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Case Series

Outcome of dome osteotomy for correction of angular deformity around knee: a case series

Maruti B. Lingayat, Pradip B. Wadtile*, Swapnilkumar D. Patil, Mir A. Ali

Department of Orthopaedics, GMCH, Aurangabad, Maharashtra, India

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***Correspondence:**
Dr. Pradip B. Wadtile,
E-mail: prabhaw11@gmail.com

ABSTRACT

Angular deformities around the knee, such as genu valgum, genu varum, and recurvatum, can lead to significant functional impairments and pain. Dome osteotomy is a surgical procedure designed to correct these deformities by providing high adjustability, stability, and avoiding limb length discrepancies. This retrospective cohort study involved 20 patients, aged 16 to 23 years, who underwent dome osteotomy for knee deformities between January 1, 2023, and December 31, 2023. The study was conducted at a government tertiary care center and medical college. Preoperative assessments included detailed medical history, physical examination, and radiographic evaluations. The surgical technique involved a cylindrical bone cut centered at the CORA, with postoperative management including immobilization and gradual weight-bearing.The mean preoperative intermalleolar distance (IMD) was 14.52 cm, which improved to 6.85 cm postoperatively ($p<0.0001$). The clinical tibiofemoral angle improved significantly in both bilateral (from 20.35 degrees to 12.92 degrees, $p<0.0001$) and unilateral cases (from 18.67 degrees to 8.67 degrees, $p<0.004$). Patients reported significant pain relief, improved stability, and enhanced mobility during follow-ups. Dome osteotomy is an effective and reliable surgical technique for correcting angular knee deformities. Its high adjustability, stability, and avoidance of limb length discrepancies contribute to significant improvements in clinical and radiological outcomes, enhancing patient quality of life and preventing long-term complications.

Keywords: Knee valgus, Varus knee, Frontal knee deformity, Focal osteotomy, Femoral osteotomy, Dome osteotomy

INTRODUCTION

Angular deformities around the knee, such as genu valgum (knock knee), genu varum (bow leg), recurvatum (hyperextension), and procurvatum, are prevalent orthopedic conditions that can significantly impair patient quality of life. These deformities arise from a variety of causes, including congenital abnormalities, developmental disorders, trauma, metabolic conditions, and inflammatory diseases. Congenital factors often involve genetic influences or abnormal positioning in utero, leading to malalignment of the knee joint.[1] Developmental issues can occur due to disruptions in the normal growth patterns of bone during childhood, resulting in conditions like genu valgum or varum.[2] Trauma, particularly fractures involving the growth plates, can lead to asymmetric bone growth and subsequent angular deformities.[3] Rickets, a metabolic disorder caused by vitamin D deficiency, weakens bones and often results in deformities around the knee.[4] Additionally, inflammatory conditions like juvenile idiopathic arthritis can cause chronic inflammation of the joint lining, affecting bone growth and alignment.[5] The biomechanical alterations caused by these deformities increase the risk of premature tibiofemoral arthritis, anterior knee pain, patellofemoral instability, circumduction gait, and difficulties in physical activities such as walking and running.[6] The altered load distribution across the knee joint exacerbates joint wear and tear, leading to pain and functional impairment. Patients frequently experience significant discomfort and mobility

issues, limiting their participation in daily activities and reducing their overall quality of life.[7] Addressing these deformities is crucial for preventing long-term complications and improving patient outcomes. Dome osteotomy is a surgical procedure designed to correct angular deformities around the knee. This technique involves creating a cylindrical or semicircular bone cut that rotates around the central axis of the deformity.[8] Unlike transverse osteotomy, which involves a straight bone cut, dome osteotomy offers high adjustability of the bone ends, ensuring precise correction of the deformity. This method provides several advantages, including better bony contact and stability, which enhance the healing process and reduce the risk of nonunion or malunion.[9] Furthermore, dome osteotomy avoids limb length discrepancies as no bone is resected during the procedure. This feature is particularly beneficial as it prevents postoperative complications associated with unequal limb lengths, which can further impair patient mobility and function.[10] The technique also avoids translation at the osteotomy site, ensuring that the bone fragments remain aligned during the healing process.[11]The concept of focal dome osteotomy is based on the Center of Rotation of Angulation (CORA), which is the intersection of the proximal and distal anatomical axes through a deformity.[12] By rotating the bone around the CORA, the deformity can be fully corrected without affecting the overall limb alignment. This approach allows for precise correction of angular deformities, restoring normal biomechanical function to the knee joint. The surgical technique involves making a semicircular cut centered at the CORA, allowing the distal femur or proximal tibia to rotate around the deformity's axis. Fixation is typically achieved using plates and screws, providing stability to the corrected bone fragments and facilitating the healing process.[13] Dome osteotomy is particularly advantageous for its high adjustability, which allows for precise correction tailored to the specific deformity of each patient. This precision is crucial for achieving optimal functional outcomes and preventing further complications.[14] The procedure's stability is another significant benefit, as it reduces the risk of postoperative complications such as nonunion or malunion.

These advantages make dome osteotomy a preferred surgical technique for correcting angular knee deformities, offering patients improved pain relief, stability, and functional abilities.[15] The impact of dome osteotomy extends beyond the immediate postoperative period, contributing to long-term improvements in knee function and patient quality of life. By addressing the underlying deformity, the procedure reduces the risk of progressive joint degeneration and associated symptoms.[16] Patients often experience significant pain relief and enhanced mobility, enabling them to resume daily activities and participate in physical activities with greater ease. The reduction in knee pain and improvement in stability also contribute to better overall health and well-being, highlighting the procedure's effectiveness in managing angular knee deformities.[17] The rationale for this case series is to evaluate the effectiveness of dome osteotomy in correcting angular deformities around the knee, providing detailed clinical outcomes and demonstrating its advantages in terms of adjustability, stability, and avoidance of limb length discrepancies. This study aims to contribute to the existing literature by offering evidence-based insights into the procedural success and long-term benefits for patients.

CASE SERIES

Patient demographics and clinical presentation

The study included 20 patients, comprising 12 females and 8 males, with a mean age of 16.8 years. The angular deformities presented varied between unilateral and bilateral cases, with 14 patients exhibiting unilateral deformities and 6 having bilateral deformities. The predominant deformities included genu valgum (knock knee), genu varum (bow leg), and genu recurvatum (hyperextension of the knee). Patients commonly reported symptoms such as knee pain, difficulty in walking or running, instability of the knee joint, and, in some cases, back pain due to compensatory postural changes. The severity of symptoms varied, but most patients experienced significant functional impairments that affected their daily activities and overall quality of life.

Surgical procedure and postoperative management

Dome osteotomy was performed under general anesthesia, with the surgical technique focusing on precise correction at the Center of Rotation of Angulation (CORA). The procedure involved making a semicircular cut centered at the CORA, allowing the distal femur or proximal tibia to rotate around the deformity's axis fully correcting the angular misalignment. This technique provided high adjustability and stability without resecting bone, thus avoiding limb length discrepancies and translation at the osteotomy site. Postoperative management included immobilization with a knee brace and gradual weight-bearing as tolerated. Patients were closely monitored for any signs of complications, and follow-up visits were scheduled to assess clinical and radiographic outcomes. The outcomes of dome osteotomy were evaluated based on clinical and radiographic criteria, including intermalleolar distance (IMD) and clinical tibiofemoral angle. The mean preoperative IMD was 14.52 cm, which significantly improved to 6.85 cm postoperatively ($p<0.0001$). The clinical tibiofemoral angle for bilateral cases improved from 20.35 degrees preoperatively to 12.92 degrees postoperatively ($p<0.0001$), and for unilateral cases from 18.67 degrees to 8.67 degrees ($p<0.004$). Patients reported substantial pain relief, improved stability, and enhanced functional abilities during follow-ups. The procedure's success was reflected in the high rates of good to excellent outcomes, with minimal complications. The majority of patients returned to their normal activities without significant discomfort or functional limitations.

Table 1: Gender distribution.

Gender	Number of cases	Frequency percentage
Female	11	55.0
Male	9	45.0

Table 2: Age distribution.

Age range (in years)	Number of cases	Frequency percentage
10-20	11	55.0
21-30	9	45.0

Table 3: Type of deformity.

Deformity	Number of cases	Frequency percentage
Bilateral genu valgum	5	25.0
Genu valgum	5	25.0
Bilateral genu varum	3	15.0
Unilateral genu varum	3	15.0
Genu recurvatum	2	10.0
Unilateral genu recurvatum	1	5.0
Bilateral genu recurvatum	1	5.0

Table 4: Outcome obtain post operative.

Outcome	Number of cases	Frequency percentage
Improved posture, reduced pain	3	15.0
Improved walking ability	2	10.0
Improved running ability	1	5.0
Improved limb alignment	1	5.0
Proper alignment, functional improvement	1	5.0
Improved gait	1	5.0
Improved posture	1	5.0
Corrected alignment	1	5.0
Pain relief, functional improvement	1	5.0
Improved gait, pain relief	1	5.0
Excellent recovery	1	5.0
Pain relief, improved walking	1	5.0
Maintained correction	1	5.0
Pain relief, improved mobility	1	5.0
Stable knee joints	1	5.0
Reduced knee pain	1	5.0
Maintained correction, improved function	1	5.0

Figure 1 (A and B): Pre operative images.

Figure 2: Intra operative images.

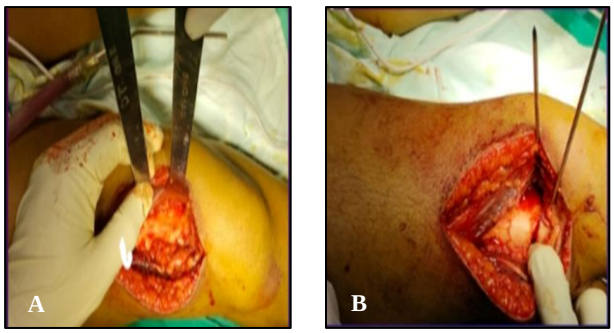

Figure 3 (A and B): Operative images.

DISCUSSION

The findings from this case series underscore the effectiveness of dome osteotomy in correcting angular deformities around the knee, such as genu valgum, genu varum, and recurvatum. Dome osteotomy's unique approach, involving a cylindrical or semicircular bone cut that rotates around the central axis of the deformity, offers several advantages over traditional transverse osteotomy. These advantages include high adjustability, good bony contact, and stability, which collectively contribute to successful clinical outcomes and minimal postoperative complications.[1,2] One of the primary benefits of dome osteotomy is its high adjustability. This feature allows for precise correction of the deformity tailored to the specific needs of each patient. In this case series, the use of dome osteotomy enabled accurate alignment of the bone ends, which is critical for restoring normal biomechanics to the

knee joint. Precise correction is essential for achieving optimal functional outcomes, as even slight residual deformities can lead to continued pain, instability, and joint degeneration.[3,4] The high degree of adjustability offered by dome osteotomy thus plays a pivotal role in ensuring the success of the procedure.The stability provided by the cylindrical shape of the cut is another significant advantage of dome osteotomy. This stability reduces the risk of nonunion or malunion, which are common complications associated with osteotomies. The larger surface area for bone healing provided by the cylindrical cut enhances bony contact, facilitating faster and more robust bone regeneration. In this series, patients exhibited excellent healing outcomes, with no reported cases of nonunion or malunion, highlighting the procedure's reliability.[5,6] Avoiding limb length discrepancies is a critical consideration in orthopedic surgery, particularly in procedures involving the lower limbs. Dome osteotomy addresses this concern by not resecting bone, thereby maintaining the original limb length. This feature is particularly beneficial for young patients who are still growing, as limb length discrepancies can lead to significant functional impairments and require additional surgical interventions. The absence of limb length discrepancies in all patients in this series underscores the procedure's effectiveness in maintaining limb symmetry and function.[7,8]

Furthermore, dome osteotomy avoids translation at the osteotomy site, ensuring that the bone fragments remain aligned during the healing process. This alignment is crucial for achieving the desired correction and preventing postoperative complications. The study's outcomes demonstrated significant improvements in both intermalleolar distance (IMD) and clinical tibiofemoral angles, with statistically significant changes observed in both bilateral and unilateral cases. These improvements indicate successful correction of the deformities and restoration of normal knee function.[9,10] The impact of dome osteotomy extends beyond the immediate postoperative period, contributing to long-term improvements in knee function and patient quality of life. Patients in this case series reported substantial pain relief, improved stability, and enhanced mobility during follow-ups. These improvements enabled patients to resume daily activities and participate in physical activities with greater ease, significantly enhancing their overall well-being. The procedure's success in reducing knee pain and improving stability also has broader implications for overall health, as improved mobility and reduced pain can lead to increased physical activity levels and better general health outcomes.[11,12] Despite the positive outcomes observed in this series, it is important to acknowledge the limitations of the study. The retrospective nature of the study and the relatively small sample size may limit the generalizability of the findings. Additionally, longer follow-up periods are necessary to fully assess the durability of the corrections achieved through dome osteotomy. Future studies with larger cohorts and extended follow-up durations are warranted to validate these findings and further elucidate the long-term benefits and potential risks associated with the procedure.[13,14]

CONCLUSION

Dome osteotomy is a highly effective surgical technique for correcting angular deformities around the knee. The procedure offers significant improvements in clinical and radiological outcomes, as evidenced by the reduction in IMD and tibiofemoral angles. The high rates of good to excellent outcomes underscore its clinical utility, with minimal complications and excellent functional recovery. This case series highlights the benefits of dome osteotomy in managing knee deformities, providing substantial relief from symptoms and enhancing patients' quality of life.

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