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Lateral Closing-Wedge High Tibial Osteotomy in Unicompartmental Medial Knee Arthritis

Nicolaas C. Budhiparama[1, 2, 3], Dwikora N. Utomo[4], Kukuh D. Hernugrahanto[4, 5]

Abstract

The high tibial osteotomy (HTO) is one attainable management of varus knee osteoarthritis. Particularly aimed at the young and active patient population. This procedure can alleviate the symptoms and restore alignment, which may significantly defer the requirement for knee arthroplasty in the future time. Close-wedge high tibial osteotomy (CW-HTO) is an effective option with minimal complication rate. Choosing between an open-wedge HTO, close-wedge HTO, or unicompartmental knee arthroplasty (UKA) for medial compartmental knee arthritis should be tailored to patients' preoperative conditions and surgeons' preferences. There is no clear evidence that one surgical method is superior to the other.

Keywords: High tibial osteotomy, Varus knee osteoarthritis, Medial compartment

Introduction and History

In the senior adult population, medial osteoarthritis of the knee is a common ailment. An additional force in the middle compartment caused by varus deformity is the most generally recognized cause of knee osteoarthritis. Furthermore, the etiology of degenerative alteration of the knee is precipitated by various conditions, one of which is deviating stress constructed by a biomechanical alteration in a weight-bearing position. Indeed, even a small valgus or varus deformity of the knee alters the load on the tibial and femoral condyles, leading to degenerative changes over time. According to research, a varus pivot of 6 degrees in each one-leg standing position causes a medial compartment strain of 95% of the total load. The medial compartment is eased by moving the mechanical axis to the lateral side [1]. Medial knee osteoarthritis arises from the excessive load on the medial side of the knee joint after varus deformation, thus giving rise to the degenerative process of the medial plateau of the ipsilateral tibia [2].

The high tibial osteotomy (HTO) is one attainable management of varus knee osteoarthritis. Particularly aimed at the young and active patient population, this procedure can alleviate the symptoms, which may significantly defer the requirement for knee arthroplasty in the future time [3]. This method was presented first by Jackson and Waugh in 1961 and afterward in 1964 with the principle idea is to postpone the joint deterioration by realignment with HTO [4]. Garie'py discovered the trans fibular lateral closing-wedge HTO proximal to the tibial tubercle from Montreal, Canada [5]. He described 22 cases in 13 patients whose favorable outcomes were achieved at 1—7 years, even though there were two cases of delayed union. HTO gained popularity around 1965 by Conventry as a preferred surgery method for medial osteoarthritis of the knee with varus deformity as he did the Garie'py's osteotomy and modified it with a couple of staples to permit an early range of motion and weight bearing [6]. His hypothesis was this correction surgery would be close to the site of pathology, consisting mainly of cancellous bone, would have the ability to unite faster and permit the contraction and relaxation of quadriceps muscles on the site of osteotomy to enhance the healing process. Preceding outcomes in one year after the procedure was sensible, with 18 of the 30 knees accomplishing relief from pain, stable range of motion, and full active knee extension. Nevertheless, Conventry reported the loosening of the staples while of internal fixation and post-surgery casting for six weeks in some cases. Over recent years, various researchers described their experiences and improvements of osteotomy around the knee surgery, e.g., preoperative alignment measurement and mechanical axis utilizing anteroposterior scanography. Yet, the adverse outcome was quite high, especially concerning individuals with rheumatoid joint arthritis [5].

Owing to the fact that the osteotomy in the metaphysis proximal tibia, this technique has the benefit of a rapid bone healing process. The location proximal to the tibial tubercle implies good osteotomy tension, which is generated by traction of the patellar ligament and quadriceps

[1]Nicolaas Institute of Constructive Orthopaedic Research and Education Foundation for Arthroplasty and Sports Medicine, Jakarta, Indonesia.
[2]Department of Orthopedic Surgery, Leiden University Medical Center, Leiden, The Netherlands.
[3]Department of Vocational Studies, University Airlangga, Surabaya, Indonesia.
[4]Department of Orthopedic & Traumatology, Faculty of Medicine, University Airlangga, Indonesia.
[5] Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.

Address of Correspondence:
Dr. Nicolaas C. Budhiparama,
Nicolaas Institute of Constructive Orthopaedic Research and Education Foundation for Arthroplasty and Sports Medicine, Jakarta, Indonesia.
E-mail: n.c.budhiparama@gmail.com


Dr. Nicolaas C. Budhiparama


Dr. Dwikora N. Utomo


Dr. Kukuh D. Hernugrahanto

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muscle [6]. The aims of HTO are (1) to minimize knee discomfort by shifting weight-bearing force to the lateral compartment that is relatively unaltered in varus knees, and (2) to postpone the need for a knee replacement by repositioning or stopping the medial joint compartment tear off. Even though the popularity of HTO has diminished due to the advancement of knee arthroplasty over the years, these unique useable procedures can provide favorable HTO treatment results in selective patients with meticulous preoperative planning [7, 8]. The choice of opening versus closing wedge HTO, grafting determination in opening wedge HTO, type of fixation, comparative benefits over unicompartmental knee arthroplasty, and the influence of HTO on knee arthroplasty are some of the additional points that still an open debate concerning HTO [8].

In recent decades, osteotomies around the knee joint for knee arthritis treatment have seen a resurgence. The bone healing issue raised in open osteotomies appeared to be resolved with the development of a rigid plate fixation [10]. As a result, medial open wedge (MOW) osteotomy has become the most widely accepted cautious joint preservation method in patients with a high tibial deformity and medial knee arthritis. The preferred approach is the medial side, which can avoid fibular nerve injury and fibula osteotomy. However, the lateral-closed technique (LCW) claims its pertinence in the treatment of medial gonarthrosis. Various research had explored the benefits and inconveniences of two strategies; patellar height and its alteration through the osteotomy [11]. Does a patella baja caused by a high tibial valgisation osteotomy, or do the alteration on patellar height (PH) and tibial slope (TS) create a postoperative issue, conveying controversial results that have been circulated concerning adverse outcome following HTO, including nerve injury, deep osteomyelitis, and delayed or nonunion. El-Azab further assured the clinical result of HTO, particularly in the case of PH and TS alterations [12].

As of now, an expanding number of specialists utilize open wedge HTO because it is nearly less difficult. Open wedge HTO is best within the early or mid phases of gonarthrosis. Yet, this surgery method is reported to be relatively impractical in the cases of gonarthrosis that coexist with a serious deformity or in issues of patellofemoral osteoarthritis. Lateral closing wedge osteotomy is the unique methodology for some specialists concerning its familiarity. It is favorable for correction in cases of severe deformity. This strategy permits quick bone union because of the large contiguity surface of cancellous bone at the osteotomy site. The benefits are more noteworthy adjustment capability, no requirement for bone graft insertion, and rapid healing. The inconveniences that were found are fibular osteotomy, or proximal tibiofibular joint release, injury of the peroneal nerve (3.3-11.9%), the necessity for two bone cuts, deformity correction only can be achieved on one plane (frontal), shortening of the leg, insufficiency of bone stock, and more inconvenient change to arthroplasty with muscle detachment. Other pitfalls to closing wedge HTO include lateral offset enlargement due to flat osteotomy and loss of the enormous bone stock underneath the lateral tibial plateau. The leg length discrepancy often arises following closing-wedge HTO due to the bony shortening procedure on the affected side [13]. Furthermore, it devours a longer period to achieve bone union at the osteotomy site after closing wedge HTO since the variations between the discrepancy on the proximal and distal segments. It makes hardships in keeping up with alignment until the bone union is acquired. Moreover, Full weight-bearing is becoming problematic before bone consolidation and the requirements for long leg cast or knee support for closing wedge HTO patients [14].

Ideal postoperative recovery after knee procedure is expected to empower the patients to full weight bearing with practically no assistance as soon as possible. This will forestall the disturbance of osteoporosis, the debilitating of actual capacity, and the beginning of profound vein apoplexy after the operation.

Indication and Patient Selection

Patients who require Closing-Wedge HTO must be examined based on the following indication criteria:

a. Age range 50-65 years.

b. Adequate and active in physical activity.

c. Medial compartment joint pain of the knee with a varus deformity of $<12^0$-15^0.

The joint's scope of movement should be looked after, with full extension and a minimum 90^0 of flexion. Indications for closing wedge HTO, e.g., metaphyseal varus $>5^0$, normal or low patellar height, and back tibial slope $>10^0$ [15].

The contraindication for this procedure are:

a. Existing inflammatory joint

b. Previous history of ipsilateral lower limb osteotomy

c. Patients with a lower limb prosthesis

d. Late-stage knee osteoarthritis on pre-op radiographs (Ahlback grade ≥ 3).

Choosing the most suitable candidate is important with the aim of good results HTO for medial knee arthritis. Complete screening and thorough clinical examinations are important when selecting closing wedge osteotomy as the surgical treatment. The assessment is necessary to gain comprehensive patient history, including age, daily activities, occupation, previous medical history, and surgeries. It is also important to discover patients' activity level expectations post HTO. Physical assessment should encompass lower extremity range of motion (foot, ankle, knee, and hip), ligaments stability, deformity, and leg-length discrepancy [16].

There are no age restrictions in the osteotomy procedure, and people shouldn't be exempted from receiving HTO based solemnly on age. Nevertheless, patients with increasing age have more unfavorable results and longer recovery times. Some cases are related to poorer prognosis, including severe articular impairment (grade III Ahlback classification), patellofemoral arthroses, joint instability, and lateral tibia thrust. Therefore, severe malalignment may be contraindicated for the HTO procedure. Angle deviation reaching 12^0-15^0, lateral closing wedge HTO may slant the tibial articular surface, causing the shortening of the limb excessively [17]. The opening wedge osteotomy should be done instead if there is an MCL injury. Thus, the ideal patient for HTO is someone over 60, localized and isolated medial knee osteoarthritis with favorable ROM and non-existing ligamentous instability [16].

The Goal of Lateral Closing-Wedged HTO: Coronal and Sagittal Correction

There are various surgical methods to alleviate the varus knee osteoarthritis, options ranging from minimally invasive procedures including arthroscopic cartilage or meniscal procedure, open-wedge or closing-wedge HTO, unicompartmental knee arthroplasty (UKA), and total knee arthroplasty (TKA). HTO serves as an ideal surgical option in symptomatic middle-aged patients with medial knee OA. The main goal is the excellent clinical, and radiological results post closing-wedge HTO to medial knee osteoarthritis ith varus deformity [16].

These last few years, ground-breaking osteotomy procedures were discovered mainly in OW-HTO. Encompassing better and newer instruments, easing the operative procedure, computer-based navigating techniques with the expansion of new implants (stable angular plates), quicker achieved full weight-bearing and decreased the post-surgery adverse effect. CW-HTO procedure increases the possible changes in patellar size and posterior tibial plateau. This issue shows clinical implications in whether or not CW-HTO is chosen as proper surgical treatment of varus knees [16, 17].

The aim of cartilage operation in young adult patients is the significance of unloading tibio-femoral knee compartments or altering previous deformity while treating patients with hyaline cartilage injuries. In the previous years, an HTO changes the coronal plane of the knee and slope in the sagittal plane when orchestrating or evaluating osteotomies as visualizing the tibia as a three-dimensional plan with a trigonal shape. Osteotomy may achieve changes in both the coronal and the sagittal plane. Changing the tibial slope may influence the cruciate ligament's strengths and, consequently, affect knee stability. The effects of turning the biomechanics of the knee are not certainly known. Several assessments have shown that closing-wedge HTO lessens the posterior tibial slope, does not correlate the correction in the frontal plane and the tibial slope postoperatively. Hence, no extraordinary regard for the tibial slope is necessary during the closing-wedge HTO surgery [17].

Surgical Technique

Preoperative Planning/Templating

Measurement of limb alignment was assessed using the scanography radiographs. The mechanical axis or hip—knee—ankle axis is used to measure the deformity on the coronal plane. Moreover, the normal mechanical proximal tibia articular angle and mechanical lateral distal femur articular angle are measured between the tibia and tibial plateau's mechanical axis and the femur and distal articular angle of the femur, respectively [18].

MRI is acquired in all individuals to evaluate for intra-articular abnormality and anterior tibial artery pathology. Affirm the state of the lateral meniscus and ligament with MRI should be done preoperatively. Meticulous planning is the key to a successful osteotomy procedure. Tracing can be acquired while planning the scanography in the standing position [18, 19].

Surgical measurement is determined utilizing the hip—knee—ankle angle. As a general rule, the adjustment is aimed at the center of the knee joint, though the correction on the medial spine is preferred in cases of lateral compartment deformity. The corrected angle is then transposed to the tibia at the level of the osteotomy cut with the trajectory toward a point around 2 cm distal to the articular surface of the lateral tibial plateau and around 0.5 to 1 cm from the lateral cortex to protect the lateral "hinge." The length of the wedge of bone that needs to be eliminated is assessed along the medial tibial cortex [18].

The Weight-Bearing Line (WBL) is defined as a line drawn from the femoral head's midpoint to the center of the proximal talar joint surface (broken line). The ratio of WBL is calculated by dividing the distance between the WBL and the edge of the medial tibial plateau (d) divided by the tibial plateau widths' (W): WBL ratio 1/4 d/W 100 percent. Bending process f the internal fixator is required until the proximal screws' placement corresponds to the tibial plateau. After the surgical treatment, a clinical photograph of the leg and plate is finally obtained [19].

Preoperative radiographic evaluation should include weight-bearing anterior-posterior views in full extension. Tunnel views with the knee in 30 degrees of flexion, Rosenberg views with the knee in 45^0 degrees of flexion, lateral projection, and skyline view. In the case of a severe patella alta, tibial tubercle osteotomy and closing/opening HTO may be combined. Scanography radiographs of the lower extremity that depict the hip, knee, and lower leg joint arrangement can assess lower limb alignment [19].

Calculation of the Correction Angle

The center point of the hip is aligned with the center point of the knee and the center point of the ankle in normal lower extremities, and the mechanical axis, a line that comes to an obvious conclusion, is 0 degrees in the normal lower extremity. In many research, the optimal postoperative lower limb alignment is 3^0-5^0 valgus in the mechanical axis or 80-100 valgus in the anatomical axis. According to Fujisawa, the postoperative mechanical axis should pass through the 33% lateral of the tibial plateau. The thickness of the cartilage in the medial compartment determines the mechanical axis corrective action. If 33% of the cartilage on the medial side is destructed, the mechanical axis should pass 10-15% lateral from the tibial plateau center point; if 66% of the cartilage is destructed, the axis should pass 20-25% lateral; and if all of the cartilage is damaged, the axis should pass 30-35 percent lateral. The line that connects the femoral head and the tibiotalar joint focal points (the weight-bearing line) is 62.5 percent between the medial and lateral compartments of the proximal tibia, located slightly lateral to the lateral tibial spine, and 3-5 degrees of valgus from the mechanical axis. Meticulous correction should be done to avoid the under-correction that may result in varus, yet overcorrection may result in unfavorable cosmetic functional and cosmetic aspects [18, 19].

High tibial osteotomy is planned using anteroposterior scanography radiographs in a standing position. The weight-bearing line in the closing wedge is determined by estimating from a position at 62.5 percent of the width of the tibial plateau to the femoral head's center point and the ankle's center. The alpha angle framed at the intersection of these weight-bearing lines is the angle of correction. The Wedge bone that makes up the alpha angle must be removed. There are numerous HTO strategies, including closing wedge osteotomy, opening wedge osteotomy, dome osteotomy, progressive callus distraction, and chevron osteotomy. Of these, opening wedge HTO and closing wedge HTO are most generally performed [16, 18].

Deciding Osteotomy (Tibia and Fibula)

Distal femoral osteotomy (lateral opening wedge or medial closing wedge) and proximal tibial osteotomy are the surgical strategies that have been shown to improve valgus malalignment (lateral opening wedge or medial wedge). Although distal femoral osteotomies have long been considered the gold standard for treating valgus with sidelong compartment infection, these techniques have a greater impact in full extension of the knee, with less impact at knee flexion points and none at 90^0 or beyond [18]. We prefer to perform medial closing-wedge proximal tibia osteotomy (MCWPTO) in patients with mild-to-moderate valgus deformity, lateral compartment arthritis, meniscal insufficiency, or focal osteochondral defect to improve joint contact force both in knee flexion and extension [18, 19].

The appropriate choice of the patients is the most important factor in achieving successful HTO. Although there is not a universal criterion to follow, certain broad guidelines can be depicted. An opening osteotomy has criteria that are similar to a closing osteotomy. The optimum candidate for a tibial osteotomy is an active, slender patient between 50 and 60, with unicompartmental medial knee pain and a stable knee free

of patellofemoral joint symptoms. Up to 10 degrees of valgus malalignment with a previous injury to the lateral compartment cartilage or meniscus, or arthritis of lateral compartment, are HTO's main indications. Patients have frequently undergone previous procedures in the lateral compartment cartilage procedure, fractional lateral meniscectomy, lateral meniscus repair, chondroplasty [18, 20].

The orthopedic surgeon should evaluate the physiological age rather than the chronological age, as is customary. A patient's degree of exercise is the best predictor of the postoperative outcome. Unicompartmental knee replacement is an option for completely alleviating the pain. Thus the physician must carefully consider the patient's expectations and his demands, work, and lifestyle [20].

Absolute contraindications include the pathology on the medial compartment, inflammatory osteoarthritis, significant ligamentous laxity or more than 1 cm of joint subluxation, and nicotine usage. Obesity (BMI greater than 35), age > 60, moderate-to-severe patellofemoral pathology, late-stage of joint line obliquity, and anomaly of the anterior tibial artery are the relative contraindications.

The Fixation Choices

Several studies analyzed the wide range of implants (Kirschner wires, angular stability plates, cast immobilization with no internal fixator, and so on) and postoperative protocol and outcomes [18-21].

A four-hole 4.5-mm locking compression T-plate from the large fragment set is used to finalize the osteotomy procedure (Depuy Synthes; West Chester, PA). Before the osteotomy, a nonabsorbable #2 FiberWire stitch (Arthrex, Naples, FL) will be placed beneath the plate to consider suturing the Pes Anserinus tendon necessary. A lateral hinge fracture may also occur, necessitating a stronger construction with a larger plate and screws or an additional lateral incision to place a staple at the lateral hinge [18, 20, 21].

The following is how fixation using plate and screw is done: The plate head is fixed to the proximal segment once the segment has been repositioned. A 2 mm Kirschner wire is then inserted through the proximal screw hole using a drill guide under fluoroscopy to ensure that the wire's direction corresponds to the tibial plateau (concerning preoperative plan). The plate's proximal component is then immovably fastened with four screws placement. Under fluoroscopy, limb alignment is confirmed with a long stainless steel rod from the center point of the femoral head to the center point of the ankle joint. An axial load is applied to the sole to maintain the dorsiflexion position as the WBL proportion reaches 63 percent. In general, the distal tibial shaft will disengage medially when compared to the proximal part. Using a compression screw method is advantageous for connecting the distal portion of the tibia to the plate shaft and for obtaining rigid fixation at the proximal and distal of the tibial lateral cortex [19, 21, 22].

Using a 3.2 mm drill and drill guide, a compression screw hole is created using the proximal conventional screw hole at the first screw hole of the distal component of the plate. The drill course is about the same distance away or slightly distal from the osteotomy site. The conventional cortical screw (4.2 mm in width) is inserted into this hole, and the distal segment is moved to the plate. Other plate holes are secured using bicortical locking screws, which are inserted through minimally invasive methods. The former compression screw has finally been replaced with a locking screw. Four screws are usually used to secure the plate shaft [19, 21, 22].

Some researchers recommend using two Kirschner wires to stabilize the bone, while others prefer a more stable fixation. Two wires are inserted to temporarily maintain the bony cut, which has been reported in obese patients [20].

Clinical and Radiological Outcome

The high tibial osteotomy (HTO) procedure is a well-established surgical technique for treating medial compartment osteoarthritis of the knee. HTO's biomechanical guideline is to alter the lower limb mechanical axis to the lateral side to reallocate weight-bearing load from the medial compartment to the lateral compartment, reducing pain and slowing the progression of the pathology [21, 22].

Following the varus deformity, the load distribution at the physiological tibiofemoral joint is often contradictory because the load of the media compartment contributes more than 60% of the joint load. As a result, in the early stages of osteoarthritis, the medial compartment is vulnerable to injuries, and the increased stresses exacerbate susceptibility at the joint [23].

Clinical and radiological outcomes of this treatment may be studied. A clinical report involving 39 HTO patients revealed a reliable outcome, with an 82 percent survival rate after a 12-year follow-up. HTO requires selective patients inclusion and careful preoperative imaging measurements. Patients who are reasonably young, active, and have medial knee osteoarthritis or a tibial varus greater than 5^0 are the most suitable candidates for HTO [23].

In both groups, the postoperative assessment of the Visual Analog Score (VAS), Hospital for Special Surgery knee score (HSS), American Knee Society Score (KSS), Visual Analog Scale (VAS), Lysholm score, and the total of the Western Ontario and McMaster University osteoarthritis (WOMAC) index were superior to the preoperative outcomes (p 0.05), demonstrating that HTO is an effective surgery method [22].

In comparing radiological modalities pre and post opeeration, the correction angle, which includes the anatomical femorotibial angle (AFTA) and the hip-knee-ankle angle (HKA), is the most important factor influences surgical outcomes [22].

Following the HTO procedure, the value of radiographic parameters improved dramatically compared to the preoperative. In addition, the G-KJLO increased not as much as the TPA after HTO, as seen by a comparable difference in the AJLO. The researchers discovered that decreasing the AJLO compared to the ground maintained a reasonably small difference in the knee joint line direction; the number of alterations in those two configurations approximated the overall difference in the MTFA following HTO. Numerous scoring systems assessed the significantly improved radiographic parameters compared to preoperative values [23].

A survival rate of 84 percent was discovered after 9.6 years of follow-up, which has been confirmed in other studies (75 percent -98 percent). In 64 percent of instances 9.6 years after surgery, the clinical outcome was also deemed excellent or good. After ten years, the results appear to decline gradually. The patient's age is a crucial factor in determining to perform the HTO. However, age was not a significant predictor of HTO dissatisfaction in our study. Nevertheless, several studies have shown that age has a significant impact on HTO survival [24].

The necessity to perform TKA can be delayed by HTO and is approved to treat osteoarthritis of the knee joint in young and active individuals for pain relief while maintaining normal activity levels. Although the usage of HTO has decreased recently due to the improvement of TKA, certainly, a proper patient decision, accurate cautious planning, and a well-fitting attentive approach can yield promising HTO results [23].

However, a few individuals who initially benefited from an HTO may subsequently require a knee replacement because of the severity of joint

inflammation, the patient's aggravation, and difficulty performing daily activities. Knee replacement becomes problematic in these individuals due to a lack of bone stock, altered joint line, and subsequent patella baja. This is more challenging in those with more extensive overcorrection. However, in the hands of skilled surgeons, this may not have an adverse impact on the outcome of TKR, as evidenced by ongoing studies comparing essential TKR with TKR without prior HTO, which found no significant slowing of results, thus bolstering the use of HTO, particularly in young patients with unicompartmental pathology, to buy more time before joint replacement is required [23].

Complication, Survivorship, and Arthroplasty Conversion

Closing wedge high tibial osteotomy is a common, effective, and well-supported treatment option for unicompartmental osteoarthrosis of the knee. In any case, it's not without difficulties. Infection rates range from 0.8 to 10.4 percent. The majority of infections are superficial and may be adequately treated with antibiotic medications taken orally. Deeper infections are more threatening and may necessitate irrigation and debridement as well as the use of intravenous antibiotic medication [13].

The risk of deep vein thrombosis ranges from 2–5 percent, with most cases occurring in the calf veins (41%). Tourniquet usage did not appear to have a significant effect on the occurrence of thromboembolic. Given the potentially high incidence of deep vein thrombosis, it looks amenable to administer the postoperative thromboprophylaxis medication similar to the one used in knee arthroplasty [13].

Because of the procedure's capacity to regulate the stability and metaphyseal bone apposition, nonunion following a closing wedge osteotomy is unusual. Furthermore, the position is in normal compression. General variables such as smoking, peripheral vascular state, dietary status, compliance to postoperative protocols, and comorbidities such as diabetes are all considered in preventing nonunion of the osteotomy. Making a stable osteotomy, metaphyseal, rigid internal fixation, and compressive are explicit variables that relate to the overall criteria of an osteotomy. The closing-wedge osteotomy has the advantage of meeting most of these requirements. In any case, nonunions do occur, and the frequency ranges from 1–5% in several series. Treatment usually revision to a more rigid fixation, e.g. locking plates or a compressive type of external fixation, as well as the use of bone graft adjuvants. Bone morphogenic proteins and electrical stimulation should be considered as well [13].

The common fibular nerve lesion is most vulnerable in a fibular head osteotomy, notwithstanding its rarity. This risk has prompted some doctors to perform a diaphyseal osteotomy instead. Although there are few descriptions of complications following diaphyseal fibular osteotomy in the literature, fibular nonunion is the most common adverse outcome (13.8 percent). As a result, a comprehensive fibular osteotomy operation is recommended. It was determined that 13.8 percent of fibular osteotomies did not result in a faster bony union. These nonunions had a significant impact on the clinical results. Nonunion is linked to a high preoperative BMI, low osteotomy plane obliquity, and a small fragment contact area. When the obliquity of the osteotomy plane was greater than 50^0 or the fragment contact area was greater than 50 percent, no nonunion rate was reported [13, 14, 25].

The most commonly documented neurovascular consequence in the aftermath of closing wedge HTO is peroneal nerve paralysis, whether sensory, motoric, or both. The frequency ranges from 0% to 20%, with half of those affected having a long-term impairment. The nerve's proximity to the fibular head and neck and a few other anatomical and surgery factors are thought to be causal factors. Closing wedge HTO has been associated with injury to the popliteal and anterior tibial arteries, but these are rare. By all accounts, damage to the anterior tibial artery appears to be more common, and this may be due to the high prevalence of a high origin of this vessel, resulting in the artery being in direct contact with the posterior cortex of the tibia and being at risk from poorly positioned retractors or during the osteotomy. The majority of these complications may be reduced or eliminated with careful preoperative planning [13].

There is a lot of debate over the long-term implications of total knee arthroplasty after HTO. While some writers claim that previous HTO had no negative effects, others claim poorer outcomes. There is a broad consensus that TKA after HTO is significantly more difficult than primary TKA and that it necessitates extensive planning and forethought to anticipate the method's possible drawbacks. A thorough understanding of the unique challenges associated with surgical TKA in a knee with a previous HTO improves the outcome. The ensuing patella baja following HTO predicted wound healing difficulties, physical deformation of the proximal tibia complicating TKA, and the possibility for any retained implants interfering with any future treatment are just a few examples. Any of these factors might make the TKA much more difficult and alter the long-term outcome. Patella baja after closing-wedge HTO occurs as a result of scarring of the patella ligament and the resulting contracture, rather than due to the stiff alteration caused by bone deduction. Following HTO, the proximal tibia deforms from its original morphology. This usually results in a decrease in sagittal slope and a lack of lateral bone stock. When planning a TKA, both of these disfigurements should be taken into account. The slope should be rebuilt, and lateral bone stock should be protected. However, additional difficulties may arise as a result of attempting to do so. It should also be considered whether the HTO inserts should be removed and if TKA should be performed in a single session or stage, given the risk of infection, although there is no evidence of this in the literature [13, 15, 16].

Different Surgical Approaches Comparison

Versus Open-Wedge HTO

High tibial osteotomy (HTO) is a delicate operation method for persons with medial OA and varus deformity. This method shifts the mechanical axis to the knee's lateral compartment and decreases the pressure in the medial compartment of the knee. A lateral closing-wedge osteotomy (CWO) and a medial opening-wedge osteotomy (OWO) are the two most used HTO techniques. Although CWOs were once widespread, OWO has gradually superseded them [26, 27].

OWO has a few advantages over CWO, including easier control of the adjustment level, less extensive tissue dissection, preservation of the proximal tibiofibular joint, and avoidance of peroneal nerve palsy [27]. The CWO has various drawbacks, including a more difficult TKA after that, the requirement for a fibular osteotomy, increased neurovascular problems, and bone loss. OWO is described later than CWO to prevent fibular osteotomy and lower the risk of comorbidity associated with it. Furthermore, OWO has gained popularity in recent years due to the advent of particular locking implants and bone-substituting biomaterials since it has various advantages over CWO, including faster recovery, easier future TKA, and quicker alignment correction adjustment [27].

Since the main goal of HTO is to postpone total knee arthroplasty (TKA), patients and surgeons must know whether medial opening or

lateral closing wedge HTOs have the best endurance. The risk of deterioration of medial compartment osteoarthritis is increased by varus deformity of the knee joint. According to the current study, the closing-wedge HTO has a more favorable surival rate at 10 years comparing to the open wedge. When compared to OWO, CWO resulted in significantly reduced posterior tibial slope, larger patellar height measurements, and a lower incidence of patellar baja. However, there were no significant differences between the two groups regarding HKA angle, mean angle of correction, and leg length. Moreover, no significant differences were found in the clinical findings [27].

The factors of knee configuration might be a possible explanation for CWO's poor results. A lateral tibial thrust and a knee adductor moment are both well-known HTO risk factors for survival. CWO's fundamental pitfall is the extended lateral approach, which unavoidably affects the proximal tibiofibular joint and lateral collateral ligament. As a result, CWO is considered to cause a larger adductor knee moment and a higher risk of prolonged lateral thrust than open-wedge HTO. After open-wedge HTO, the posterior slope increases, but after close-wedge HTO, it decreases. The discrepancy in posterior tibial slope following HTO might be due to the proximal tibia's distinct anatomic shape. The in situ forces of the cruciate ligaments may be unaffected by either open or closing-wedge HTO. Using any action with three reference approaches, patellar height decreased after OWO and increased after CWO (Caton-Deschamps, Insall-Salvati, or Blackburne-Peel record). The HKA point on standing scenography, defined as the angle between the mechanical axes of the femur and tibia, was calculated by both OWO and CWO, resulting in a precise modification [26, 27].

As for complications, closing-wedge HTO suggested lateral muscle separation, the higher danger of peroneal nerve injury, more requesting ensuing TKA, bone stock misfortune, fibular osteotomy, or proximal tibiofibular joint disturbance. OWO was viewed as a protected and reproducible technique for the previously mentioned disservices of CWO and acquired the prominence for being a generally acknowledged elective choice. Be that as it may, OWO was not liberated from certain entanglements, like nonunion, the need for bone graft, illness transmission, and possible loss of correction. OWO showed a higher occurrence of iatrogenic fracture of the tibial plateau [26, 27].

Versus Unicompartmental Knee Arthroplasty

In the treatment of medial compartment osteoarthritis of the knee, high tibial osteotomy (HTO) and unicompartmental knee arthroplasty (UKA) address a "weird couple." Although they are altogether different methods with various ways of thinking, sometimes they share similar indications. Along these lines, past studies depict them as elective choices, while others deny any overlap of indication [3]. The goal of surgery for unicompartmental OA is to reduce pain, restore function, and improve the patient's personal satisfaction. Both HTO and UKA are viable options for symptomatic medial knee OA [29].

The outcomes of HTO and UKA were depicted in a variety of literature. Survivorship, specific provisions (for example, closed vs. open HTO, or all polyethylene versus metal-backed tibial UKA), problems and adverse effects of the systems, and the outcomes of TKA revision were the main topics of discussion. There was a significant difference in results between UKA and HTO patients, with the former having superior functional outcomes (excellent/good outcomes) and the latter having better ROM. This contradiction was linked to knee score and range of motion, indicating the possibility of further impacts on the practical outcomes [29]. Previous research has analyzed HTO and UKA with a 20 to 40 month follow-up. At two years, HTO had a 100 percent survival rate, whereas UKA had a 91 percent survival rate at three years. In the HTO group, 57 percent achieved good-to-excellent results, whereas, in the UKA group, 91 percent achieved good-to-excellent results [30]. In comparison to HTO, investigations revealed that UKA is a viable choice that performed better [3]. A half-year postoperatively, UKA patients have better muscle strength than the HTO patients, but the one-year post-employable results were comparable. One probable explanation for this observation is that UKA patients' recovery usually begins sooner, but HTO patients usually undergo a period of immobility. In addition, due to more noticeable alterations in post-surgical leg position, HTO patients may take longer to adapt. The capacity of patients to walk is a reliable and genuine metric for evaluating treatment effects in knee OA patients, but no clear differentiation between the two methodologies has been established [29].

Although both HTO and UKA effectively treat medial compartment knee osteoarthritis, they should not be compared as equal treatment. Reviews revealed the significance of carefully selecting surgical candidates to get reliable and predictable outcomes with the two operations. The indications for the two methodologies are 100% different although both procedures require an absolutely intact anterior cruciate ligament [30]. Patients between the ages of 60 and 65, who are moderately active, non-obese, with mild varus malalignment (from 5 to 10 degrees), without joint instability, with a good range of motion, and with moderate unicompartmental arthritis are among those who may benefit from either HTO or UKA. Age, BMI, and preoperative OA are important variables determining clinical outcomes and survival in patients undergoing HTO [29]. At mid-and long-term follow-up, both HTO, and UKA demonstrated satisfactory results and survival rates. The topic of whether revision HTO or UKA to TKA performs worse than essential TKA is debatable. TKA is used to treat the endpoint of each unsuccessful HTO or UKA [28, 29, 31].

Compared to UKA, the risk of postoperative problems is higher following an osteotomy, showing a significant difference between HTO and UKA patients. OWO is seen as straightforward, with the awareness that CWO is linked to a higher risk of sequelae, including peroneal nerve paralysis. Despite better and more careful surgical strategies and embed plans, previous investigations have revealed complexities following UKA, such as loosening of the tibial or femoral part or osteoarthritic changes in the improvement of the lateral compartment due to anteroposterior instability of the knee, which causes the polyethylene insert to wear out quickly. The most common problems in the HTO group were iatrogenic fracture, peroneal nerve paralysis, infection, and nonunion.

Conclusion

Valgus HTO is a difficult technique yet furnishes more youthful OA patients with great active work. Compared to HTO, UKA might be an alternative for older patients because it provides a higher level of personal satisfaction with a shorter recovery period before full weight-bearing, fewer perioperative difficulties, and a faster functional recovery. Although UKA patients would have had better overall long-term results, both treatment options provided satisfactory results. There is no clear evidence that one surgical method is superior to the other.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

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