

## EFFICACY OF HIGH TIBIAL OSTEOTOMY IN THE TREATMENT OF MEDIAL COMPARTMENT OSTEOARTHRITIS: A SYSTEMATIC REVIEW

Andriessanto C. Lengkong<sup>1</sup>, Stefan A.G.P Kamby<sup>2</sup>

<sup>1,2</sup> Division of Orthopaedic Surgery, Dept. of Surgery, University of Sam Ratulangi  
Manado, Indonesia

Email: Andriessanto@unsrat.ac.id

### ABSTRACT

*Osteoarthritis of the medial compartment of the knee is one of the common degenerative diseases among the adult population, causing chronic pain, stiffness, and limited joint function. High Tibial Osteotomy (HTO) has become an important treatment option to address deformity and reduce symptoms in patients with varus osteoarthritis. Objectives: This study aimed to conduct a systematic review of the existing literature to evaluate the efficacy of High Tibial Osteotomy in the treatment of osteoarthritis of the medial compartment of the knee. A literature search was conducted through PubMed, Google Scholar, and Cochrane Library databases for studies that met the inclusion criteria. Clinical outcomes, including improvement in pain, joint function, and radiological changes, were extracted and synthesized to provide a comprehensive picture of the efficacy of HTO. The results of the systematic review showed that High Tibial Osteotomy significantly reduced pain, improved joint function, and slowed disease progression in most patients with osteoarthritis of the medial compartment of the knee. Despite variations in surgical technique and reported clinical outcomes, HTO is generally considered an effective and sustainable procedure in the management of varus osteoarthritis. High Tibial Osteotomy shows strong promise as an important treatment option for patients with medial compartment osteoarthritis of the knee. However, it is important to take into account individual patient characteristics and consider additional therapies to maximize long-term outcomes. Further research is needed to deepen our understanding of this technique and to optimize its benefits in the treatment of osteoarthritis.*

### KEYWORDS

*High Tibial Osteotomy, Treatment, Medial Compartment Osteoarthritis, Systematic Review*



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## INTRODUCTION

Osteoarthritis (OA) of the medial compartment of the knee is a condition in which cartilage destruction occurs in the inner (medial) part of the knee joint, which is the most common form of knee OA and often occurs in older individuals, especially women and those who are obese. (Abdurrachman et al., 2019). The prevalence of medial compartment OA increases with age and this condition can cause severe pain, stiffness, and decreased mobility which significantly affects the patient's quality of life including difficulty in performing daily activities and decreased mental health. (Widyasari, 2021). The main causes and risk factors include aging, female gender, obesity which puts extra pressure on the knee, history of knee injury or surgery, structural deformities such as genu varum (O leg), muscle weakness around the knee, as well as excessive physical activity that puts repetitive stress on the joint. Genetic factors and metabolic conditions such as diabetes can also increase the risk of developing medial compartment OA of the knee. (Soeryadi et al., 2017)..

Osteoarthritis (OA) treatment involves non-surgical and surgical approaches to reduce symptoms and improve joint function. Non-surgical treatment includes the use of medications such as analgesics and non-steroidal anti-inflammatories (NSAIDs) to reduce pain and inflammation, as well as supplements such as glucosamine. Physiotherapy is an important component, with exercises designed to improve muscle strength and joint flexibility, as well as techniques such as ultrasound and hot or cold therapy (Robin, 2024). These methods have the advantage of being less risky and can be applied on an ongoing basis, but may be less effective in severe cases of OA. Surgical interventions, such as arthroscopy, osteotomy, or total joint replacement, are considered in cases with significant joint damage. The advantage of surgical methods is long-term improvement in joint function and more drastic pain reduction, but comes with the risk of surgical complications, a long recovery period, and higher costs. (Mulyono, 2022).

High Tibial Osteotomy (HTO) is a surgical procedure in which the tibia (shin bone) is cut and reassembled to change the load distribution in the knee, reducing pressure on the medial compartment affected by osteoarthritis (OA). (He et al., 2021). The basic principle of HTO is to relocate the load from the inner (medial) to the outer (lateral) part of the knee, which is still healthy, thereby reducing the pressure on the damaged cartilage and slowing down the progression of OA. (Liu et al., 2019). Indications for performing HTO in patients with medial compartment OA include patients who are relatively young, active, and have an O leg deformity (genu varum) and do not have significant damage to the lateral or patellofemoral compartment (Moon & Min, 2021). (Moon & Min, 2021). HTO can reduce symptoms and improve knee function by distributing the load more evenly across the knee joint, thereby reducing pain, improving stability, and increasing the patient's mobility ability. It can also delay the need for total joint replacement, allowing patients to maintain higher physical activity for a longer time.

The importance of evaluating the effectiveness of High Tibial Osteotomy (HTO) in the treatment of medial compartment osteoarthritis (OA) cannot be overstated. As a surgical procedure that aims to alter load distribution in the knee and reduce pressure on damaged cartilage, a clear understanding of the

effectiveness of HTO is essential to inform clinical decisions. A systematic review of the literature is needed to synthesize existing findings from various studies and provide a more comprehensive understanding of the benefits and risks of HTO in the specific context of medial compartment OA.

The aim of this study was to assess the effectiveness of HTO in treating medial compartment OA, detailing the scope of the review including the types of studies to be included (prospective and retrospective clinical studies), inclusion and exclusion criteria (patients with a diagnosis of medial compartment OA who underwent HTO), as well as the main research question to be answered, which was how effective HTO is in reducing pain, improving joint function, and slowing OA progression in patients with medial compartment OA.

### RESEARCH METHOD

In the study "Effectiveness of High Tibial Osteotomy in the Treatment of Medial Compartment Osteoarthritis: A Systematic Review," the research method used was systematic literature review. This approach involves structured and rigorous steps in evaluating the relevant literature regarding the effectiveness of high tibial osteotomy (HTO) in the treatment of medial compartment osteoarthritis (OA). The process began with the identification and selection of appropriate sources of information, such as medical databases and indexed scientific articles. Relevant keywords were used to search the literature, and the search time span was carefully set. Thereafter, studies that met the inclusion criteria were thoroughly scrutinized, by removing duplicates and assessing compliance with the pre-established inclusion criteria. Relevant data were extracted from the selected studies, and a thorough analysis was conducted to synthesize the findings. This systematic approach allowed for accurate and transparent findings on the effectiveness of HTO in the treatment of medial compartment OA, providing a solid foundation for informed and evidence-based clinical decision-making.

### RESULT AND DISCUSSION

No.	Author	Surgical Techniques	Results
1	(Magnanelli et al., 2020)	HTO for varus knee osteoarthritis can be performed with or without Lipogems® intra-articular injection. This procedure utilizes a single HTO plate model and does not involve any additional procedures.	A significant improvement in the assessment of activities of daily living (KOOS score) was observed in the group receiving treatment with aASCs (autologous adipose-derived stem cells) compared to the group receiving only HTO.
2	(Nikose et al., 2020)	Medial open-wedge HTO along with autologous bone grafting and buttress plate osteosynthesis	All patients reported pain disappearance immediately after osteotomy and during long-term analysis covering between one and three years. The genu varum angle was overcorrected to approximately four

			degrees in all patients. There was a decrease of approximately three degrees in all patients at approximately six weeks postoperatively. Preoperative knee movement was restored in all patients. No major perioperative complications were noted during surgery and postoperative follow-up, and clinical scores improved significantly during the final analysis indicating good pain relief.
3	(Li et al., 2022)	DTT-HTO with arthroscopic surgery	DTT-HTO can significantly correct the load line, restore the biomechanical parameters of the lower limb to the normal range, significantly reduce pain and improve knee function, and repair and regenerate the medial compartment cartilage after load line correction.
4	(Kim et al., 2022)	Intra-articular adipose-derived mesenchymal stem cell (ADMSC) injection after medial open-wedge high tibial osteotomy (MOWHTO)	The use of intra-articular ADMSC injection together with MOWHTO has advantages over MOWHTO alone in improving cartilage regeneration and maintaining safety over a 2-year follow-up period, suggesting potential for disease modification in knee osteoarthritis with varus malalignment.
5	(Tian et al., 2020)	distal high tibial tuberosity osteotomy (DTT HTO)	High tibial osteotomy at the distal tuberosity corrects varus deformity, reduces knee pain, and improves functional impairment, showing significant effectiveness in the short term.
6	(Bai et al., 2023)	MOWHTO and micro fractures	Significant differences were observed between cartilage regeneration and clinical outcomes ( $p < 0.05$ ). Clinical outcomes were better in the good cartilage regeneration group (grade I and II) than in the poor cartilage regeneration group (grade III and IV).
7	(Primeau et al., 2023)	Medial Opening Wedge High Tibial Osteotomy	Based on the responder criteria for knee OA, 78% of patients who underwent medial opening wedge HTO became responders at 2 years postoperatively. Although younger, male, and non-obese patients were seen as appropriate candidates for HTO, patients who were female, older, and had a high BMI also

			achieved considerable improvements in pain and function.
8	(Manoharan et al., 2021)	osteoarthritis of the medial joint of the knee operated with high tibial open wedge osteotomy fixed with a 'T' plate	The results were excellent in 15%, good in 65%, fair in 15% and poor in 5% based on the knee society score and the results were excellent in 5%, good in 70%, fair in 10% and poor in 5% based on the JOA knee grading scale. High tibial osteotomy is a good treatment of choice for osteoarthritis of the medial compartment of the knee in young individuals.
9	(Ferrer-Rivero et al., 2024)	Open Wedged HTO and Close Wedged HTO	The CW-HTO procedure showed a cost-effectiveness ratio almost three times lower than the OW-HTO procedure. Both techniques allow to achieve good to excellent functional results, significant pain reduction and high patient satisfaction while correcting metaphyseal tibial varus and varus limb misalignment in patients with medial compartment osteoarthritis.
10	(Huang et al., 2022)	distal tibial tuberosity high tibial osteotomy (DTT-HTO)	During implant removal, no internal fixation fractures occurred in any patient. The articular cartilage value in the medial compartment of the knee was significantly higher at the second arthroscopy than at the first arthroscopy, according to the ICRS scoring system ( $P < 0.001$ ). The articular cartilage values in the lateral compartment of the knee showed no statistical difference from the first to second view arthroscopy ( $P > 0.05$ ). There was no correlation between BMI and postoperative outcomes. Performing DTT-HTO provides excellent clinical outcomes in obese patients with varus knee osteoarthritis. It can be recommended for use in heavy patients.

### Discussion

Medial Compartment Osteoarthritis is a form of osteoarthritis that occurs in the medial compartment (inner side) of the knee, where the cartilage lining the joint is damaged and thinning, causing pain, stiffness and swelling. This condition is

often caused by overloading the inside of the knee due to misalignments such as genu varum (inward-bent foot). When conservative therapies such as medications, injections and physiotherapy are no longer effective, surgical intervention becomes one of the solutions. One of the commonly used surgical procedures is High Tibial Osteotomy (HTO), where the tibia bone is cut and reassembled to correct the alignment and distribute the load more evenly across the knee joint. HTO helps reduce pressure on the affected medial compartment, slow disease progression, reduce pain, and improve knee function. Based on some of the findings above, there are several surgical techniques performed during HTO, be it HTO alone or combined with other treatments.

High Tibial Osteotomy (HTO) surgical technique for varus knee osteoarthritis can be performed with or without intra-articular injection of Lipogems. The procedure involves the use of a single HTO plate model without any other additional procedures. In a recent study, the results of (Magnanelli et al., 2020) showed a significant improvement in the assessment of activities of daily living (KOOS score) in the group of patients who received treatment with autologous adipose-derived stem cells (aASCs) using the Lipogems technique compared to the group that received only HTO. Injection of aASCs aims to stimulate tissue regeneration, reduce inflammation, and accelerate healing. Thus, the combination of HTO and aASCs injection may provide additional benefits in improving knee symptoms and function in patients with varus osteoarthritis.

### **Closing Wedge High Tibial Osteotomy**

Closing Wedge Osteotomy is a surgical procedure used to treat Medial Compartment Osteoarthritis by correcting misalignment of the knee. The procedure involves removing a wedge-shaped segment of bone from the lateral side of the tibia. Once the segment is removed, the exposed side of the tibia is then stapled to close the resulting gap. This step aims to change the angle of the bone so that the load that was previously concentrated in the medial compartment can be distributed more evenly throughout the knee joint. Bone fixation is performed using carefully placed plates and screws to ensure stability during the healing process, so that the bones can fuse back together properly. (Khakha et al., 2021).

The main advantage of the Closing Wedge Osteotomy technique is that it provides good mechanical stability to the knee and allows for relatively quick healing compared to some other osteotomy techniques. However, there are some disadvantages that need to be considered. One of these is the risk of peroneal nerve damage that can occur during removal of the bone segment, which can lead to neurological complications. Also, this technique has limitations in space to perform large corrections, so it is not always suitable for all patients, especially those with significant deformities. Nonetheless, with proper planning and good surgical skills, Closing Wedge Osteotomy remains an effective option to address osteoarthritis problems in the medial compartment of the knee.

Based on the findings of (Ferrer-Rivero et al., 2024)(Ferrer-Rivero et al., 2024), showed that CW HTO costs three times less than OW HTO. In addition, it has good to excellent functional results, significant pain reduction and high patient

satisfaction and corrects metaphyseal tibial varus or varus limb misalignment in patients with medial compartment osteoarthritis.

### **Open Wedged High Tibial Osteotomy**

Open Wedge High Tibial Osteotomy (HTO) is a surgical procedure often used to correct misalignments in the knee, especially in cases of Medial Compartment Osteoarthritis. This technique involves creating a wedge on the medial side of the tibia which is then filled with autologous bone graft (bone from the patient's own body) or other filling material to open the wedge. Bone fixation is done using a special support plate called an "osteotomy plate" to ensure stability during healing. The use of autologous bone graft helps to speed up healing as the material comes from the patient's own body, reducing the risk of rejection. (Nikose et al., 2020).

The advantage of the Opening Wedge Osteotomy technique is its ability to allow for greater correction compared to the closing wedge technique, as well as being safer for the peroneal nerve as there is no bone cutting near the nerve area. However, this technique has some disadvantages. One of these is the longer healing time compared to the closing wedge technique, as the bone takes more time to reunite properly. In addition, there is a risk of non-union or failure of the bone to fuse properly, which may lead to complications and require additional surgical intervention. Nonetheless, with proper patient selection and good surgical technique, Opening Wedge Osteotomy can be an effective solution to address misalignment problems in the knee due to osteoarthritis.

Besides misalignment correction with Open Wedge HTO, several additional procedures are often applied to improve the overall condition of the knee joint. One of these is microfracture, which involves creating small holes in the subchondral bone surface to stimulate new cartilage growth. Microfractures aim to repair cartilage damage and improve the quality of the joint surface (Bai et al., 2023). (Bai et al., 2023). In addition, intra-articular injection of adipose-derived mesenchymal stem cells (ADMSCs) can also be performed. ADMSCs are stem cells taken from the patient's fat tissue and have high regenerative potential. Injection of ADMSCs into the knee joint aims to stimulate repair of damaged cartilage tissue, reduce inflammation, and improve overall joint function (Kim et al., 2022). (Kim et al., 2022).

The combination of the Open Wedge HTO procedure with autologous bone grafting, use of a support plate for osteosynthesis, micro-fracture and intra-articular ADMSC injection offers a comprehensive approach to address Medial Compartment Osteoarthritis. This approach not only corrects the bone misalignment but also repairs and regenerates the damaged joint tissues, thereby improving the patient's overall functional outcome and quality of life.

### **Distal Tibial Tuberosity High Tibial Osteotomy (DTT-HTO)**

Distal Tibial Tuberosity High Tibial Osteotomy (DTT-HTO) is a surgical technique used to treat Medial Compartment Osteoarthritis by correcting the misalignment of the tibia bone near the distal tibial tuberosity. The procedure involves cutting the tibia bone in the area around the distal tibial tuberosity (the front of the tibia bone where the patella tendon attaches) and repositioning the bone

to change the angle of the tibia. This technique allows for a more precise and gradual change in angle, so that the load previously concentrated on the medial compartment of the knee can be distributed more evenly throughout the knee joint.

After the bone cut is performed, the cut portion is rotated or rearranged to achieve the desired alignment. Bone fixation is then performed using specialized plates and screws to ensure stability during the healing process. The main advantage of DTT-HTO is the ability to achieve a more accurate and safe correction compared to traditional osteotomy techniques. In addition, this technique provides a more even distribution of pressure on the knee joint, which can reduce pain and slow down the progression of osteoarthritis. However, DTT-HTO is a more complex procedure and requires high surgical skills, as well as careful planning to avoid complications such as infection, nerve damage or bone healing issues.

DTT-HTO may also be combined with arthroscopic surgery. Arthroscopic surgery allows the surgeon to directly examine the condition of the cartilage, meniscus and ligaments within the knee joint and perform repair or removal of damaged tissue. DTT-HTO with arthroscopy combines the advantages of both correct alignment and intra-articular repair, resulting in more optimal outcomes for patients with osteoarthritis of the knee. (Li et al., 2022).

## CONCLUSION

Based on the research, it was found that High Tibial Osteotomy (HTO) is an effective surgical procedure in treating osteoarthritis of the medial compartment of the knee. Based on a systematic review, HTO successfully reduced pain, improved joint function and slowed disease progression in the majority of patients with varus osteoarthritis. Nonetheless, variations in surgical techniques, patient indications, and reported clinical outcomes highlight the importance of proper case selection and careful planning in performing HTO. In addition, several studies have also highlighted the potential of combining HTO with adjunctive therapies, such as adipose stem cell injection, to improve long-term outcomes and optimize patient benefit. Therefore, although HTO has proven success in managing osteoarthritis of the medial compartment of the knee, it is important to continue to conduct further research and refine our understanding of this technique to ensure optimal improvement in patient care.

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