Management of Chronic Osteomyelitis Bone Defect with Titanium Cage Combined with the Masquelet Technique: A Case Report

Talal Almalki[1], Eyad Alahmeri[1], Mohammed Alshwieer[1], Ahmad Alhamoud[1], Ahmad Alsalloum[1]

Learning Point of the Article:

Sequential Masquelet technique followed by cylindrical titanium cage placement effectively manages intra-articular tibial COM with 12 cm bone loss, enabling independent weight-bearing and ambulation within 6 months.

Abstract

Introduction: Managing large segmental bone defects secondary to chronic osteomyelitis is a major challenge in orthopedic surgery requiring both long term and complex management. This study reports the outcome of effectively managing intra-articular tibial 12 cm bone loss with secondary to chronic osteomyelitis (COM) withsequential Masquelet technique followed by cylindrical titanium cage placement.

Case Report: A 37-year-old male with chronic distal tibia osteomyelitis, unresponsive to prior treatments, underwent a two-stage Masquelet technique with titanium cage, autograft, and allograft for a 12 cm defect. Despite subsequent complications including plate breakage, varus deformity requiring revision, and plate removal due to skin complications, he achieved full pain-free weight-bearing within 1-year post-cage placement.

Discussion: This report describes the first documented case of managing chronic osteomyelitis with this specific combined technique. It demonstrates successful long-term functional recovery in complex distal tibia osteomyelitis, with sustained efficacy over a 2-year follow-up, validating this reconstructive approach despite significant post-operative complications.

Keywords: Orthopedic, trauma, osteomyelitis, bone infection, bone defect.

Introduction

Long bone defects result from trauma, infection, non-union, or tumors, posing major challenges for patients and physicians [1]. Critical-sized defects (>5–6 cm) often lead to non-union, limb shortening, and functional loss, requiring reconstruction to restore limb function [1,2]. Available techniques include bone grafting, Ilizarov transport, vascularized fibula grafts, and the Masquelet procedure [2,3,4,5]. The cylindrical titanium mesh cages have emerged as a promising novel option for large traumatic defects [6,7,8,9,10].

This case report details the successful management of a patient presenting with chronic osteomyelitis (COM) and a large post-resection bone deficit, treated through a staged approach involving the Masquelet technique followed by the application of a mesh cage. Written informed consent was obtained from the patient for publication of this case report and any associated images.

Case Report

A 34-year-old male, previously healthy with no significant past medical history, sustained multiple traumatic injuries from a 10-m fall. Initial injuries included left hand multiple tendon rupture, left scapular fracture, bilateral closed shoulder dislocations, left talus open fracture, and right distal tibia open fracture.

At initial presentation following the fall, the patient underwent emergency management:

1. Left ankle external fixation for talus open fracture
2. Right distal tibia external fixation for open fracture
3. Bilateral shoulder closed reduction for dislocations.

All acute injuries were managed appropriately according to standard trauma protocols. Timeline of the events listed in Table

Access this article online

Website: www.jocr.co.in

DOI: https://doi.org/10.13107/jocr.2026.v16.i07.7692

[1]Department of Orthopedic Surgery, Security Forces Hospital, Riyadh, Saudi Arabia.

Address of Correspondence:
Dr. Mohammed Alshwieer,
Department of Orthopedic Surgery, Security Forces Hospital, Riyadh, Saudi Arabia.
E-mail: m.alshwieer@gmail.com

Submitted: 03/04/2026; Review: 13/05/2026; Accepted: June 2026; Published: July 2026

DOI: https://doi.org/10.13107/jocr.2026.v16.i07.7692

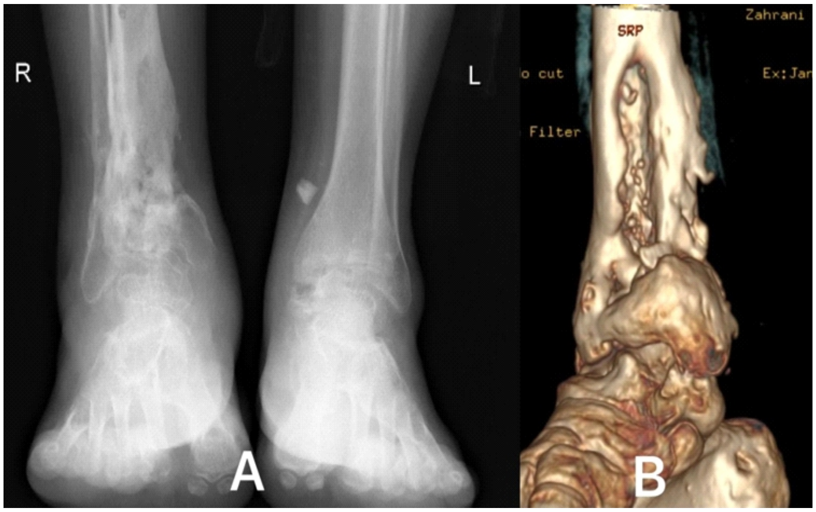

Figure 1: (a) This is X-ray anteroposterior view of the bilateral ankle of the patient. Detailing the signs of chronic osteomyelitis in the right distal tibia. (b) 3D computed tomography scan of the right distal tibia and ankle joint.

1. During early follow-up (2-month post-injury), the left talus open fracture demonstrated complete healing, allowing for: Removal of the left ankle external fixator and doing left-hand tendon repair.

The right distal tibia open fracture was converted from external fixation to open reduction and internal fixation with a lateral tibia plate at 4-weeks post-injury.

Several months later, despite achieving full weight-bearing, the patient was readmitted as COM of the left tibia. Despite 7 times of irrigation and debridement procedures with implant removal through an anteromedial approach, the infection persisted, leading to transfer to a specialized tertiary care center.

Tertiary care presentation (4-year post-injury)

Approximately 4 years after the initial trauma, the patient presented to our hospital clinic bearing weight on both limbs with an antalgic gait and persistent sinus discharge from the right distal tibia.

Initial radiographic and computed tomography evaluation (Fig. 1) revealed destructive changes and diffuse osteopenia in the distal tibia. Notably, despite COM, the patient remained afebrile and fully weight-bearing on both limbs, though the right lower limb continued to drain purulent material. Laboratory investigations demonstrated normal white cell count and C-reactive protein levels. Surgical intervention options were discussed, including Ilizarov technique, amputation, bone transport, and free tissue transfer. The patient initially refused all proposed interventions.

Definitive management: Masquelet technique (5-year post-injury)

One year later (5 years post-injury), the patient consented to surgical intervention. Following comprehensive preoperative investigation, he underwent right distal tibia bone resection through an anterolateral approach, cement spacer insertion, and external fixation application with a delta frame external fixator. Approximately 12 cm of bone loss resulted from the resection (Fig. 2). Intraoperative cultures grew Pseudomonas aeruginosa, necessitating a 6-week inpatient course of intravenous antibiotics.

Spacer exchange was attempted at 4 months following the initial procedure. The patient was readmitted due to the development of an anteromedial sinus extending to the cement spacer, without active purulent discharge. He underwent second-stage irrigation and debridement, spacer exchange, and excision of the sinus.

Six-month post-initial procedure (5.5-year post-injury), with no evidence of infection, the patient underwent third-stage reconstruction: Cement removal, titanium cylindrical mesh cage placement with iliac crest bone graft, external fixator removal, and lateral plate fixation. Intraoperatively, a well-developed membrane was observed. Fixation included a cage filled with allograft and autograft, a distal fibula plate used in the lateral tibia spanning the ankle to talus, and an anteroposterior ⅓ tubular plate securing the cage (Fig. 3). The decision to avoid a lateral tibia plate was due to poor skin condition overlying the tibia.

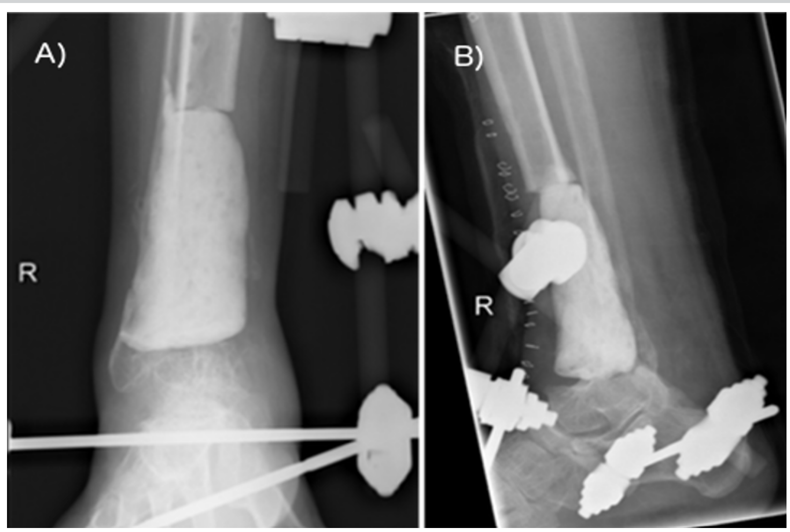

Figure 2: Right distal tibia anteroposterior and lateral views showing cement application with external fixation representing the first stage of Masquelete technique.

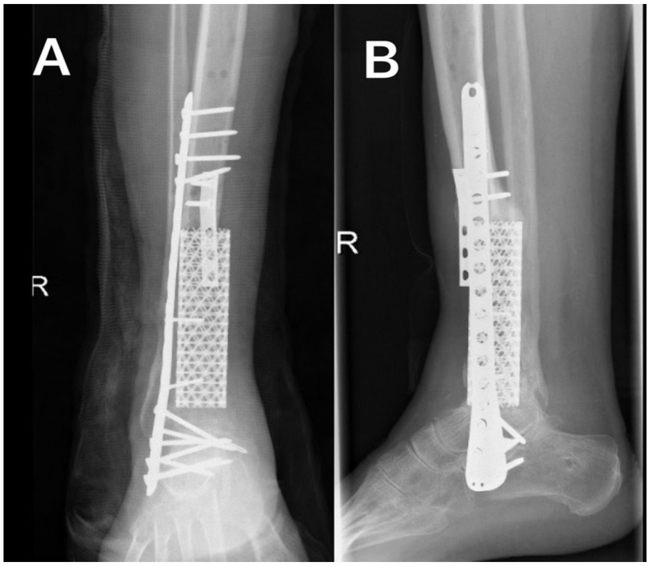

Figure 3: Right distal tibia anteroposterior and lateral views following second stage operation, showing titanium mesh cage fixed with 1/3 tubular plate.

Post-reconstruction complications and revisions

At 1-year follow-up from the reconstruction, radiographs showed persistent non-union. Weight-bearing was initiated by the patient. Three weeks later, the patient presented with pain. Imaging revealed broken plate and varus deformity (Fig. 4). Revision surgery included medial and lateral plating, fibular tibialization, and additional bone grafting.

Intraoperatively, cage distal fusion with ankle fusion was noted, and proximal loosening was identified. A proximal cage window was created, mixed cancellous grafts were impacted, and a fibular osteotomy was performed. The fibular graft was placed outside the cage and fixed laterally, while the medial and tibial surfaces were roughened to promote healing (Fig. 5).

Six months of clinic follow-up showed minimal signs of union on radiographs. The patient was instructed to begin weight-bearing as tolerated. Two months later (8 months from the last revision), he achieved full weight-bearing on the right side and was ambulating freely with the aid of a cane.

The second complication occurred 1 year later (7.25 years post-injury), and the case was complicated by an exposed medial plate, though the wound was clean with no signs of infection. The procedure done was irrigation and debridement, plate removal, and application of magnifuse and bone morphogenetic protein (BMP) for bone healing augmentation.

Intraoperative findings showed: After plate removal, the underlying bone was exposed, and the cage was circumferentially covered with bone proximally. Distally, the cage was exposed only on the posteromedial side (approximately 70° of the circumference). The bone was fully integrated into the cage and ankle, functioning as a single unit with the leg and ankle with excellent healing (Fig. 6). BMP, activated for 15 min, was then applied as a foam to the same region. Primary wound closure was performed. The final X-ray is shown in Fig. 6.

Final outcome (almost 8 years post-injury)

The immediate post-operative period was uneventful. The patient was instructed to start full weight-bearing at 2 weeks post-operatively after wound healing. By 6 weeks, the patient had progressed to full weight-bearing, entirely pain-free (Fig. 6). Leg length discrepancy was measured using centogram and estimated to have the right side 2 cm shorter than the left side.

Discussion

Long bone open fractures, particularly those with significant bone loss, pose substantial reconstructive challenges. The tibia is most commonly affected (68%), followed by the femur (22%) [11]. Defects exceeding 3 cm are especially problematic, often necessitating bone-length reconstruction and, in severe cases, amputation, as classified by Ferreira and Tanwar (types 2, 3, and 4) [1,2,12].

Titanium cylindrical cage mesh, typically filled with bone graft, originated in spinal surgery, receiving Food and Drug Administration approval in 1990 [6]. Its application historically expanded to maxillofacial surgery and acetabular

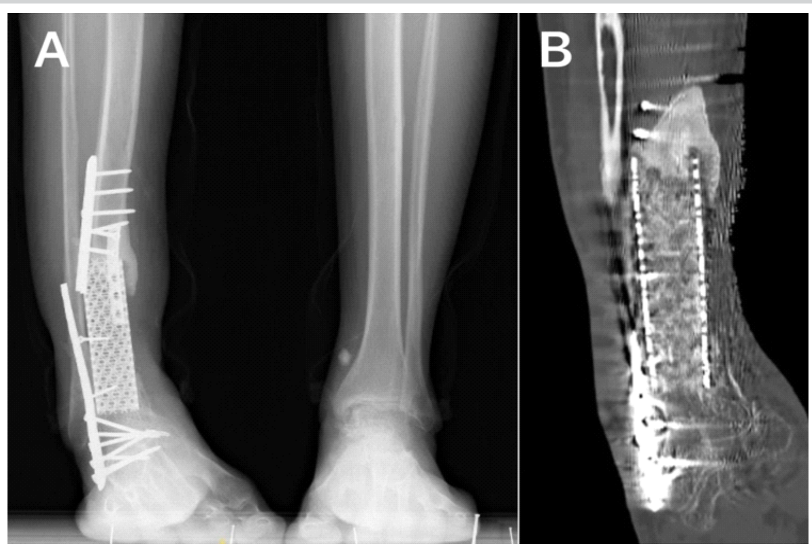

Figure 4: (a) Anteroposterior view of bilateral ankle showing right distal tibia going in varus deformity as a complication of fixation failure. (b) Computed tomography scan of the right distal tibia following plate failure showing plate full breakage.

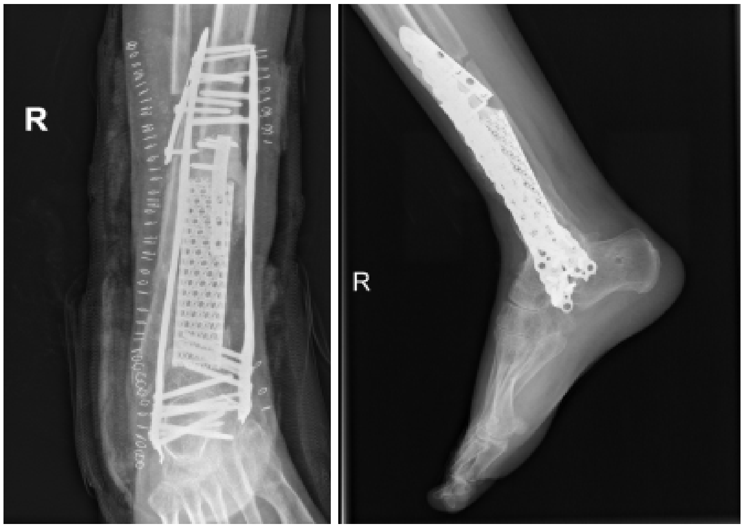

Figure 5: Right distal tibia anteroposterior view showing the addition of medial tibia plate with augmentation with fibula tibialization.

reconstruction, becoming a well-established method in spine procedures with favorable outcomes [13,14].

Cobos et al. first documented the use of cylindrical titanium mesh for long bone segmental defects in 2000 [6]. Their initial report detailed two cases of extra-articular traumatic defects treated immediately with a graft-filled cage and intramedullary fixation, enabling early weight-bearing at 1-year follow-up. This pioneering work was supported by numerous subsequent case reports demonstrating similar positive results [7,15,16].

Further evidence of efficacy includes a 2004 case series on six traumatic bone defects, which showed reliable healing without autogenous cancellous bone grafting [17]. More recently, a 2018 study of 17 patients with segmental long bone diaphyseal defects reported favorable outcomes and radiological healing in 16 cases when treated with titanium mesh cages filled with cancellous bone grafts, combined with intramedullary nailing and plate osteosynthesis [8].

While previous investigations consistently reported favorable outcomes with single-stage cage stems and bone grafts in traumatic patients with substantial bone loss, none specifically addressed this method's utility in COM [7,8,15,16,17]. Effective COM management requires thorough debridement and bone resection, irrespective of resulting defects [18], a gap this case addresses.

Management of COM usually consists of bone resection and prolonged antibiotics. Hence, the application of Masqulete technique emerged. Recent research highlights the effectiveness of application of the Masquelet technique with titanium cylindrical mesh cages. Kaya et al. demonstrated superior outcomes in animals with combined procedures versus mesh cage alone [9]. Ma et al. reported satisfactory results in open fractures with significant bone loss (average 8.3 cm) using a two-stage Masquelet technique followed by titanium mesh implantation [19]. Chen et al. further supported combined approaches, successfully using 3D-printed titanium porous prostheses with the Masquelet technique for large osteomyelitis-induced femoral defects [10].

This case report details the successful management of intra-articular tibial COM with 12 cm bone loss, using a sequential Masquelet technique followed by cylindrical titanium cage placement. The patient achieved independent weight-bearing and ambulation within 6-month post-cage placement, demonstrating a favorable functional outcome.

Future advancements may include 3D-printed mesh cages for

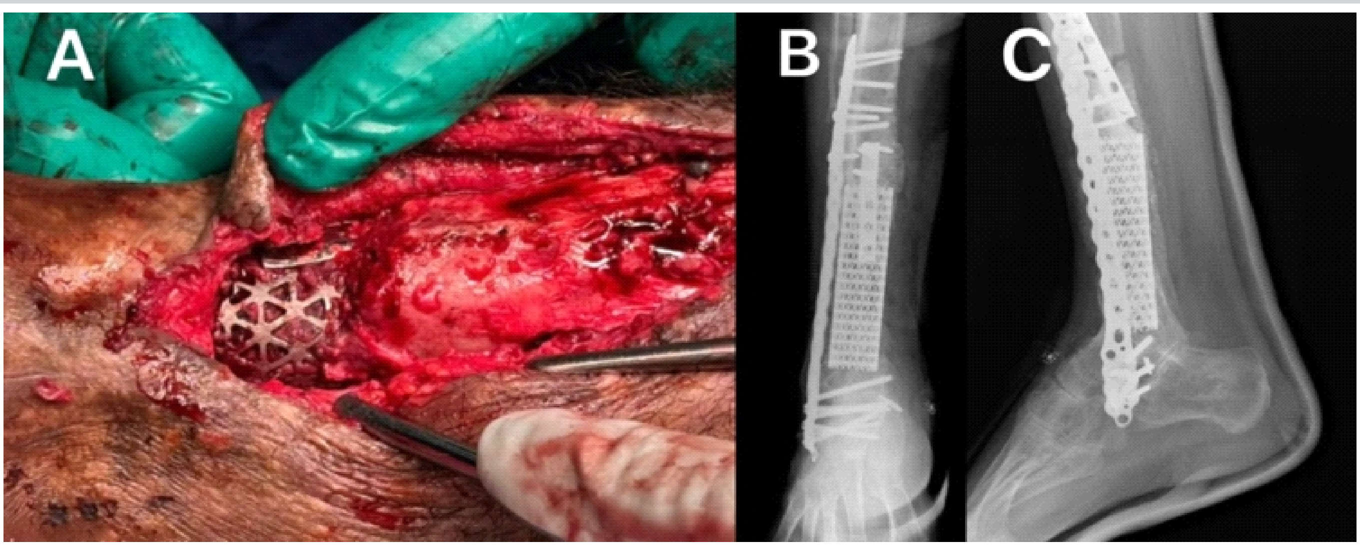

Figure 6: (a) Intraoperative image showing full integration of the cage proximally and distally acting as a single unit with the leg and foot. This figure shows complete coverage of the anterior surface of the tibia. (b and c) Final right distal tibial X-ray following medial tibia plate removal due to exposed plate. With a clinical picture of the affected limb, the patient is bearing full weight on it.

Table 1: Timeline from the start to the finish which includes all key interventions done to the patient

Timeframe	Times from initial trauma	Procedure	Comments
Initial trauma	--	1. Left ankle external fixation 2. Right distal tibia external fixation 3. Bilateral shoulder closed reduction	Trauma falling from 6 m distance. Injuries included left hand multiple tendon rupture, a left scapular fracture, bilateral closed shoulder dislocations, a left talus open fracture, and a right distal tibia open fracture.
After 2 months	2 months	1. Removal of left ankle external fixator 2. Right distal tibia conversion to ORIF 3. Left-hand tendon repair	
Within next 4 months	6 months	Multiple irrigation debridements for right ankle	development of right distal tibia osteomyelitis
After 3 years	4 years		Initial presentation and discussion of possible interventions
After 1 year	5 years	Bone resection, cement spacer insertion, and external fixation	Followed by 6-week IV antibiotics
After 4 months	5 years and 4 months	Sinus excision with spacer exchange	
After 2 months	5 years and 6 months	Cement removal, titanium cylindrical mesh cage placement with iliac crest bone graft, external fixator removal, and lateral plate fixation.	
After 1 year	6 years and 6 months	Revision surgery included medial and lateral plating, fibular tibialization, and additional bone grafting.	Procedure done due to the failure and breakage of the applied plate.
After 6 months	7 years		Good union on X-ray. Patient started and reached full weight bearing with no complaint
After 3 months	7 years and 3 months	Medial tibia plate removal.	Procedure done due to the medial tibia plate being exposed from skin.
After 6 months	Almost 8 years from initial injury.		6-month postoperatively, patient demonstrated full weight bearing from week 2 postoperatively with no further complications.

ORIF: Open reduction internal fixation

enhanced customization [10,20]. However, our successful outcome with a standard cylindrical titanium mesh is promising due to its greater accessibility compared to specialized 3D-printed alternatives. In this case, an initial autograft and cancellous allograft within the cage failed due to plate failure. Subsequent revision involved augmenting the cage with a fibula strut bone, a viable option for large segmental defects, especially after previous iliac bone grafts or with multiple fractures [5, 21].

Conclusion

Managing large segmental bone defects is a major challenge in orthopedic surgery. A promising approach uses a spinal cage as a contained space for bone graft. We applied this method to an iatrogenic defect caused by chronic osteomyelitis, augmenting it with the Masquelet technique to allow bacterial eradication before cage placement. This combined strategy resulted in a successful outcome, with the patient achieving full weight-bearing approximately six months after bone resection.

Clinical Message

Sequential Masquelet technique followed by cylindrical titanium cage placement effectively manages intra-articular tibial COM with 12 cm bone loss, enabling independent weight-bearing and ambulation within 6 months.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

References

1. Rosslenbroich SB, Oh CW, Kern T, Mukhopadhaya J, Raschke MJ, Kneser U, et al. Current management of diaphyseal long bone defects-a multidisciplinary and international perspective. J Clin Med 2023;12:6283.

2. Salcedo Cánovas C, Martínez Ros J, Ondoño Navarro A, Molina González J, Hernández Torres A, Moral Escudero E, et al. Infected bone defects in the lower limb. Management by means of a two-stage distraction osteogenesis protocol. Eur J Orthop Surg Traumatol 2021;31:1375-86.

3. Masquelet AC, Begue T. The concept of induced membrane for reconstruction of long bone defects. Orthop Clin North Am 2010;41:27-37.

4. Dheenadhayalan J, Devendra A, Velmurugesan P, Shanmukha Babu T, Ramesh P, Zackariya M, et al. Reconstruction of massive segmental distal femoral metaphyseal bone defects after open injury: A study of 20 patients managed with intercalary gamma-irradiated structural allografts and autologous cancellous grafts. J Bone Joint Surg Am 2022;104:172-80.

5. Jayaramaraju D, Venkataramani H, Rajasekaran RB, Agraharam D, Sabapathy SR, Rajasekaran S. Modified capanna's technique (vascularized free fibula combined with allograft) as a single-stage procedure in post-traumatic long-segment defects of the lower end of the femur: Outcome analysis of a series of 19 patients with an average gap of 14 cm. Indian J Plast Surg 2019;52:296-303.

6. Cobos JA, Lindsey RW, Gugala Z. The cylindrical titanium mesh cage for treatment of a long bone segmental defect: Description of a new technique and report of two cases. J Orthop Trauma 2000;14:54-9.

7. Attias N, Lindsey RW. Case reports: management of large segmental tibial defects using a cylindrical mesh cage. Clin Orthop Relat Res 2006;450:259-66.

8. Attias N, Thabet AM, Prabhakar G, Dollahite JA, Gehlert RJ, DeCoster TA. Management of extra-articular segmental defects in long bone using a titanium mesh cage as an adjunct to other methods of fixation: A multicentre report of 17 cases. Bone Joint J 2018;100-B:646-51.

9. Kaya O, Mirioglu A, Ozkan C, Bicer OS, Deveci MA, Tekin M, et al. Reconstruction of critical size segmental femoral diaphyseal defects of New Zealand rabbits by using combined titanium mesh cage and induced membrane technique. Eur J Orthop Surg Traumatol 2023;33:629-37.

10. Chen Z, Xing Y, Li X, Liu B, Liu N, Huo Y, et al. 3D-printed titanium porous prosthesis combined with the Masquelet technique for the management of large femoral bone defect caused by osteomyelitis. BMC Musculoskelet Disord 2024;25:474.

11. Study to Prospectively Evaluate Reamed Intramedullary Nails in Patients with Tibial Fractures Investigators, Bhandari M, Guyatt G, Tornetta P 3rd, Schemitsch EH, Swiontkowski M, et al. Randomized trial of reamed and unreamed intramedullary nailing of tibial shaft fractures. J Bone Joint Surg Am 2008;90:2567-78.

12. Ferreira N, Tanwar YS. Systematic approach to the management of post-traumatic segmental diaphyseal long bone defects: Treatment algorithm and comprehensive classification system. Strategies Trauma Limb Reconstr 2020;15:106-16.

13. Grob D, Daehn S, Mannion AF. Titanium mesh cages (TMC) in spine surgery. Eur Spine J 2005;14:211-21.

14. Zhang ZX, Li T, Hao DJ. Single-stage treatment of osteomyelitis of the cervical spine using anterior instrumentation and titanium mesh cages. Spine (Phila Pa 1976) 2016;41:E949-54.

15. Ostermann PA, Haase N, Rübberdt A, Wich M, Ekkernkamp A. Management of a long segmental defect at the proximal meta-diaphyseal junction of the tibia using a cylindrical titanium mesh cage. J Orthop Trauma 2002;16:597-601.

16. Reynders P, Broos PL, Stoffelen D. The use of cylindrical

titanium mesh cages in the treatment of post-traumatic segmental bone loss of the femur. Osteosynthesis Trauma Care 2003;11:99-104.

17. Lindsey RW, Gugala Z. Cylindrical titanium mesh cage for the reconstruction of long bone defects. Osteosynthesis Trauma Care 2004;12:108-15.

18. Panteli M, Giannoudis PV. Chronic osteomyelitis: What the surgeon needs to know. EFORT Open Rev 2016;1:128-35.

19. Ma XY, Yuan H, Cui D, Liu B, Han TY, Yu HL, et al. Management of segmental defects post open distal femur fracture using a titanium cage combined with the Masquelet technique A single-centre report of 23 cases. Injury 2023;54:111130.

20. Tetsworth K, Woloszyk A, Glatt V. 3D printed titanium cages combined with the Masquelet technique for the reconstruction of segmental femoral defects: Preliminary clinical results and molecular analysis of the biological activity of human-induced membranes. OTA Int 2019;2:e016.

21. Kim WY, Ji JH, Park SE, Kim YY, Jeong JJ, Kang HT. Surgical management of pilon fractures with large segmental bone defects using fibular strut allografts: A report of two cases. Eur J Orthop Surg Traumatol 2011;21:439-44.

Conflict of Interest: Nil
Source of Support: Nil

Consent: The authors confirm that informed consent was obtained from the patient for publication of this article

How to Cite this Article

Almalki T, Alahmeri E, Alshwieer M, Alhamoud A, Alsalloum A. Management of Chronic Osteomyelitis Bone Defect with Titanium Cage Combined with the Masquelet Technique: A Case Report. Journal of Orthopaedic Case Reports 2026 July;16(07): 366-372.