



High Tibial Osteotomy Scientific Update

First introduced by Jackson and Waugh in 1961, high tibial osteotomy (HTO) became a popular treatment modality for medial compartment osteoarthritis (OA) of the knee with varus deformity.¹ Over the past decade, improvements in implants and techniques, such as the iBalance® HTO system, have revolutionized treatment of this condition.

Hohmann E,
Tetsworth K,
Glatt V,
Ngcelwane M,
Keough N

Surgical Technique

[Increased posterior slope of the medial and lateral meniscus posterior horn is associated with anterior cruciate ligament injuries.](#) *Arthroscopy.* 2022;38(1):109-118. doi:10.1016/j.arthro.2021.04.066

- The purpose of this study was to measure the slope of the medial and lateral posterior meniscus to determine its contribution to overall posterior tibial slope in knees with intact and deficient ACLs.
- Researchers evaluated MRIs from 424 patients with an intact meniscus and measured posterior tibial slope and meniscus slope. The variance was used to determine differences between ACL-intact and ACL-deficient knees.
- The authors found that knees with a lower meniscal slope are associated with ACL injuries in male and females.

Takeaway

Increased tibial slope is a contributor to ACL injuries. This study shows the tibial slope cannot be ignored during ACL injuries, and patients may need to be evaluated for a slope-correcting osteotomy.

Cantivalli A,
Rosso F,
Bonasia DE,
Rossi R

[High tibial osteotomy and anterior cruciate ligament reconstruction/revision.](#) *Clin Sports Med.* 2019;38(3):417-433. doi:10.1016/j.csm.2019.02.008

- HTO is a procedure commonly used to treat medial early OA in young and active patients.
- Combined HTO and ACL reconstruction is indicated in patients with medial OA and varus alignment associated with an ACL tear with symptomatic anteroposterior instability, failed ACLR, or increased posterior tibial slope.
- A posterior tibial slope greater than 12° is a risk factor for ACLR failure and should be modified.

Takeaway

There are different surgical techniques to perform a concomitant HTO and ACLR. Opening wedge and closing wedge HTO are most commonly performed, but there is no evidence supporting the superiority of one procedure over the others. For ACLR, soft-tissue autograft or allograft is commonly used in association with anatomic reconstruction. There are few studies on combined HTO and ACLR; those that exist have short follow-ups and few patients. However, most of these studies reported good outcomes, with complication rates similar to isolated or staged ACLR.

[High tibial osteotomy in the ACL-deficient knee with medial compartment osteoarthritis.](#)

J Orthop Traumatol. 2016;17(3):277-285. doi:10.1007/s10195-016-0413-z

- Realignment surgery is now considered an important part of the treatment algorithm for the unstable knee. Biomechanical studies have shown that planned alteration of the posterior tibial slope can also help improve or restore stability in the sagittal plane in ligament-deficient knees.
- The study addressed the biomechanical rationale for an HTO and its relationship with varus malalignment, posterior tibial slope, and ACL insufficiency. Additionally, it reviewed patient selection, surgical planning, and specific surgical techniques.
- ACL deficiency alters knee kinematics and may contribute to accelerated degenerative changes, particularly in the medial compartment. Osteotomy or realignment surgery can be used in this setting to treat both pain and instability by altering the posterior tibial slope, changing the sagittal plane and coronal alignment.

Takeaway

HTO is an effective procedure for treating varus malalignment with ACL deficiency. Decreasing posterior slope helped improve knee stability with or without ACL reconstruction.

[Sports and high tibial osteotomy.](#) In: Doral MN, Karlsson J, eds. *Sports Injuries.* Springer, Berlin, Heidelberg; 2015:2451-2459.

- The possibility of returning to sporting activity is an important consideration in the decision-making process for femorotibial OA in young patients. Selecting between HTO, total knee arthroplasty, and unicompartmental knee arthroplasty depends on several factors, including the patient's way of life.
- This study investigates the potential advantage of an osteotomy in patients' return-to-sport rates.
- The return-to-sport rate of 139 patients after HTO was evaluated; 71% of patients participated in light sports, such as biking, swimming, or golfing; 80% participated in intermediate sports, such as hiking; and 28% participated in strenuous sports, such as running, tennis, or skiing.

Takeaway

Results showed that resuming sports activity after osteotomy can be satisfying in young and motivated subjects. Given the excellent survival rates of HTO and the potential risks of wear, loosening, or periprosthetic fractures related to sports activity with the use of a prosthesis, HTO in patients (when suitable indication criteria are present) is preferred.

Keyt LK,
Hevesi M,
Levy BA,
Krych AJ,
Camp CL,
Stuart MJ

iBalance® HTO Implant

[High tibial osteotomy with a modern polyetheretherketone \(PEEK\) system: mid-term results at a mean of 6 years follow-up.](#) *J Knee Surg.* 2022;35(8):916-921. doi:10.1055/s-0040-1721090

- PEEK Implants are relatively new to HTO procedures. This study evaluated patient satisfaction and the improvement of patient knee scores (VAS, KOOS, SF-36) and compared PEEK implants to traditional metal plate and screw systems.
- This prospective study evaluated HTO procedures performed between 2010 and 2016 with a minimum 2-year follow-up.
- Patients who received a PEEK implant experienced a substantial decrease in their postoperative VAS scores, a comparable complication rate to metal implants of 13%, and similar rates of UKA/TKA conversion. PEEK-based implants were found to have low hardware removal rates of 6% at 5 years, which compare favorably to historic metal fixation.

Takeaway

At midterm follow-up, medial opening-wedge HTO using a modern PEEK-based system was found to be safe, efficacious, and durable with satisfactory patient-reported outcomes scores and a low rate of conversion to arthroplasty.

Hevesi M,
Macalena JA,
Wu IT,
Camp CL,
Levy BA,
Arendt EA,
Stuart MJ,
Krych AJ

[High tibial osteotomy with modern PEEK implants is safe and leads to lower hardware removal rates when compared to conventional metal fixation: a multi-center comparison study.](#) *Knee Surg Sports Traumatol Arthrosc.* 2019;27(4):1280-1290. doi:10.1007/s00167-018-5329-0

- The purpose of this study was to compare metal and PEEK implants and determine safety, varus deformity correction, short-term to midterm hardware removal, and arthroplasty rates.
- A prospective study included patients who underwent HTO between 2000 and 2015 with a minimum 2-year follow-up. Postoperative complications, radiographic measures, and osteotomy union were compared between metal and PEEK implants.
- PEEK implants improved coronal deformity, had lower rates of hardware removal compared to metal implants, and were superior in terms of implant tolerance and retention with hardware removal rates more than sixfold lower than the metal cohort.

Takeaway

Modern PEEK implants are both safe and efficacious with decreased rates of implant removal as compared to conventional metal plate and screw implants.



Thompson KA,
Darden CN,
Katsman A,
Alaia MJ,
Strauss EJ,
Jazrawi LM

[Short-term clinical outcomes of high tibial osteotomy with the iBalance HTO system.](#)

Bull Hosp Jt Dis (2013). 2019;77(4):256-262

- This study evaluated short-term outcomes in patients who underwent an open-wedge HTO with the iBalance® HTO system. The PEEK iBalance HTO system is designed to make the osteotomy safer and more reproducible and to reduce metal–hardware-related complications.
- The study followed patients who received an HTO using the iBalance system with a minimum 2-year follow-up. Patients' KOOS and VAS scores were recorded before and after surgery.
- The study found vast improvement and a low occurrence of adverse effects with the iBalance HTO implant system. Patients who received the iBalance implant had a quicker return to walking, improved KOOS scores, and decreased hardware-removal rates compared to traditional methods.

Takeaway

This study suggests that the iBalance medial opening wedge HTO system implant can be used with comparable outcomes to traditional methods and has been shown to be safe, removing many of the complications existing with other osteotomy implant options.

Roberson TA,
Momaya AM,
Adams K,
Long CD,
Tokish JM,
Wyland DJ

[High tibial osteotomy performed with all-PEEK implants demonstrates similar outcomes but less hardware removal at minimum 2-year follow-up compared with metal plates.](#)

Orthop J Sports Med. 2018;6(3):2325967117749584. doi:10.1177/2325967117749584

- Study aimed to compare patient outcomes and complication rates of HTO using PEEK iBalance implants versus traditional metal plates.
- This level 3 cohort study followed 41 patients who received an HTO from a single surgeon with a minimum 2-year follow-up over a 4-year period.
- No significant difference was found for any patient-reported outcomes between the PEEK implant and metal plates. However, the PEEK implant group did not have any hardware removal compared to 4 patients in the metal group.

Takeaway

This study suggests that an all-PEEK implant may be safely used with comparable outcomes and complication rates to the traditional method but with less need for hardware removal.

Ghinelli D,
Parma A,
Baldassarri M,
Olivieri A,
Mosca M,
Pagliazzi G,
Buda R

[High tibial osteotomy for the treatment of medial osteoarthritis of the knee with new iBalance system: 2 years of follow-up.](#)

Eur J Orthop Surg Traumatol. 2016;26(5):523-535. doi:10.1007/s00590-016-1768-9

- The purpose of this study was to determine short-term outcomes of the iBalance implant for patients with varus malalignment and medial compartment OA.
- 15 patients with symptomatic varus knee were treated with an iBalance HTO. IKDC, KOOS, and VAS scores were recorded before and after surgery.
- The iBalance implant caused no severe intraoperative complications or failures. All patients showed complete articular recovery, no loss of correction, no substantial variation in A/P slope, and no hardware problems.

Takeaway

The iBalance system proved to be effective and safe and produced good overall results. Consolidation and osseointegration of the system took place rapidly and recovery was precocious, was comparable with traditional methods, and had no severe complications.



Van Genechten W,
Van den Bempt M,
Van Tilborg W,
Bartholomeeusen S,
Van Den Bogaert G,
Claes T,
Claes S

Biologic Augmentation

Structural allograft impaction enables fast rehabilitation in opening-wedge high tibial osteotomy: a consecutive case series with one year follow-up. *Knee Surg Sports Traumatol Arthrosc.* 2020;28(12):3747-3757. doi:10.1007/s00167-019-05765-z

- A slow and painful recovery is a major disadvantage of HTO as compared to TKA. This study evaluated the effect of press-fit structural impacted bone allograft on early ambulation, postoperative pain levels, and resumption of daily activities.
- A prospective study was conducted with patients who received an opening wedge HTO with 1-year follow-up. Clinical assessment included NRS, KOOS, and Lysholm scores.
- The most notable findings of this study were significantly reduced pain levels 4 weeks after surgery, early resumption of daily life activities (eg, walking, stairs, housekeeping), and short-term clinical improvement (0-6 months) after opening-wedge HTO with structural allograft bone.

Takeaway

Bone allograft with HTO surgery leads to low postoperative pain levels, accelerated recovery, and excellent short-term clinical outcomes.

Scordino LE,
Obopilwe E,
Charette R,
Edgar CM,
DeBerardino TM,
Mazzocca AD

Calcium phosphate cement enhances the torsional strength and stiffness of high tibial osteotomies. *Knee Surg Sports Traumatol Arthrosc.* 2017;25(3):817-822. doi:10.1007/s00167-015-3692-7

- The purpose of this paper was to investigate the effect of injectable calcium phosphate cement on the biomechanical stability of standard HTO defects with applied torsional load and ultimate stiffness of the supporting construct.
- Cadaver specimens were treated with a 10° opening wedge osteotomy and received an iBalance® implant. Quickset™ calcium phosphate injectable cement was used and then the constructs were tested for stiffness, torsional loads to failure, and mechanisms of failure.
- The addition of Quickset cement to an HTO significantly increased load to failure in torsion. Torque to failure and construction stiffness were both significantly greater in samples that included biologic augmentation.

Takeaway

Injectable calcium phosphate cement improves the initial maximal torsional strength and stiffness of HTO constructs.