial osteotomy (Fig. 3) as a new alternative with features that should better solve this extra-articular varus. The uni-condyle osteotomy line is at only one condyle and the correction restores only medial tibio-femoral compartment without affecting the plane of the lateral tibial condyle. Moreover, with this technique, the medial tibial antero-posterior slope can also be adjusted independently.

### Surgical technique

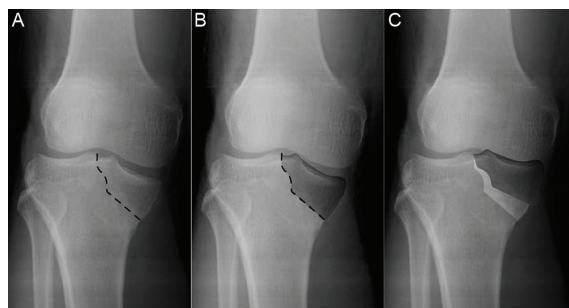
The incision is medial para-patellar and curves proximally toward medial epicondyle of femur and extends for 5 to 7 centimeters distally. The superficial medial collateral ligament is identified and subperiosteal dissection is carried around the back of tibia and a blunt retractor is placed to protect the neurovascular bundle. Patellar tendon is identified and retracted laterally to expose the bone above the tibial tuberosity. Mini-arthrotomy at anterior aspect of the joint is made to enable palpation and visualization of the tibial spine during the procedures.



**Fig. 1** The pre-operative radiographic measurement demonstrates (A) 15 degrees varus in AP view, (B) 14 degrees posterior slope of medial condyle in lateral view, and (C) 29 degrees postero-medial inclination in oblique view



**Fig. 2** (A, B) The simulation of the osteotomy line of conventional medial opening wedge, and (C) demonstrates how the lateral tibio-femoral articulation would be affected when the wedge is open



**Fig. 3** The uni-condyle high tibial osteotomy. (A, B) the osteotomy line is at only one condyle, and (C) the correction restore only medial tibio-femoral compartment without affecting the plane of the lateral tibial plateau

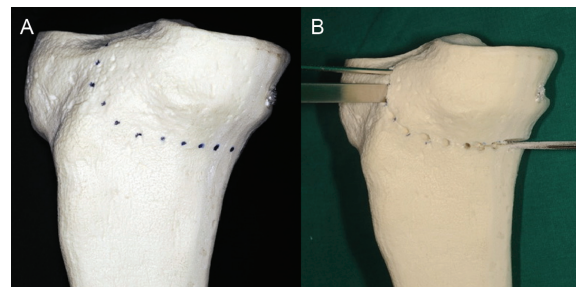
The osteotomy level is about three centimeters below the medial tibial condyle (Fig. 4A), so that the osteotomized part can be covered and fixed with the

proximal four holes of the locking compression plate (LCP) for medial proximal tibia. The osteotomy line is slightly oblique toward and curve along medial border of tibial tuberosity and end at the apex of the tuberosity. Pre-drilling with 2.7 mm drill bit along the planned osteotomy line, especially from anterior to posterior cortex of tibia, helps to prevent the fracture of posterior tibial cortex when chisel is used in the next step. One guide pin is drilled, under fluoroscopic guidance, from above the tibial tuberosity, at the level of 5 mm below the joint line, mid-line direction, to the posterior cortex. This AP pin is to guide the antero-posterior osteotomy. Another two guide pins are drilled at the osteotomy level of the medial tibial cortex, under fluoroscopic guidance, to the optimal depth and direction. These two pins will guide the osteotomy of the medial, anterior, and posterior cortex of the medial tibial condyle. Straight 1/4 inch chisel is used to cut the bone under the tibial spine in antero-posterior direction, guided by the AP pin (Fig. 4B). Care should be taken not to fracture the tibial spine. Appropriate depth of the cut is confirmed by fluoroscopy. This chisel is also used to complete the curve osteotomy line at the medial border of the tibial tuberosity. The medial, anterior and posterior cortexes are then cut with the oscillating saw and chisel.

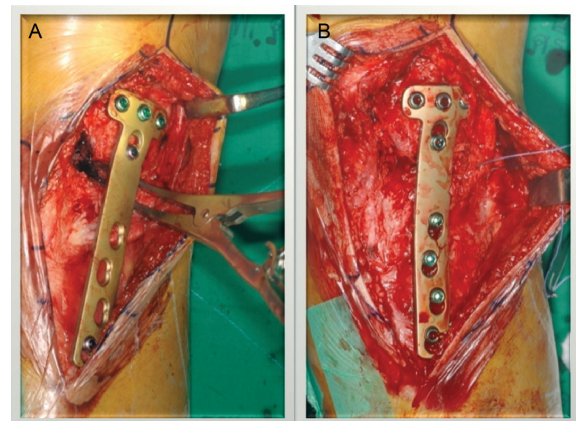
After performing the osteotomy completely, the osteotomy is gradually opened by using two osteotomes. Slowly opening of the medial tibial condyle minimizes the chance of fracture through the tibial spine. The desired correction angle is checked under fluoroscopic control. The correction is maintained and finely adjusted by using the bone spreader. Locking Compression Plate (LCP) for medial high tibia is selected for stable fixation of the medial tibial condyle (Fig. 5A). After having achieved a stable fixation, the osteotomy gap can be filled with autogenous iliac bone graft. If the donor site morbidity and the increasing of blood loss are to be avoided, bone substitutes such as the  $\beta$ -tricalcium phosphate ( $\beta$ -TCP) wedge can be an alternative. In this case, the semi-circular TCP wedge was used. The TCP wedge was adapted to the diameter of the gap, then wedged into the osteotomy gap, seating it firmly in the cortical bone of the gap. TCP granules were also used to fill small remaining space, especially at the antero-medial aspect of tibia (Fig. 5B).

The patient started active knee range of motion exercise post-operatively with a six-week

period of non-weight bearing ambulation and then full weight bearing was allowed. Post-operative weight-bearing radiograph at 2-years comparing with the left knee (Fig. 6) demonstrates the well-restored medial tibial plateau as well as the medial posterior slope. The plane of the lateral tibial plateau is unchanged. The locking compression plate and screws are all removed. The radiographic measurement after implant removal

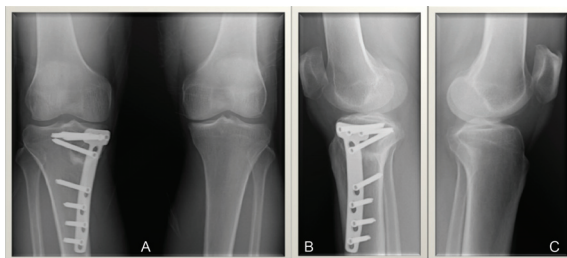


**Fig. 4** (A) The osteotomy level is about 3 centimeters below the medial tibial condyle and slightly oblique toward and curve along medial border of tibial tuberosity and end at the apex of the tuberosity. (B) One guide pin is below the joint line, another two guide pins are drilled at the osteotomy level of the medial tibial cortex, straight chisel 1/4 inch is used to cut the bone under the tibial spine in antero-posterior direction, guided by the AP pin

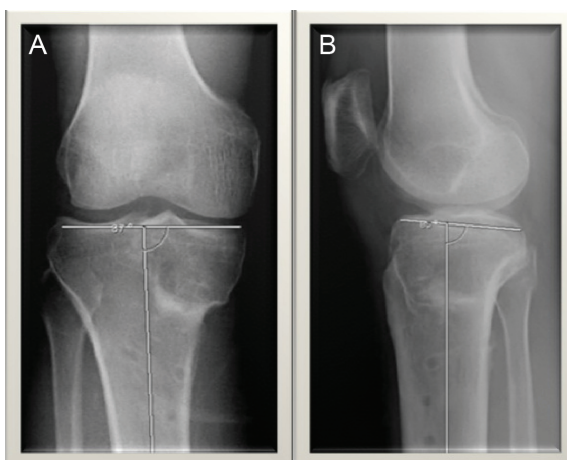


**Fig. 5** (A) The desired correction angle is maintained and finely adjusted by using the bone spreader. Locking Compression Plate (LCP) is selected for stable fixation of the medial tibial condyle. (B) The TCP wedge was wedged into the osteotomy gap seating it firmly in the cortical bone of the gap. TCP granules were also used to fill small remaining space, especially at the antero-medial aspect of tibia





**Fig. 6** Post-operative weight-bearing radiographs at 2-year follow-up (A) antero-posterior view, (B, C) lateral view



**Fig. 7** Radiographic measurement after implant removal. (A) medial proximal tibial angle (MPTA) is 87 degrees (B) the slope of the medial tibial condyle is 5 degrees

(Fig. 7) shows 87 degrees of medial proximal tibial angle (MPTA) and the slope of the medial tibial condyle is 5 degrees.

### Discussion

Medial opening wedge HTO is considered a treatment option for varus knee in young, active patients to correct the mal-alignment and prevent early degenerative changes. However, most concerns are usually directed to the correction of tibio-femoral alignment in coronal plane, despite the fact that opening the medial wedge may also affect the tibio-femoral alignment in the sagittal plane due to change in posterior slope of tibia. Interest in this aspect is reflected in many reports in the recent years<sup>(13-17)</sup>. According to the reports of Marti et al<sup>(13)</sup> and Jung et al<sup>(14)</sup>, opening wedge HTO increases the posterior slope ranging from 2.7 to 3.3 degrees. The consequence of this sagittal plane change on the biomechanics of

the knee in a cadaveric study reported by Giffin et al<sup>(18)</sup> is the antero-posterior translation of tibia on femur, a mean increase of 4.4 degrees resulted in an anterior shift of the resting position of the tibia relative to the femur. More significant changes of posterior slope may affect knee biomechanics. It is estimated that a 10 degree increase in posterior tibial slope can result in a 6 mm increase in anterior tibial translation, which in turn can lead to a 3-fold increase in the anterior cruciate ligament load<sup>(13)</sup>. Furthermore, posterior tibial slope alteration induced by medial opening HTO can generate more technical problems and complications in cases of up-coming total knee arthroplasty<sup>(19)</sup>. Sterett et al<sup>(20)</sup> suggested that several factors likely influence the change in sagittal plane during the medial opening HTO, placement of the cutting jig or K-wire guide parallel to the joint line in sagittal plane and positioning of the plate as far posteriorly as possible could minimize inadvertent alignment changes of posterior slope. Sariali and Catonne<sup>(21)</sup> advised that performing a medial opening using rigid wedges inserted as far as possible along the posterior tibial cortex could avoid tibial-slope modification.

The main advantage of uni-condyle HTO is the ability to correct the plane of the medial tibial plateau in coronal plane independently, without affecting the plane of the lateral tibial plateau, thus arthritic change of the lateral compartment in long term can be avoided. This technique is suitable for extra-articular varus knee with large angle of correction at the medial tibial condyle. With the meticulous opening of the postero-medial osteotomized part, under fluoroscopic control, the posterior slope of the medial plateau can be adjusted to the optimal angle, as compared with that of the contralateral knee, thus avoiding the possible effects of increasing or decreasing posterior slope caused by other techniques of medial opening wedge HTO. Locking compression plate provides rigid fixation of the osteotomized medial condyle and postoperative range of motion exercise of the knee can be started very early.

### Potential conflicts of interest

None.

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## การตัดกระดูกทibiaส่วนบนคอนดัยล์เดียวสำหรับการติดฝักรูปของทibiaพลาโตด้านใน: รายงานเทคนิคการผ่าตัดและผู้ป่วย

สุกิจ แสงนิพันธ์กุล

การตัดกระดูกทibiaส่วนบนเป็นวิธีการผ่าตัดเพื่อจัดแนวของข้อเข่าที่มีแนวโก่งออกหรือโก่งเข้าผิดปกติ การตัดกระดูกทibiaส่วนบนโดยเปิดลิ้นด้านในเป็นการผ่าตัดที่เลือกทำให้สำหรับข้อเข่าที่มีการโก่งออก โดยมีข้อได้เปรียบเมื่อเทียบกับการเปิดลิ้นด้านนอก อย่างไรก็ตามการเปิดลิ้นด้านในทำให้ระนาบของพื้นผิวทibiaด้านนอกมีการเปลี่ยนแปลงด้วย โดยเฉพาะอย่างยิ่งหากมุมที่แก้ไขมีความกว้างมาก ซึ่งอาจเป็นสาเหตุให้เกิดการเปลี่ยนแปลงของช่องข้อด้านนอกเร็วขึ้น มีหลายการศึกษาที่รายงานการเปลี่ยนแปลงของความลาดด้านหลังของทibiaส่วนบนด้านใน หลังการผ่าตัดเปิดลิ้นด้านใน ซึ่งกระทบต่อชีวกลศาสตร์ของข้อเข่า รายงานนี้แนะนำเสนอการตัดกระดูกทibiaส่วนบนคอนดัยล์เดียว ซึ่งเป็นเทคนิคการผ่าตัดใหม่ที่สามารถแก้ไขแนวของพื้นผิวทibiaด้านในได้ทั้งในระนาบหน้า-หลัง และระนาบซ้าย-ขวา โดยไม่กระทบต่อระนาบของพื้นผิวทibiaด้านนอก

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