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Case Report

Supramalleolar dome osteotomy after a childhood ankle fracture malunion: a case report

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ABSTRACT

Proper ankle alignment is essential for maintaining normal gait mechanics and balanced load transmission across the tibiotalar joint. Coronal plane malalignment, whether varus or valgus, alters joint loading patterns and increases stress on one side of the ankle, leading to progressive cartilage damage and the development of ankle osteoarthritis. If left uncorrected, such deformities may result in chronic pain, instability, functional decline, and reduced quality of life. We report the case of a 38-year-old woman with a residual varus ankle deformity secondary to childhood fracture malunion, who was successfully treated with dome supramalleolar osteotomy. This case highlights the role of the Dome shaped Supramalleolar osteotomy (SMO) as an effective joint-salvage procedure for distal tibial malalignment, demonstrating favorable clinical and patient-reported outcomes.

Keywords: Supramalleolar osteotomy, Alignment, Coronal plane deformity

INTRODUCTION

Alignment of the ankle joint is very important to preserve normal gait biomechanics and load distribution across the joint.[1] Coronal plane deformity, either varus or valgus, changes the loading conditions of the tibiotalar joint and creates additional mechanical leverage on either the medial or lateral side. Such distorted stress results in accelerated cartilage degeneration and development of ankle osteoarthritis (OA).[1] If not properly treated, malalignment induces pain, instability and a stepwise joint degeneration with loss of function and quality of life.[1]

Supramalleolar osteotomy SMO aims to correlate distal tibial malalignment and physiologic joint axis through a joint-preserving surgical procedure.[2] With the repositioning of the tibial plafond, SMO achieves an even distribution of loads over the ankle joint, leading to pain relief and postponing or avoiding fusion (arthrodesis) or replacement (arthroplasty) surgery.[2] Several other series have demonstrated significant improvements in clinical scores, as measured by the American Orthopaedic Foot and Ankle Society (AOFAS) score and radiological parameters, after SMO for varus valgus (VV) deformity.[3] Barg et al described the indications, technical approach, and good results of SMO in degenerative ankle joint disease, stressing its efficacy and an acceptable complication rate.[2]

Zhao et al demonstrated that SMO proved beneficial for individuals suffering from ankle arthritis associated with post-traumatic fractures, resulting in significant pain reduction, improvements in function, and a high level of patient satisfaction during the midterm follow-up period.[4] A recent systematic analysis performed by Butler et al (2023) also supported this, providing good clinical and radiological outcomes as well as low rates of complications at mid-term follow-up.[5]

With the dome-shaped SMO, multiplanar correction is achieved around a central arc, resulting in minimal bone shift.[2] The SMO dome has been demonstrated to effectively correct local deformities and normalize the hip-knee-ankle axis to the neutral position.[6] It is particularly warranted in patients with opposing deformities of the ankle below that of the mechanical axis of the lower limb, as in a varus ankle deformity with valgus malalignment of the lower limb, in whom wedge osteotomy tends to induce translations which may worsen overall alignment. This method is particularly helpful in cases of complex varus deformities with congruent joints and minimal talar tilt.[2]

We describe a 38-year-old woman who was successfully treated by dome supramalleolar osteotomy due to residual varus deformity following childhood ankle fracture malunion conservatively managed in the primary care service. This case demonstrates the utility of SMO as a joint-salvaging surgical procedure for distal tibial malalignment and functional disability. And patient-reported outcomes after the procedure.

CASE REPORT

A 38-year-old female presented with a history of right ankle varus deformity sustained during childhood, which was a sequela of ankle fracture which was managed conservatively at that time, she was presented to the clinic with main complaint of deformity and ankle moderate pain with weightbearing, her preoperative active ankle range of motion was full, with AOFAS 79/100.

Figure 1: (A) preoperative clinical photograph and (B) radiograph showing varus deformity of the right ankle.

After clinical and radiological evaluation, a supramalleolar dome osteotomy was planned as the corrective surgical procedure. Preoperative radiographic assessment revealed a lateral distal tibial angle (LDTA) of 117°, a medial proximal tibial angle (MPTA) of 87°, and a center of rotation of angulation (CORA) located at the distal tibia with magnitude of angulation (mag) 34 deg, indicating a significant varus deformity originating at the distal tibial metaphysis (Figure 2).

Figure 2: (A and B): showing anterior and lateral standing radiographs of the patient.

Surgical description

The patient was placed in the supine position under general anesthesia with a tourniquet applied. The right lower limb was prepared and draped. An anterior approach was utilized. An incision of approximately 8 cm was made between the tibialis anterior and extensor hallucis longus (EHL), extending to the ankle joint. The neurovascular bundle was identified and carefully retracted laterally. Hemostasis was maintained throughout the procedure. After identification of the center of rotation of angulation (CORA) under fluoroscopy, a dome-shaped osteotomy was performed using a 3.5 mm drill, followed by completion with an oscillating saw.

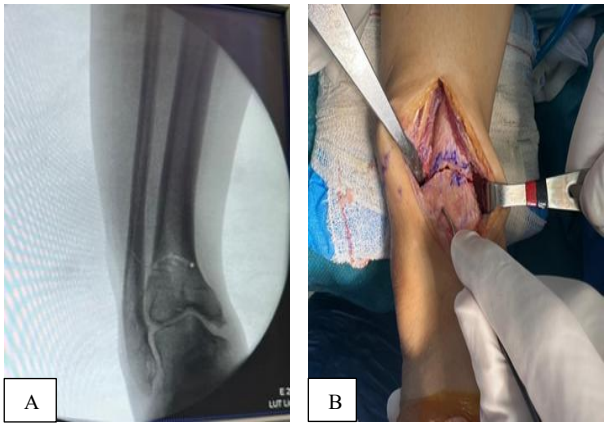

Figure 3: (A) intraoperative radiograph marking the osteotomy and (B) intraoperative photographs showing the osteotomy line.

Attention was then directed to the fibula. A longitudinal incision was made directly over the fibula at the level of the tibial osteotomy. An oblique osteotomy was carried out from lateral-proximal to medial-distal, with a 1 cm bone graft harvested from the same osteotomy site. The tibial deformity was passively corrected and confirmed under intraoperative fluoroscopy. Fixation was achieved using an anterior 6-hole T-plate. A combination of cortical

allograft, autograft from the fibula, and bone chips was inserted to fill the osteotomy defect.

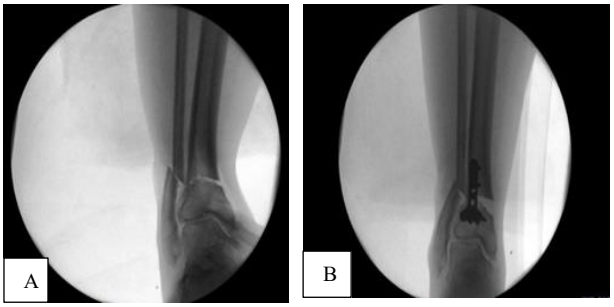

Figure 4: (A) intraoperative post osteotomy and (B) tibial deformity fixed with anterior 6-hole T-plate.

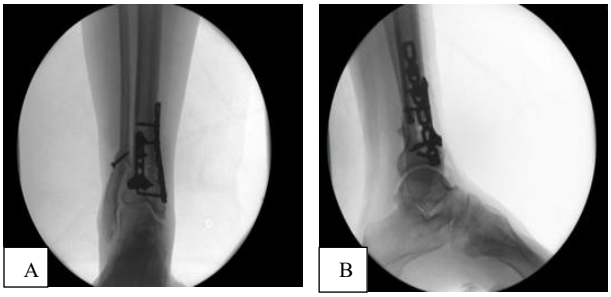

Figure 5: (A and B): medial locking plate and fibular lag screw were applied; final fixation confirmed with radiographs.

A second medial 6-holes locking plate was applied and secured with three screws. The fibular osteotomy was fixed with a lag screw following standard technique. Final correction and fixation were confirmed with intraoperative radiographs. A backslab was applied at the end of the procedure.

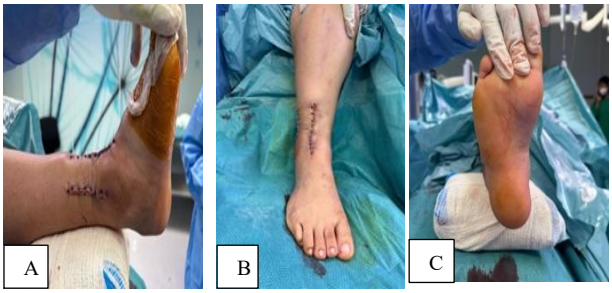

Figure 6: Photographs of the postsurgical wound. (A) lateral, (B) anterior and (C) inferior view.

At the 6th week follow up, the patient demonstrated significant functional improvement following dome SMO for correction of residual varus deformity and prevention of further joint degeneration. She was allowed to start to bear weight gradually at the 6th week.

In the 6th month of following her up, her ankle active range of motion was almost full however her radiographs showed healed and united fibula fracture with ongoing union of the tibia osteotomy, and her AOFAS was 88/100.

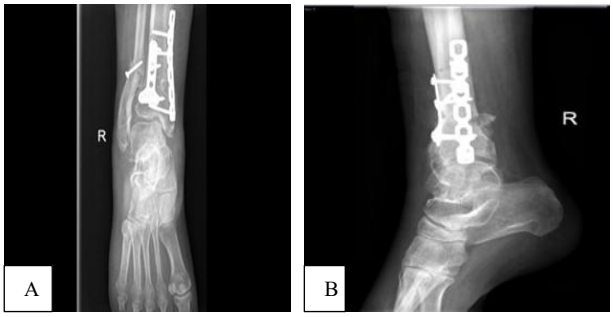

Figure 7: (A and B): Radiograph in 6 weeks follow-up after supramalleolar osteotomy.

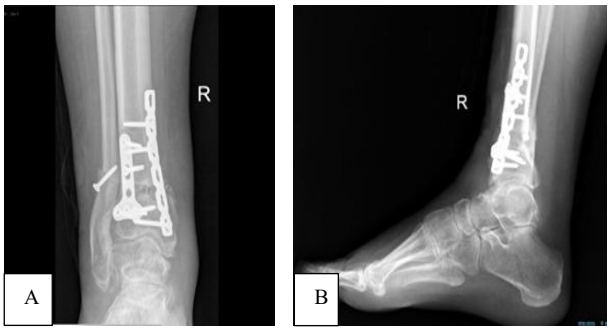

Figure 8: (A and B): Radiograph in 6 months follow-up.

Figure 9: (A and B): Clinical pictures in 6 months follow-up.

DISCUSSION

Optimal alignment of the ankle joint is essential to maintain the biomechanical stability and normal distribution of stress points for tibiotalar articulation. Conditions such as varus malalignment in the coronal plane disrupt this balance, causing the excessive stress in the medial compartment resulting in the degenerative processes of the articular cartilage and eventual ankle osteoarthritis.[1] Such abnormal stresses that are not corrected timely or with the help of appropriate interventions can lead to chronic pain, instability,

reduction in the joint function and finally osteoarthritis with serious implications for the walking ability and overall quality of life. Supramalleolar osteotomy is a well-established joint-preserving surgical technique specifically developed to correct distal tibial malalignment and reestablish a physiological load distribution through the ankle joint. This procedure realigns the tibial plafond to equalize the mechanical forces through the tibiotalar articulation, resulting in decreased pain, increased ankle stability, and improved gait mechanics. The effect of realignment extends beyond symptom control, as it has also been shown to slow the progression of ankle osteoarthritis; thus, one could reasonably hope that more extensive measures like arthrodesis and total ankle replacement will be less frequently required, if ever.[2]

Comprehensive clinical and radiographic researches have confirmed the successful experience of using the SMO technique to manage varus ankle osteoarthritis, for both idiopathic and post-traumatic deformities which have shown significant pain reduction, functional improvement, and high patient satisfaction at mid-term follow-up.[3,5,7] The recent meta-analysis performed by Christidis et al supports these findings, as it identifies favorable clinical and radiologic results and high patient satisfaction as well as low complication rates and improved joint survival and high patient satisfaction rates, reinforcing the role of SMO as an effective joint-preserving alternative.[7] From various osteotomy designs, the dome-shaped SMO has become truly unique due to its multiplanar correction achieved around a single rotational axis: this approach reduces translational shifts and helps to preserve limb alignment during the procedure.[2-6]

This constructive element is especially important for complex deformity cases, such as a varus ankle with a valgus lower-limb setting, as wedge osteotomies often induce malalignment.[2-8] Based on the findings of Lee et al, such cases are critically influenced by patient selection criteria: the best outcomes can be expected when patients present with preserved joint surfaces, modest talar tilt, and moderate OA stages.[8] The current patient, a 38-year-old female who had an ankle fracture malunion resulted in varus deformity of the distal tibia, was successfully addressed using dome SMO and fibular osteotomy. The mechanical axis was derived from preoperative measurements, showing extensive deviation to varus angulation, and the CORA was localized to the distal tibia. Consolidated correction was confirmed utilizing intraoperative fluoroscopy and postoperative radiography to restore the anatomic axis to acceptable measures and re-establish joint congruity. On the other hand, adjuvant fibular osteotomy allowed lateral realignment and enhanced tibiotalar contact. It is further assisted by modern biomechanical data that proposes coexisting fibular osteotomy to enhance talar tilt accuracy and more even load distribution toward the mortise.[9] The postoperative clinical course and radiographic improvement noted in this case corroborate the accumulating evidence that dome SMO is a reliable, joint-preserving procedure for distal tibial malalignment.[2,5,7] Although a single case, this report mirrors the existing literature suggesting that proper correction of mechanical axis deformity significantly mitigates patient complaints, restores the functional capacity, and slows the process of degenerative arthritis. More long-term observations are necessary to corroborate the data and define the indications more precisely. Nevertheless, dome SMO is an excellent reconstructive method for patients suffering from distal tibia varus deformity, especially those of post-traumatic etiology. As with other case reports, the current one had a number of limitations. Only one case with a six-month follow-up was reported by us. Therefore, it is uncertain if patients with severe varus distal tibia deformity may benefit from this kind of procedures. Additionally, the long-term follow-up data may yield different findings. Lastly, the case reports findings may have been affected by the operator bias. Despite these limitations, our current study demonstrated the effectiveness of dome SMO in treating varus distal tibia deformity with significant LDTA. However, we think more research is required before this approach can be recognized as a successful treatment for such a condition.

CONCLUSION

In conclusion, the presented case demonstrates that dome SMO with fibular osteotomy is a reliable joint-preserving surgical option for distal tibial vagarus deformity resulting from childhood Salter-Harris fractures. As shown here, the procedure corrected limb alignment and maintained ankle congruence, which led to objective radiographic and subjective clinical improvement. By restoring physiological load distribution, SMO not only controls symptoms but also eliminates the fundamental mechanical factor leading to degenerative changes progression. Given the available evidence from biomechanics and clinical data, dome SMO with fibular osteotomy is indicated as a viable reconstructive option for carefully selected patients with early to moderate varus ankle osteoarthritis. However, the experience of SMO in the long term and the accumulation of more extensive patient samples are needed for sustainable evidence of its effectiveness and potential in maintaining ankle joint function and postponing major intervention.

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