Research Article

Results of Dome-shaped Proximal Tibial Osteotomy in Varus and Axial Malalignment of Tibia

Hamidreza Yazdi, MD
Dorsa Bahrami Zanjanbar, MD
Mehrzad Solooki, MD

ABSTRACT

Background: Anterior knee pain, with varus deformity and excessive external tibial torsion, can markedly impair function and quality of life. Although various surgical techniques address these deformities, dome-shaped osteotomy offers a promising approach for correcting malalignment while preserving joint integrity. This study evaluated clinical and radiological outcomes of dome-shaped osteotomy in patients with these combined deformities.

Methods: Twenty-eight knees from 21 patients with anterior knee pain, varus deformity (more than 5°), and excessive external tibial torsion (more than 30°) but acceptable hip anteversion (anteversion 30°) underwent dome-shaped tibial osteotomy proximal to the tibial tubercle. The group comprised nine male (32.1%) and 19 female patients (67.9%) with an average age of 28.5 years (17 to 45 years) and a mean body mass index of 19.9 kg/m^2. Sixteen surgeries were done on right knees and the rest on left knees. Five female and two male patients were operated on bilaterally. Surgical steps included internal tibial rotation to correct axial deformity, medial translation as needed, valgus correction for optimal coronal alignment, and stabilization with a medial locking plate. Postoperative protocols included early mobilization with range-of-motion exercises. Outcomes were assessed using Western Ontario and McMaster Universities Osteoarthritis Index score (WOMAC scores) and The Knee injury and Osteoarthritis Outcome Score and radiographic evaluations of varus correction and patellar position.

Results: Postoperative Q-angle and thigh-foot angles normalized. WOMAC and pain scores markedly improved, with most patients reporting complete or high satisfaction (P value <0.001). Complications were minimal, including transient peroneal nerve paresis in two knees and a small peroneal arterial aneurysm in one knee, which was managed conservatively. No infections, compartment syndrome, patella baja, or delayed/nonunion were observed.

From the Departement of Knee Surgery, Firoozgar Hospital, Iran University of Medical Sciences (Yazdi), the Pharmaceutical Science Research Center, Tehran Medical Sciences, Islamic Azad University (Bahrami Zanjanbar), the GI Pharmacology Interest Group (GPIG), Universal Scientific Education and Research Network (USERN) (Bahrami Zanjanbar), and the Bone and Joint Reconstruction Research Center, Department of Orthopedics, School of Medicine, Iran University of Medical Sciences, Tehran, Iran (Solooki).

Correspondence to Dr. Solooki: m72_solooki@yahoo.com

None of the following authors or any immediate family member has received anything of value from or has stock or stock options held in a commercial company or institution related directly or indirectly to the subject of this article: Yazdi, Bahrami Zanjanbar, and Solooki.

This study was reviewed and approved by the Ethics Committee of Iran University of Medical Sciences (Approval Code: IR.IUMS.FMD.REC.1401.509).

Written informed consent was obtained from all participants before their inclusion in the study. Personal patient information was anonymized at the initial stage, and throughout the study, each patient was identified using a unique code.

Availability of data and material: All data generated or analyzed during this study are included in this published article

Yazdi, Bahrami Zanjanbar, and Solooki contribute in all sections.

J Am Acad Orthop Surg 2025;00:1-10

DOI: 10.5435/JAAOS-D-25-00667

Conclusion: Dome-shaped osteotomy above the tibial tubercle is an effective surgical option for improving pain, function, and satisfaction in patients with anterior knee pain, varus deformity, and excessive external tibial torsion.

Level of Evidence: Level IV.

Proximal tibial osteotomy is a frequently performed surgical procedure aimed at correcting painful knee malalignment, yielding favorable long-term outcomes.[1]Knee osteotomy is grounded in the principle of realigning the mechanical axis to decrease contact stress on the affected compartment. This strategy is meant to prolong joint life and delays the need for replacement.[2]It aims to improve the pain and knee functions.[3]Proximal tibial osteotomy techniques include closed-wedge, open-wedge, and dome-shaped approaches.[4] Rotational deformities of the tibia represent a notable, yet often overlooked, contributor to knee pathology. Excessive tibial rotation increases the load on the patellofemoral joint, hastening cartilage degradation and impairing patellar tracking because of abnormal tibial tuberosity alignment.[5,6]Although numerous studies have reported successful outcomes for varus deformity correction, limited focus has been given to concurrent tibial rotational deformities. Standard varus correction procedures, including open wedge and closing wedge osteotomy, effectively restore coronal alignment but typically do not address tibial axial rotation.[7-9] It has been shown in one study that half of the cases of knee varus are accompanied by rotation in the axis of the limb that may cause some functional problems including the patellofemoral joint.[10]

To improve the appearance of the limb and proper limb and patellofemoral function after deformity correction, a method for correction in the both coronal and axial planes is needed at the same time, which is possible with the dome-shaped osteotomy method.[4,11]

Dome-shaped osteotomy, performed proximal to the tibial tubercle, involves fibular osteotomy and is able to correct torsional deformity through rotation of the dome osteotomy.[12]This technique effectively addresses both varus and axial rotational deformities in patients with moderate to severe tibial malalignment. Unlike other methods, it maintains tibial length, preserves bone-to-bone contact for faster healing, and usually does not require bone grafting.[11,13]

This study was aimed to assess the clinical and radiologic outcomes of dome-shaped osteotomy in patients with varus knee deformity and excessive tibial external rotation who had anterior knee pain not responded to conservative treatments.

Methods

Study Design and Participants

In this study, a total of 28 knees from 21 patients aged 17 to 46 years (mean age of 28.5 years) were enrolled. The group comprised nine male (32.1%) and 19 female patients (67.9%) with an average body mass index (BMI) of 19.9 kg/m^2. All surgeries were performed at an academic center and a private hospital, from April 1, 2017, to August 31, 2023. All patients provided informed consent to use their deidentified data and images. Inclusion criteria required patients who had anterior knee pain caused by patellar maltracking that was not improved by conservative treatments, and knee varus deformity (more than 5°) confirmed by alignment view radiographs (Figure 1), excessive tibial external rotation (more than 30°),[14] confirmed by rotational CT scan, and acceptable hip anteversion (less than 30°, confirm by physical examination and rotational CT scan; Figure 2). All measurements were conducted independently by a knee fellowship-trained surgeon and an orthopaedic resident, achieving an ICC reliability of >0.9, and the average values from the measurements were reported. Exclusion criteria included notable clinical or radiological osteoarthritis (Kellgren-Lawrence > 3), femoral anteversion more than 30°,[15,16] inflammatory arthropathies, incomplete preoperative radiographs, history of knee surgery, or revision surgery. To evaluate tibial tubercle position, the tibial tubercle-trochlear groove (TT-TG) distance was measured preoperatively using lower limb rotational CT scans.

Surgical Procedure

All surgeries were done by a knee fellowship-trained surgeon (H.R.Y.). The surgical procedure began with a tourniquet applied around the patient's thigh. A 4-cm lateral incision was made at the junction of the middle and distal thirds of the fibula, allowing access to perform fibular osteotomy (fibulotomy). A second 7-cm incision was then made on the anteromedial aspect of the proximal leg, enabling the release of the subcutaneous tissue medial and lateral of the tibial tubercle. A flat dome-shaped osteotomy was initiated in the proximal tibia using a drill to create evenly spaced holes (5 mm apart) proximal to the tubercle, which were then

Figure 1

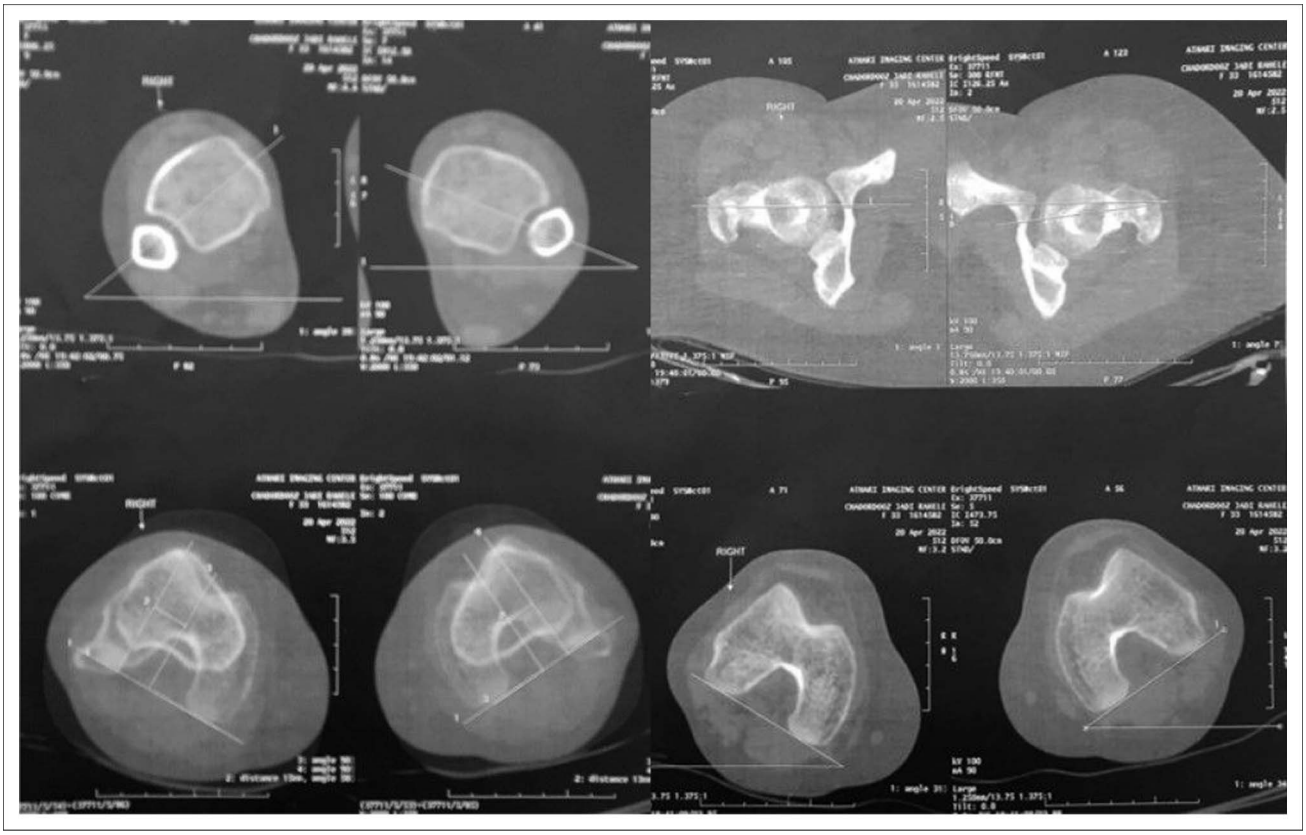
Photographs illustrating preoperative assessment. **A**, Preoperative photograph of the patient. **B**, Preoperative alignment view of the lower limb.

connected with a thin osteotome. The osteotomy line was done horizontally from above the tubercle to the lateral tibial cortex and curved distally (approximately 5° to 10°) on the medial side. Corrective steps included internal rotation of the tibia to rectify axial deformity, followed by medial translation if needed and valgus correction of the segment of tibia bone below the osteotomy line to achieve optimum coronal alignment (Figure 3). Based on preoperative planning, the correction angle was measured before the operation. During surgery, one pin was placed proximal and another pin distal to the osteotomy line with an angel equal to the correction angle using a goniometer. By rotating the distal segment and making the pins parallel in one plane, the rotation correction is achieved. The correction angle was also confirmed during surgery based on clinical data. Clinically, a cautery wire was aligned from the center of femoral head (two finger widths medial to the anterior superior iliac spine) to the center of the talar dome, confirming correct coronal alignment. The osteotomy site was stabilized with a locking plate (Marquardt locking proximal tibia plate) on medial side. Based on the Rab study, which recommended prophylactic fasciotomy of the lateral compartment to prevent compartment syndrome, we also performed prophylactic fasciotomy of lateral compartment in all cases.[17] Finally, a drain was inserted and the incision was closed in layers (Figure 4). Postoperative care and rehabilitation was done based on a home physiotherapy program, including muscle exercises and knee range of motion. The patient was mobilized with two crutches without weight bearing up to four weeks post operation and then gradual weight bearing allowed with a brace based on bone healing. All patients were followed 2, 6, and 12 weeks, 6 months, and 1-year postsurgery.

Follow-up and Evaluation

AP and lateral radiographs of the operated knee were taken early postoperation and then at 2 and 6 weeks, and, if necessary, 12 weeks after surgery. Alignment views of lower limbs were obtained at 6 months. Radiographic assessments included measurements of the medial proximal tibial angle (MPTA) and mechanical femoral mechanical tibial angle (MFMTA), along with patellar height using the Caton-Deschamps index from lateral knee radiographs at 30° flexion (Figure 5). Radiographs were also reviewed for union status, patellar alignment, and coronal deviation correction. After surgery, because of ethical issues and to avoid excessive radiation exposures, CT scanning was not performed, and instead, all cases were evaluated clinically; evaluations included knee range of motion and thigh-foot angle and Q-angle measurements (Figures 6 and 7), conducted independently by a knee fellowship-trained surgeon and an orthopedic resident, achieving an ICC reliability

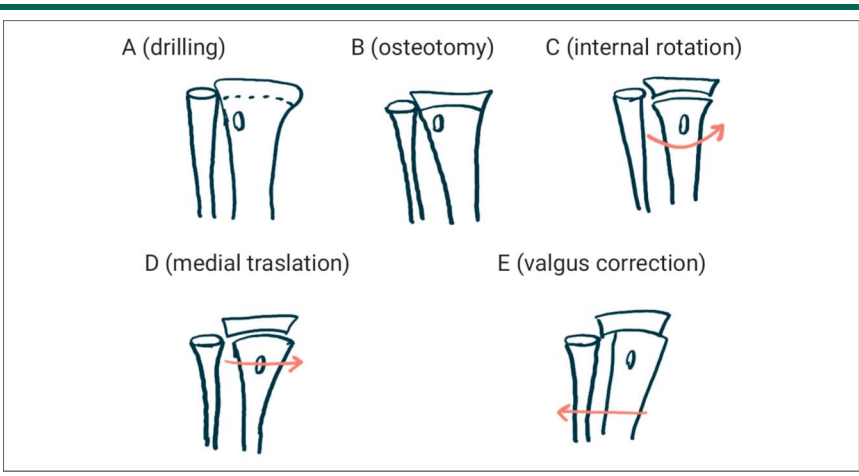
Figure 2



Rotational CT scan showing acceptable hip rotation and increased tibial tuberosity to trochlear groove distance.

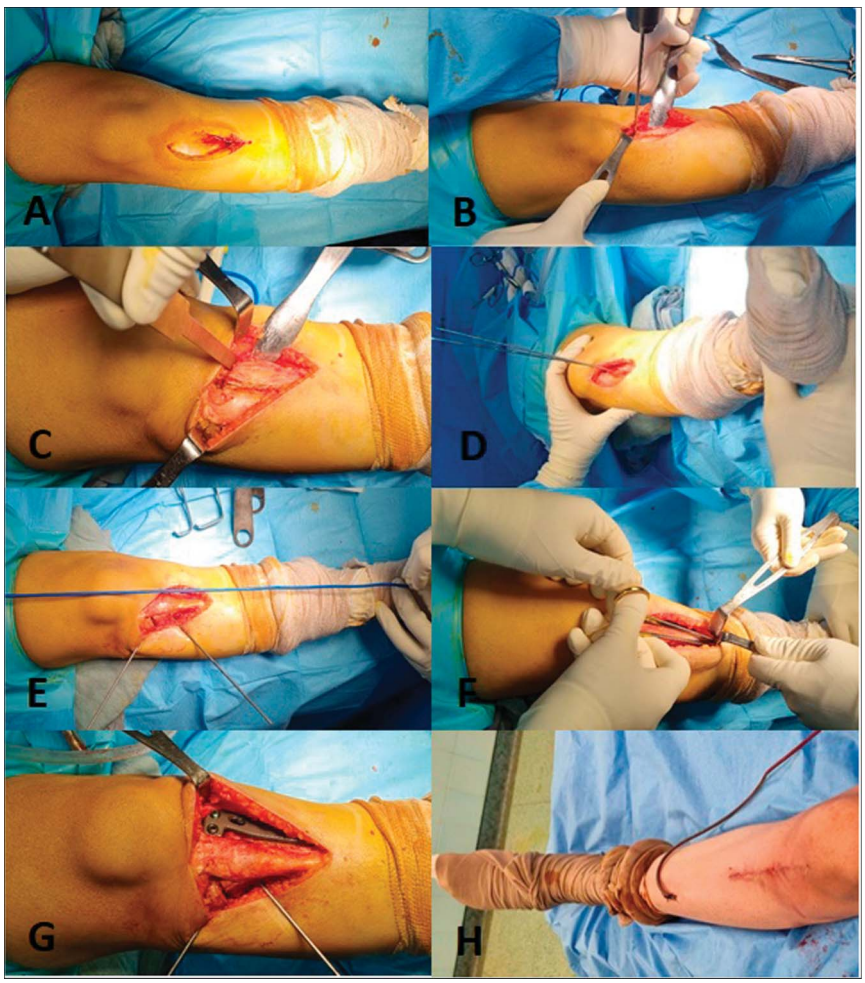
of >0.9, and the average values obtained from the measurements were reported. Patient-reported outcomes, including anterior knee pain and overall satisfaction, were evaluated using the Western Ontario and McMaster Universities Osteoarthritis Index score(-WOMAC) and The Knee injury and Osteoarthritis

Figure 3



Step-by-step schematic illustration showing the dome-shaped proximal tibial osteotomy and deformity correction. **A**, Drilling phase: Preparation of the osteotomy line on the proximal tibia. **B**, Osteotomy: Execution of the dome-shaped bone cut. **C**, Internal rotation: Correction of external tibial rotation by internally rotating the distal segment. **D**, Medial translation: Shifting of the distal tibial segment medially to correct axial alignment. **E**, Valgus correction: Final realignment to achieve a neutral or slight valgus mechanical axis.

Figure 4



Images demonstrating surgical procedures. **A**, Incision site. **B**, Drilling of the dome-shaped osteotomy site. **C**, Osteotomy performed using an osteotome. **D**, Correction of deformity, including rotation, medial translation, and valgus alignment (rotation correction is done with the use of two pins and their placement in a straight line). **E**, Alignment correction verification with a cautery wire. **F**, Prophylactic fasciotomy. **G**, Fixation with a plate. **H**, Early postoperative phase.

Outcome Score questionnaires, validated in Persian by the Orthopedic Research Center at Mashhad University of Medical Sciences.[18,19] The scores (scaled from 1 to 100) indicated patient functionality, with higher scores reflecting fewer problems. Postoperative complications, such as surgical site infection, neurovascular injuries, tibial osteotomy nonunion or delay-union, loss of correction, overcorrection, and compartment syndrome, were also monitored.

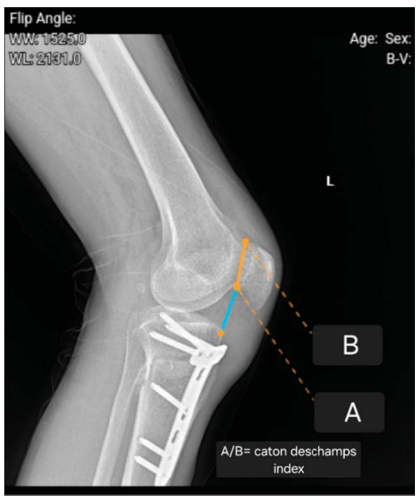
Ethical Approval and Informed Consent

This study was reviewed and approved by the Ethics Committee of Iran University of Medical Sciences (Approval Code: IR.IUMS.FMD.REC.1401.509). Written informed consent was obtained from all participants before their inclusion in the study. Personal patient information was anonymized at the initial stage, and throughout the study, each patient was identified using a unique code. No additional costs were imposed on the participants, and all radiographic expenses were covered by the researcher.

Results

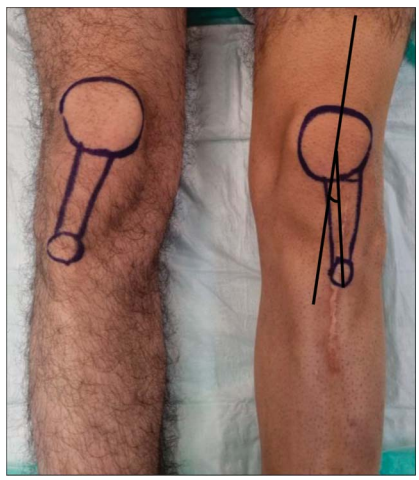
In this study, a total of 28 knees from 21 patients aged 17 to 46 years (mean of 28.5 years underwent surgery). The group comprised nine male (32.1%) and 19 female patients (67.9%), with an average BMI of 19.9 kg/m^2. Sixteen surgeries were on right knees and the rest on left side. Five female patients and two male patients were operated on bilaterally. The surgical procedures in bilateral cases were performed at least 3 months apart.

Figure 5



Knee profile radiograph demonstrating calculation of the Caton-Deschamps index.

Figure 7



Photograph illustrating measurement of the quadriceps angle (Q-angle) using a goniometer.

The average follow-up period for patients was 18.6 months (6 to 35 months).

The preoperative TT-TG distance averaged 21.8 mm (22.27 mm for female patients and 20.8 mm for male patients; normal range 10 to 15 mm),[9] indicating an increased external rotation of the tibia tubercle. Following surgery, the mean Q angle was in the normal range (female mean 13.52 to male mean 11.12),[20] The mean thigh-foot angle postsurgery was also in the normal range[21,22] (mean 18.46; Figure 8).

The postoperative Caton-Deschamps index averaged 0.90 with no cases of Patella baja or patella alta.[23] In addition, a significant correction of varus alignment was noted, with the mean MFMTA decreasing from 6.28° varus preoperatively to 0.14° valgus postoperatively (*P* value <0.001). The MPTA showed a significant change, increasing from 82.21° to 88.14° after surgery (*P* value <0.001).

Patient-reported outcomes indicated notable improvements. The average patellofemoral pain score decreased from 5.82 preoperatively to 1.5 postoperatively, highlighting a substantial reduction in pain. Twenty-two patients (78.6%) reported complete to high satisfaction, and no postoperative dissatisfaction was reported. All WOMAC scores improved markedly, except for the scores for symptoms and knee stiffness category which showed no notable change (Table 1).

Postoperative findings showed no surgical site infections, compartment syndrome, and delayed-union or nonunion at the tibial osteotomy site. The postoperative range of motion was normal in all patients. No major complications were observed following surgery, except 2 cases of transient peroneal nerve injury (7.1%). Including one sensory deficit and one motor paresis occurred in patients who required more than 25° of rotation correction. Both of these cases were recovered after 3 months. One patient (3.6%) developed a small peroneal arterial aneurysm at the fibula osteotomy site, which was managed conservatively.

Figure 6

Photograph illustrating measurement of the thigh-foot angle using a goniometer.

Discussion

The main finding of this study was that dome-shaped osteotomy can achieve good functional and clinical

Figure 8

Preoperative and postoperative photographs illustrating the outcomes of the procedure. Inward rotation of both patellas with varus of the knees in the preoperative photograph and correction of varus of the knees and patellar rotation after surgery using a dome-shaped osteotomy.

results along with simultaneous correction of varus and external rotation deformity of the tibia.

Lower extremity malalignment has been recognized as a notable risk factor for both acute and chronic injuries, including patellofemoral pain syndrome, ACL injuries, fractures, and plantar inflammation.[24,25]

The detection of a torsional deformity is not an indication for a rotational osteotomy. Primarily, patients must have notable physical symptoms despite targeted physical therapy and nonsurgical strategies. Commonly, patients have a number of anatomical predisposing factors, and it needs to be determined

Table 1. **Average WOMAC and Knee Injury and Osteoarthritis Outcome Score Scores Preoperation and Postoperation**

Questionnaire Section	Time		*P* Value
	Preoperation	Postoperation	
Total score	85.51	90.47	<0.001
Pain	82.4	91.84	<0.001
Symptoms and knee stiffness	92.2	93.4	0.313
Daily performance	91.6	97.02	<0.001
Sport (KOOS)	76.07	80.89	0.002
Quality of life	62.93	72.06	<0.001

Comparison of average scores for the total WOMAC questionnaire and its subgroups, along with KOOS sports score, before and after treatment. Notable improvements were observed in most sections, as indicated by *P* values.
KOOS = Knee Injury and Osteoarthritis Outcome Score, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index

whether the tibial torsion is the dominant cause of symptoms.[14]

Up to half of patients undergoing surgical correction for genu varum also have a rotational deformity.[10] If uncorrected, this rotation can continue to place abnormal forces on the knee, increasing the risk for patellofemoral pain, ligament injuries, meniscal tears, and cartilage damage.[26-28] Thus, addressing rotational alignment during knee varus correction surgery is essential. Despite extensive research on varus deformities,[9,29-31] few studies specifically focus on the associated rotational abnormalities.[32,33]

The dome-shaped osteotomy was first introduced by Blaimont and then popularized by Maquet.[30] Initially, a dome-shaped osteotomy was used to correct knee varus, but at that time, pin and cast fixation and external fixator fixation methods were used, which caused complications such as compartment syndrome and surgical site and pin tract infection and patella baja.[34] However, owing to the complications that occurred, attention was drawn to closed and opening wedge osteotomy. However, if correction in the both coronal and axial plane is needed at the same time, the flat dome-shaped osteotomy method is recommended.[4,11]

A dome-shaped osteotomy can be performed above or below the tibial tubercle. In our method, an osteotomy was done above the tibial tubercle; the reason is that the supra-tubercle osteotomy can correct the abnormal TT-TG distance by internal rotation and medial traslation of distal part and also reduces the valgus forces on the patella even during non–weight-bearing activities, such as jumping and the swing-through phases of walking and running. Conversely, infratubercle osteotomy functions only during weight-bearing activities.[35] By correcting the TT-TG angle simultaneously with tibial torsion, the surgeon partially corrects femoral torsion as the need for functional hip compensation is diminished.[35] Supratubercle osteotomy has the added advantage of compression from the extensor mechanism, through the large surface area of the proximal tibia, increasing stability and facilitating healing. Finally, there is the opportunity to simultaneously correct coronal malalignment of the knee if required.[35]

In this study, patients with knee varus accompanied by excessive external rotation of the tibia with normal or acceptable rotation of the femur were candidates for surgical correction of tibia. It has been seen in some studies that in patients who underwent proximal tibial osteotomy to correct rotational deformity of lower limb, the Lille patello-femural score and International Knee Society scores markedly improved and no notable differences were found in cases with femoral anteversion more than 20°, suggesting that the need for simultaneous correction of any associated femoral anteversion is not required in most patients. Of note is that only 58% of patients returned to sport at the same level postsurgery.[14] Our study also confirms these results.

Common reported complications include transient peroneal nerve injury or temporary weakness in the extensor hallucis longus, although positioning the fibular osteotomy within a safe zone (around 16 cm from the fibular head, as recommended by Kirgis and Albrecht) can help minimize these issues.[36,37] We had 2 cases of transient peroneal palsy, both needed more than 25° of tibial external rotation correction which recovered after 3 months.

We did rigid internal fixation with a locking plate which allowed early muscles exercises and mobilization after surgery. This approach minimized postoperative motion restrictions and encouraged early functional recovery. By contrast, casting or external fixation methods can lead to complications, such as patella baja risk.[29] Geiger et al[38] reported that external fixation in high tibial osteotomy is often associated with pin tract infections, temporary nerve palsy, and alignment loss. Our study showed no cases of patella baja and nonunion of tibial osteotomy or surgical site infections, probably highlighting advantages of rigid fixation over casting or external fixation methods. Dome-shaped osteotomy, which causes rotational rather than linear displacement, may help maintain patellar height by preserving the tibial tuberosity's distance from the joint line, reducing the likelihood of patella baja.[30] In addition, no cases of compartment syndrome were reported in our study. This may be attributed to prophylactic fasciotomy and no casting. Previous studies, such as those by Steel et al[39] and Rab et al,[40] suggested that fasciotomy markedly reduces the risk of compartment syndrome associated with tibial rotation procedures.

Most of patients (53.6%) were very satisfied with the surgical outcomes, 25% of patients were completely satisfied, and 21.4% of patients were moderately satisfied. We had no poorly satisfied or dissatisfied cases, which were assessed based on a WOMAC questionnaire and patient responses.

Both the postoperative Q angle and thigh-foot angle were within normal ranges, suggesting effective rotational correction following dome-shaped osteotomy.

In addition, none of our patients exhibited an in-toeing gait after surgery, indicating that additional internal rotation was not created.

Our findings demonstrated effective varus correction, with notable improvements in both the MFMTA and MPTA angles. Similar findings by Chiang et al,[30] Geith and Naggar,[41] and Porfeiz et al[42] further confirm that dome-shaped osteotomy can effectively correct varus deformities, reduce pain, and improve function.

In addition, we noted a low mean BMI among patients, supporting Fragomen et al[10]'s finding that lower BMI is a notable risk factor for varus-torsion deformities, particularly among young women. However, this issue needs more evaluation.

Limitations

This study has some limitations. Our sample size was relatively small, and further research with a larger cohort could yield more robust findings. In addition, we lacked a control group and did not compare dome-shaped osteotomy with alternative methods such as closed or open wedge techniques. Future studies could benefit from comparing different fixation methods and extending follow-up durations to assess long-term outcomes.

Conclusion

This study shows that in patients with anterior knee pain and knee varus deformity and excessive external tibial torsion with acceptable hip anteversion, a dome-shaped osteotomy above the tibial tubercle probably may decrease anterior knee pain and may improve patient functional scores and satisfaction. We did not have any cases of patellar baja or osteotomy nonunion, possibly because of rigid fixation with locking plate. However, further large-scale research is warranted to confirm these findings and establish best practices.

References

1. Billings A, Scott DF, Camargo MP, Hofmann AA: High tibial osteotomy with a calibrated osteotomy guide, rigid internal fixation, and early motion. Long-term follow-up. *J Bone Joint Surg Am* 2000;82:70-79.

2. Strecker W: Planning analysis of knee-adjacent deformities. I. Frontal plane deformities. *Oper Orthop Traumatol* 2006;18:259-272.

3. Ribeiro C, Severino N, Cury R, Opening wedge high tibial osteotomy 2012.

4. Takahashi T, Watanabe S, Hino M, Takeda H, Ito T: Excellent short-term results of dome-shaped high tibial osteotomy combined with all-inside anterior cruciate ligament reconstruction. *J Exp Orthop* 2023;10:69.

5. Kawai R, Tsukahara T, Kawashima I, Yamada H: Tibial rotational alignment after opening-wedge and closing-wedge high tibial osteotomy. *Nagoya J Med Sci* 2019;81:621-628.

6. Suero EM, Hawi N, Westphal R, et al: The effect of distal tibial rotation during high tibial osteotomy on the contact pressures in the knee and ankle joints. *Knee Surg Sports Traumatol Arthrosc* 2017;25:299-305.

7. Kawoosa AA, Wani IH, Dar FA, Sultan A, Qazi M, Halwai MA: Deformity correction about knee with ilizarov technique: Accuracy of correction and effectiveness of gradual distraction after conventional straight cut osteotomy. *Ortop Traumatol Rehabil* 2015;17:587-592.

8. Ashfaq K, Fragomen AT, Nguyen JT, Rozbruch SR: Correction of proximal tibia varus with external fixation. *J Knee Surg* 2012;25:375-384.

9. El-Azab HM, Morgenstern M, Ahrens P, Schuster T, Imhoff AB, Lorenz SGF: Limb alignment after open-wedge high tibial osteotomy and its effect on the clinical outcome. *Orthopedics* 2011;34:e622-e628.

10. Fragomen AT, Meade M, Borst E, Nguyen J, Rozbruch SR: Does the surgical correction of tibial torsion with Genu Varum produce outcomes similar to those in varus correction alone? *J Knee Surg* 2018;31:359-369.

11. Gama DF, Cabral J, Vale M, Freitas RT, Varatojo R: Dome-shaped osteotomy for revision of failed closing-wedge high tibial osteotomy. *Orthop J Sports Med* 2019;7:2325967119857047.

12. Soudy E, Atia MES, El Alfy MN, Ali Basiony AAED: Outcome of dome-shaped proximal tibial osteotomy in infantile Genu Varum. *Egypt J Hosp Med* 2021;85:3893-4897.

13. Hofmann AA, Tkach TK, Evanich CJ, Camargo MP, Zhang Y: Patellar component medialization in total knee arthroplasty. *J Arthroplasty* 1997;12:155-160.

14. Snow M: Tibial torsion and patellofemoral pain and instability in the adult population: Current concept review. *Curr Rev Musculoskelet Med* 2021;14:67-75.

15. Cibulka MT: Determination and significance of femoral neck anteversion. *Phys Ther* 2004;84:550-558.

16. Reikerås O, Bjerkreim I, Kolbenstvedt A: Anteversion of the acetabulum and femoral neck in normals and in patients with osteoarthritis of the hip. *Acta Orthop Scand* 1983;54:18-23.

17. Rab GT: Oblique tibial osteotomy revisited. *J Child Orthop* 2010;4:169-172.

18. Khoshrou H, Mostafaee N, Negahban H, Raeesi SJ: Reliability and validity of the Persian version of the University of California at Los Angeles (UCLA) activity scale in candidates for knee replacement surgery. *J Rehabil* 2022;23:112-125.

19. Saraei-Pour S, Salavati M, Akhbari B, Kazem-Nezhad A: Translation and adaptation of knee injury and osteoarthritis outcome score (KOOS) in to Persian and testing Persian version reliability among Iranians with osteoarthritis. *Arch Rehabil* 2007;8:42-46.

20. Allen J, Taylor K: Physical examination of the knee. *Prim Care* 2004;31:887-907.

21. Kim HD, Lee DS, Eom MJ, Hwang JS, Han NM, Jo GY: Relationship between physical examinations and two-dimensional computed tomographic findings in children with intoeing gait. *Ann Rehabil Med* 2011;35:491-498.

22. Stuberg W, Temme J, Kaplan P, Clarke A, Fuchs R: Measurement of tibial torsion and thigh-foot angle using goniometry and computed tomography. *Clin Orthop Relat Res* 1991:208-212.

23. Ntagiopoulos P, Bonin N, Sonnery-Cottet B, Badet R, Dejour D: The incidence of trochlear dysplasia in anterior cruciate ligament tears. *Int Orthop* 2014;38:1269-1275.

24. Hertel J, Dorfman JH, Braham RA: Lower extremity malalignments and anterior cruciate ligament injury history. *J Sports Sci Med* 2004;3:220-225.

25. Powers CM, Chen PY, Reischl SF, Perry J: Comparison of foot pronation and lower extremity rotation in persons with and without patellofemoral pain. *Foot Ankle Int* 2002;23:634-640.

26. Eckhoff DG, Brown AW, Kilcoyne RF, Stamm ER: Knee version associated with anterior knee pain. *Clin Orthop Relat Res* 1997:152-155.

27. Goutallier D, Van Driessche S, Le Mouel S: Comments on: "Proximal tibial derotation osteotomy for torsional distal deformities generating patella-femoral disorders" by N. Fouilleron, E. Marchetti, G. Autissier, F. Gougeon, H. Migaud and J. Girard, published in Orthop Traumatol Surg Res 2010;96:785-92. *Orthop Traumatol Surg Res* 2011;97:681; author reply 682.

28. Weinberg DS, Park PJ, Liu RW: Association between tibial malunion deformity parameters and degenerative hip and knee disease. *J Orthop Trauma* 2016;30:510-515.

29. Asik M, Sen C, Kilic B, Goksan SB, Ciftci F, Taser OF: High tibial osteotomy with puddu plate for the treatment of varus gonarthrosis. *Knee Surg Sports Traumatol Arthrosc* 2006;14:948-954.

30. Chiang H, Hsu HC, Jiang CC: Dome-shaped high tibial osteotomy: A long-term follow-up study. *J Formos Med Assoc* 2006;105:214-219.

31. Sun H, Zhou L, Li F, Duan J: Comparison between closing-wedge and opening-wedge high tibial osteotomy in patients with medial knee osteoarthritis: A systematic review and meta-analysis. *J Knee Surg* 2017; 30:158-165.

32. Berard J, Bousquet G, Trillat A: [8 cases of external tibial torsion associated with genu varum]. *Acta Orthop Belg* 1977;43:511-524.

33. Said GZ, Hafez A: Genu varum and external genicular torsion deformities and their relationship to gonarthrosis in Egypt. *J Egypt Med Assoc* 1975;58:36-44.

34. özkaya u, Kabukçuoğlu Y, Parmaksizoğlu AS, Yeniocak S, Ozkazanli G: Açk kama yüksek tibia osteotomisi sonrasnda patella yüksekliği ve tibial eğim açsndaki değişiklikler. *Acta Orthop Traumatol Turc* 2008;42: 265-271.

35. Krengel WF III, Staheli LT: Tibial rotational osteotomy for idiopathic torsion. A comparison of the proximal and distal osteotomy levels. *Clin Orthop Relat Res* 1992;283:285-289.

36. Kirgis A, Albrecht S: Palsy of the deep peroneal nerve after proximal tibial osteotomy. An anatomical study. *J Bone Joint Surg Am* 1992;74: 1180-1185.

37. Shingade VU, Jagtap SM, Ranade AB: Weakness of extensor hallucis longus after removal of non-vascularised fibula as an autograft. *J Bone Joint Surg Br* 2004;86:384-387.

38. Geiger F, Schneider U, Lukoschek M, Ewerbeck V: External fixation in proximal tibial osteotomy: A comparison of three methods. *Int Orthop* 1999;23:160-163.

39. Steel HH, Sandrow RE, Sullivan PD: Complications of tibial osteotomy in children for genu varum or valgum. Evidence that neurological changes are due to ischemia. *J Bone Joint Surg Am* 1971;53:1629-1635.

40. Rab GT: Oblique tibial osteotomy for Blount's disease (tibia vara). *J Pediatr Orthop* 1988;8:715-720.

41. Geith MAA, Naggar AME: Modified dome shaped proximal tibial osteotomy for treatment of infantile Tibia vara. *Int J Res Orthop* 2016;2: 394-399.

42. Hossein Pourfeiz H, Soleimanpour J, Ganjpour Sales J, Taleb H, Tabrizi A. Comparison of the short time outcomes of geno varum correcting surgery between the open wedge and dome shape high tibial osteotomies. *Med J Tabriz Uni Med Sci Health Serv*. 2014;35:32–37.