

Indications for High Tibial Osteotomy

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Abstract

There is a resurgence of interest in HTO to treat young to middle aged patients with varus alignment and isolated medial joint osteoarthritis. With improvements in implant design and preoperative planning methods, good outcomes are reported in multiple studies. But the most important factor for a successful outcome is patient selection. The ideal patient would be a middle-aged patient with isolated medial joint arthritis with good range of movements, non-smoker and with reasonable functional status of knee. The indications of HTO are evolving to include patients in higher age groups, with minimal to moderate patellofemoral symptoms and varying amounts of flexion deformities. It is also increasingly being performed as a joint protective surgery following meniscus repairs and cartilage repair procedures and to correct abnormal joint alignment following neglected ligamentous injuries.

Keywords: HTO indications, Early Arthritis, Varus

Introduction

High tibial osteotomy is a powerful tool in joint preservation. Introduced by Jackson & Waugh in 1961 and popularized by Coventry in 1965, the lateral closing wedge osteotomy of the proximal tibia was a popular technique to treat medial joint OA with varus deformity [1, 2]. The predictable pain relief and the relative ease of total knee arthroplasty had eclipsed the popularity of the procedure. Medial opening wedge osteotomy of the proximal tibia became popular after the results of Hernigou [3]. It has advantages of preserving the bone stock without disturbing proximal tibio-fibular joint and to address the laxity associated with ligamentous insufficiencies. Concerns about implant survival, low activity level and dissatisfaction after TKR have led surgeons to look for joint preserving solutions. Modern osteotomy techniques that incorporate stable fixation, accurate planning and correction have resulted in improved outcomes and created a resurgence of interest of late.

Indications

Successful outcomes depend very much on the right patient selection and precise technical execution of the procedure. Poorer outcomes can still be expected in a subgroup of patients following HTO [4]. Patient factors like age, activity level, functional status, severity of OA, body mass index, smoking, expectations, ability to comply with exercises and lifestyle modifications are to be assessed thoroughly. The knee should be examined for the presence of patellofemoral symptoms, lateral joint symptoms, ligamentous laxity, recurvatum,

limb length discrepancy and range of movements [5].

In this article we will be primarily discussing indications for opening wedge high tibial osteotomy (OWHTO) in varus medial joint OA. In addition to its role in MJOA with varus, OWHTO is helpful in correcting the varus thrust resulting from neglected ligamentous injuries by shifting the load and substituting ligament function. It also offers an opportunity to modify tibial slope when faced with ligament revision situation. OWHTO is also used to protect and unload the joint following joint preserving procedures like meniscus root repair, meniscus transplantation and cartilage repair [5, 6].

Age

Younger age correlates with better outcomes. More than age, the functional status of the joint as determined by functional scores has been found to correlate well with the outcome [7]. Though the ideal age for HTO is between 40 to 60 years as per 2005 ISAKOS guidelines, HTO is possible and is being done upto 65 years according to many authors [8]. We may consider a lower cut-off age for women and osteoporotic knees. Poorer outcomes may increase after 56 years, and caution must be exercised in selecting the patients in the 55 to 65 years age group [9]. Outcomes of HTO also progressively deteriorate with age, especially above 65 years [7]. Rather than considering a numerical value of age as a cut-off, factors like functional status, quality of bone, extent of arthritis, activity level, severity of varus and patients' predicaments should be taken into consideration in patient selection.

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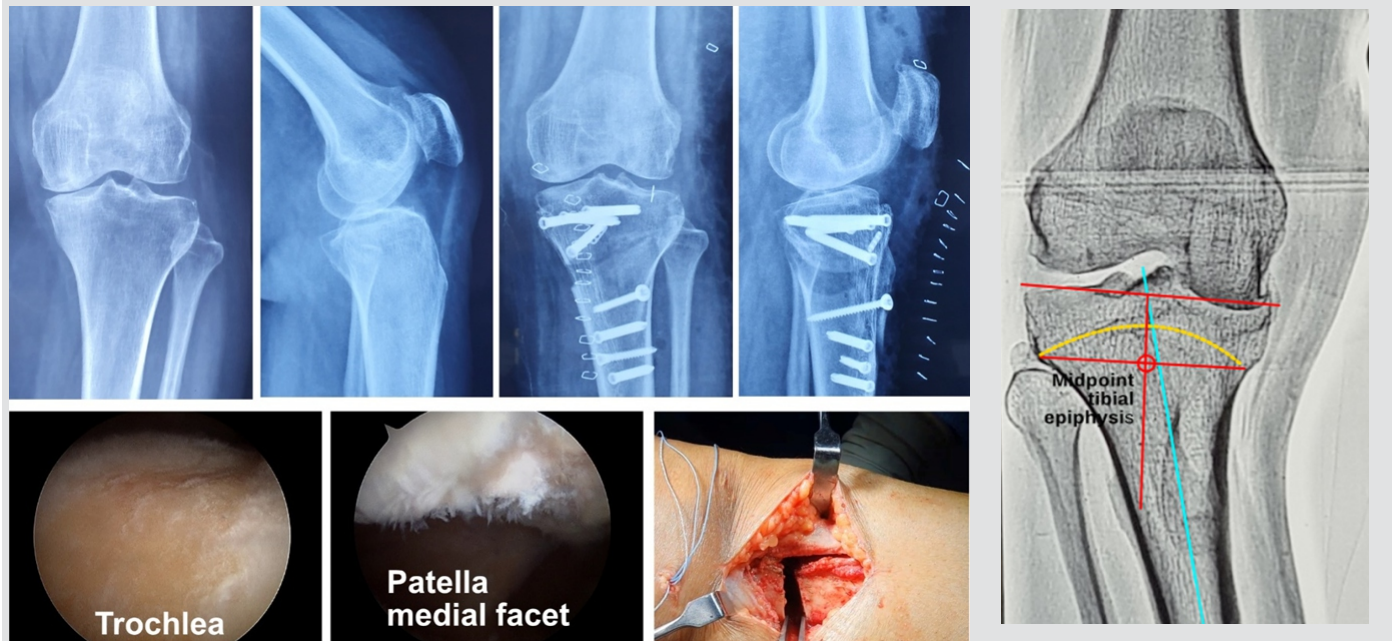


Figure 1: Medial Joint OA, Varus and Root tear in a 51 yr old female. Clinical as well as arthroscopic examination revealed patellofemoral cartilage erosions. A descending biplane osteotomy (12 mm) with root repair was carried out.

Figure 2: Metaphyseal Varus: TBVA: Tibial Bone Varus angle is formed between the epiphyseal axis (red) and mechanical axis (blue) of tibia. More than 5° of TBVA indicates a metaphyseal varus.

Obesity

Higher BMI values have been correlated with poorer outcomes, shorter painfree intervals and implant failures following the procedure [10]. HTO in patients with BMI more than 30 is associated with significant poorer results than in patients with a lower BM [11]. Even though the ideal BMI for an OWHTO is between 25 to 27.5, patients with higher BMI do benefit from this procedure but may have poorer mid-term results [12]. Strict assessment of extent of arthritis, use of stronger implants and bone grafting will be necessary in patients with high BMI. Counselling about outcomes and a postoperative weight loss program is also important in this group.

Varus

Osteoarthritis of the medial joint resulting from meniscus tears and loss of cartilage results in a varus alignment. In some patients, a deformity of the proximal tibial metaphysis (metaphyseal or constitutional varus) produces varus which leads increase medial compartmental loading [5]. The joint obliquity in relation to the mechanical axis of tibia in these patients is corrected by HTO and the procedure almost has a curative effect. Varus mostly originates in tibia. However, in a small percentage, the varus could be of femoral origin. Excessive lateral ligamentous laxity can also contribute to varus as seen in gross lateral joint opening in weight bearing X-rays (double varus). In chronic posterolateral corner insufficiency, the patient has a recurvatum and a varus thrust while walking (triple varus) [13].

Severity of Arthritis

The grade of arthritis in the medial compartment correlates with outcomes with milder grades producing good outcomes.

Surprisingly in a review of 533 patients, Floerkemeier et al, have reported good midterm results even in grade III and IV lesions and in elderly patients [14]. Similar findings have been reported by Schuster et al as well in advanced MJOA [15]. But in general, advanced medial joint osteoarthritis (>Ahlback grade III) can result in suboptimal outcomes following HTO. Tricompartamental OA is a definite contraindication for HTO. Medial joint OA with severe erosion and down sloping of the medial tibial plateau resulting in a “pagoda” type deformity is also contraindication to HTO.

A reasonably preserved lateral compartment is important for the outcome. Valgus stress X-rays to assess lateral joint cartilage and MRI scans can be helpful in assessing the lateral joint cartilage and meniscus. Arthroscopy is a gold standard for cartilage assessment. It is worthwhile to note that lateral compartment chondral softening and partial thickness chondral defects do not affect clinical outcomes [16].

Range of Movements

Overall range of 120° and a flexion deformity less than 5° have been considered ideal for HTO [11]. With modern techniques and slope modifications, upto 15° of flexion deformity can be corrected and acceptable for performing OWHTO. More than 15° of flexion deformity and less than 100° of available ROM is currently considered a contraindication for osteotomy [10].

Patellofemoral Pain

Many patients with medial joint OA also suffer from patellofemoral pain due to excessive pressure from a patella tilt, lateral retinacular tightness or patellofemoral osteoarthritic changes. The OWHTO has been found to decrease the patella height (patella infera) and increase

patellofemoral contact forces. This is especially relevant in large corrections and in cases with a postoperative increase in tibial slope [17-19]. This has a potential to increase the pain and adversely affect the outcomes. A modified technique, a descending biplanar osteotomy (Figure 1) has been shown not to alter the patellar height and may be suitable for patients with patellofemoral OA undergoing larger corrections (>10mm) [20]. Adjunct procedures like lateral retinacular lengthening or partial lateral facetectomy may help in correcting the lateral pressure due to tilt and lateral facet overhang with lateral facet arthrosis, respectively. While mild to moderate patellofemoral pain is not a contraindication for OWHTO, patient counselling and rehabilitation is important.

Ligamentous Laxity

Neglected ACL insufficiency with meniscal tears and chondral damage often results in medial joint osteoarthritis [6]. Doing ACL reconstruction alone and ignoring the varus can lead to failure of ligamentous reconstruction [21]. Combined ACL and HTO procedure can address both instability and malalignment. HTO is useful in addressing the double and triple varus by redistributing the load and balancing the deformity [13, 21]. It has a ligament substituting effect in these clinical scenarios. Varus arthritic knees with deficient ACL are more suitable for OWHTO than UKA [22]. Increased tibial slope is responsible for failure in a subset of ACL reconstructions due to the stress on the graft. HTO is helpful along with revision ACL to alter the tibial slope to ensure graft protection.

Radiological Parameters:

Radiological assessment should include weight bearing AP views, lateral view, Rosenberg views and skyline views of patella. The presence of metaphyseal varus can be assessed by tibial bone varus angle, TBVA (Figure 2) the angle between the ephiphyseal axis and the mechanical axis of tibia [5]. The amount of lateral joint space in a valgus stress AP view can indicate the lateral compartment cartilage status. Lateral views are useful to assess tibial slope and patellar height. Skyline views will be able to show patella tilt, osteophytes and patellofemoral OA changes. MRI study of the knee is useful to assess the ligaments, meniscus and the cartilage status. A full-length standing X-ray with a magnification marker is essential for planning the correction. Parameters like Medial Proximal Tibial Angle (MPTA) and Lateral Distal Femoral Angle (LDFA) can help in identifying the origin of the varus deformity. In the same X-ray, the contribution of ligamentous laxity to the varus can be assessed by Joint Line Congruence angle (JLCA).

HTO as an Adjunct to Cartilage and Meniscus Repair Procedures

HTO as a standalone procedure has shown to induce fibrocartilage regeneration in bare areas at second look arthroscopy [24]. HTO results in an environment conducive to regeneration and at least prevents cartilage deterioration. It has potential to improve the outcomes and protect the repair when combined with cartilage repair or regenerative procedures like microfracture, OATS and ACI [25]. Posterior root tears of meniscus cause of sudden onset medial joint pain and accelerated osteoarthritis due to a total loss of meniscus function. Obesity, squatting lifestyle and varus malalignment are the

risk factors. HTO when combined with a repair can reduce the stress on the repaired meniscal root and protect the repair. Even without a root repair, HTO has been shown to produce good pain improvement [26,27].

High Tibial Osteotomy or UKA

There exists a small group of patients in whom the indications for both these procedures could overlap. This group is moderately persons between 55 to 65 years, with 5 to 10° of varus, ROM of at least 100°, less than 5° of flexion contracture and Grade II medial compartment OA [23]. In this subset, patients who are younger, more active, have a metaphyseal varus (TBVA>5°), ACL insufficiency and have lesser grades of OA may be ideal candidates for HTO. Patients who are older with advanced OA changes, poorer functional scores and an intact ACL will benefit from UKA. While many earlier studies reported better outcomes with UKA, recent studies have shown better results of OWHTO in comparable groups treated with either of these procedures [23].

Contraindications

There are ideal candidates and there are candidates in whom HTO is possible. It is important to identify the patients for whom HTO is not suitable. The absolute and relative contraindications are

1. Inflammatory arthritis
2. Advanced medial joint osteoarthritis, Pagoda type erosion
3. Fixed Flexion deformity more than 15°
4. Available range of movement less than 100°
5. Lateral Joint Osteoarthritis
6. Previous lateral meniscectomy
7. Significant and predominant patellofemoral arthritis
8. Relative contraindications: BMI>30, Varus malalignment >15° (consider soft tissue laxity and femoral varus), smokers, osteoporosis

Conclusions

Right patient selection is crucial for a successful outcome. A short trial of medial unloading joint brace and improvement in pain and function can serve as a prognostic indicator. In addition to its primary role in varus MJOA, HTO is being increasingly used in ligament insufficiency situations to alter the tibial slope and to correct the varus thrust. It is also an adjunct or even a primary procedure in joint preserving procedures like cartilage repair and meniscus root repairs. The ideal patient is less than or around 55 years of age, with minimal arthritic changes, ROM of >120°, with <5° of flexion contracture with good or reasonable functional scores. With better outcomes and better implants, we have expanded the indications to include elderly age groups and even with advanced medial compartment OA changes and moderate patellofemoral symptoms. On the other hand, patients with higher grades of OA, who are not suitable for HTO may actually be willing to accept it in order to avoid TKA. The surgeon must be objective and free of bias while deciding the right candidate for this rewarding procedure.

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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References

- Jackson JP, Waugh W. Tibial osteotomy for osteoarthritis of the knee. *J Bone Joint Surg Br.* 1961 Nov;43-B:746-51. doi: 10.1302/0301-620X.43B4.746.
- Coventry, M B. "Osteotomy of the upper portion of the tibia for degenerative arthritis of the knee. A preliminary report" *J Bone Joint Surg Am.* 1965; 47:984-990. PMID: 14318636.
- Hernigou P, Medevielle D, Debeyre J, Goutallier D. Proximal tibial osteotomy for osteoarthritis with varus deformity. A ten to thirteen-year follow-up study. *J Bone Joint Surg Am.* 1987;69(3):332-354. PMID: 3818700.
- Naudie D, Bourne RB, Rorabeck CH, Bourne TJ. The Install Award. Survivorship of the high tibial valgus osteotomy. A 10- to -22-year followup study. *Clin Orthop Relat Res.* 1999;(367):18-27. PMID: 10546594.
- Capella M, Gennari E, Dolfin M, Saccia F. Indications and results of high tibial osteotomy. *Ann Joint* 2017;2;33. doi: 10.21037/aoj.2017.06.06.
- Sabzevari S, Ebrahimpour A, Roudi MK, Kachooei AR. High Tibial Osteotomy: A Systematic Review and Current Concept. *Arch Bone Jt Surg.* 2016;4(3):204-212.
- Howells NR, Salmon L, Waller A, Scanelli J, Pinczewski LA. The outcome at ten years of lateral closing-wedge high tibial osteotomy: determinants of survival and functional outcome. *Bone Joint J.* 2014;96-B(11):1491-1497. doi:10.1302/0301-620X.96B11.33617.
- Trieb K, Grohs J, Hanslik-Schnabel B, Stulnig T, Panotopoulos J, Wanivenhaus A. Age predicts outcome of high-tibial osteotomy. *Knee Surg Sports Traumatol Arthrosc.* 2006;14(2):149-152. doi:10.1007/s00167-005-0638-5.
- Bonasia DE, Dettoni F, Sito G, et al. Medial opening wedge high tibial osteotomy for medial compartment overload/arthritis in the varus knee: prognostic factors. *Am J Sports Med.* 2014;42(3):690-698.
- Akizuki S, Shibakawa A, Takizawa T, Yamazaki I, Horiuchi H. The long-term outcome of high tibial osteotomy: a ten- to 20-year follow-up. *J Bone Joint Surg Br.* 2008;90(5):592-596. doi:10.1302/0301-620X.90B5.20386.
- Flecher X, Parratte S, Aubaniac JM, Argenson JN. A 12-28-year followup study of closing wedge high tibial osteotomy. *Clin Orthop Relat Res.* 2006;452:91-96. doi:10.1097/01.blo.0000229362.12244.f6.
- Herbst M, Ahrend MD, Grünwald L, Fischer C, Schröter S, Ihle C. Overweight patients benefit from high tibial osteotomy to the same extent as patients with normal weights but show inferior mid-term results [published online ahead of print, 2021 Feb 11]. *Knee Surg Sports Traumatol Arthrosc.* 2021;10.1007/s00167-021-06457-3. doi:10.1007/s00167-021-06457-3
- Noyes, Frank & Barber-Westin, Sue. (2010). Primary, Double, and Triple Varus Knee Syndromes. In book: *Noyes' Knee Disorders: Surgery, Rehabilitation, Clinical Outcomes* (pp.821-895). 10.1016/B978-1-4160-5474-0.00031-X.
- Floerkemeier S, Staubli AE, Schroeter S, Goldhahn S, Lobenhoffer P. Outcome after high tibial open-wedge osteotomy: a retrospective evaluation of 533 patients. *Knee Surg Sports Traumatol Arthrosc.* 2013;21(1):170-180. doi:10.1007/s00167-012-2087-2
- Schuster P, Geßlein M, Schlumberger M, et al. Ten-Year Results of Medial Open-Wedge High Tibial Osteotomy and Chondral Resurfacing in Severe Medial Osteoarthritis and Varus Malalignment. *Am J Sports Med.* 2018; 46(6):1362-1370. doi:10.1177/0363546518758016
- Hohloch L, Kim S, Eberbach H, et al. Improved clinical outcome after medial open-wedge osteotomy despite cartilage lesions in the lateral compartment. *PLoS One.* 2019;14(10):e0224080. Published 2019 Oct 24. doi:10.1371/journal.pone.0224080
- Bin SI, Kim HJ, Ahn HS, Rim DS, Lee DH. Changes in Patellar Height After Opening Wedge and Closing Wedge High Tibial Osteotomy: A Meta-analysis. *Arthroscopy.* 2016;32(11):2393-2400.
- Kloos, F., Becher, C., Fleischer, B. et al. High tibial osteotomy increases patellofemoral pressure if adverted proximal, while open-wedge HTO with distal biplanar osteotomy discharges the patellofemoral joint: different open-wedge high tibial osteotomies compared to an extra-articular unloading device. *Knee Surg Sports Traumatol Arthrosc* 27, 2334–2344 (2019).
- Javidan P, Adamson GJ, Miller JR, et al. The effect of medial opening wedge proximal tibial osteotomy on patellofemoral contact. *Am J Sports Med.* 2013;41(1):80-86. doi:10.1177/0363546512462810.
- Krause M, Drenck TC, Korthaus A, Preiss A, Frosch KH, Akoto R. Patella height is not altered by descending medial open-wedge high tibial osteotomy (HTO) compared to ascending HTO. *Knee Surg Sports Traumatol Arthrosc.* 2018;26(6):1859-1866. doi:10.1007/s00167-017-4548-0.
- Noyes FR, Barber-Westin SD, Hewett TE. High tibial osteotomy and ligament reconstruction for varus angulated anterior cruciate ligament-deficient knees. *Am J Sports Med.* 2000;28(3):282-296.
- Arthur A, LaPrade RF, Agel J. Proximal tibial opening wedge osteotomy as the initial treatment for chronic posterolateral corner deficiency in the varus knee: a prospective clinical study. *Am J Sports Med.* 2007;35(11):1844-1850. doi:10.1177/0363546507304717.
- Dettoni F, Bonasia DE, Castoldi F, Bruzzone M, Blonna D, Rossi R. High tibial osteotomy versus unicompartmental knee arthroplasty for medial compartment arthrosis of the knee: a review of the literature. *Iowa Orthop J.* 2010;30:131-140.
- Kanamiya T, Naito M, Hara M, Yoshimura I. The influences of biomechanical factors on cartilage regeneration after high tibial osteotomy for knees with medial compartment osteoarthritis: clinical and arthroscopic observations. *Arthroscopy.* 2002;18(7):725-729. https://doi.org/10.1053/jars.2002.35258.
- Thambiah MD, Tan MKL, Hui JHP. Role of High Tibial Osteotomy in Cartilage Regeneration - Is Correction of Malalignment Mandatory for Success?. *Indian J Orthop.* 2017;51(5):588-599.

26. Nha KW, Lee YS, Hwang DH, et al. Second-look arthroscopic findings after open-wedge high tibia osteotomy focusing on the posterior root tears of the medial meniscus [published correction appears in *Arthroscopy*. 2019 Feb;35(2):691] [published correction appears in *Arthroscopy*. 2020 Mar;36(3):923]. *Arthroscopy*. 2013;29(2):226-231.
27. Lee DW, Lee SH, Kim JG. Outcomes of Medial Meniscal Posterior Root Repair During Proximal Tibial Osteotomy: Is Root Repair Beneficial?. *Arthroscopy*. 2020;36(9):2466-2475.

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