

Case Report

Minimally invasive management of a comminuted bicondylar middle phalanx head fracture using Joshi's external stabilization system: a case report

Sachin Sahuji*, Vijay Raghav Kanakam, J. V. Srinivas

Department of Orthopaedics, Aster RV Hospital, Bangalore, Karnataka, India

Received: 05 September 2026

Revised: 05 October 2026

Accepted: 16 October 2026

*Correspondence:

Dr. Sachin Sahuji,

E-mail: sahuji60@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Fractures of the middle phalanx head are uncommon injuries that pose a challenge in restoring articular congruity while preserving proximal interphalangeal (PIP) joint mobility and extensor tendon function. We report the case of a right-hand-dominant 29-year-old male software engineer who sustained a closed, comminuted bicondylar intra-articular fracture of the right little finger middle phalanx following a road traffic accident. Three days after injury, closed reduction under fluoroscopic guidance and percutaneous fixation using a modified Joshi's External Stabilization System (JESS) was performed under regional anaesthesia. The construct comprised two 2.0-mm and two 1.6-mm Kirschner wires, four mini-clamps, and two connecting rods. The procedure lasted 30 minutes. The fixator was maintained for four weeks, followed by supervised rehabilitation. Radiographs at four weeks confirmed fracture union, maintained articular congruity, and no loss of reduction. At final follow-up, the patient achieved a total active motion of 220°, with MCP, PIP, and DIP joint arcs of 90°, 100°, and 30°, respectively. Grip strength recovered to 95% of the contralateral hand, and pain was minimal (VAS 1/10). The patient returned to full occupational computer work at four weeks, without pin-tract infection, joint stiffness, malunion, or hardware-related complications. This case highlights modified JESS fixation as a minimally invasive option for selected comminuted intra-articular fractures of the middle phalanx head. It may facilitate maintenance of reduction while preserving tendon gliding and supporting functional recovery through timely rehabilitation.

Keywords: Middle phalanx fracture, JESS, Mini-external fixator, Bicondylar intra-articular fracture, Capsulo-ligamentotaxis, Hand trauma

INTRODUCTION

The human hand possesses an unparalleled balance of structural strength and fine motor dexterity, dependent upon the precise integrity of its skeletal framework, delicate joint surfaces and complex musculotendinous apparatus.^{1,2} Metacarpal and Phalangeal fractures account for 10% to 30% of all upper limb trauma presented to emergency departments.¹⁻⁴ Among these, intra articular

fractures involving the head of middle phalanx are relatively rare but complicated and clinically challenging injuries.^{5,6}

The middle phalanx head forms the proximal articulation of the distal interphalangeal joint and contributes to biomechanical leverage of flexor digitorum profundus (FDP) and extensor mechanisms.^{2,6} Fractures involving this bicondylar articular surface typically result from high-

energy axial loading, crushed compression, or rotational trauma during road traffic accidents (RTAs) and sports injuries.^{3,4,7} Treatment requires simultaneous fulfilment of four rigorous objectives: anatomical restoration of articular congruity, stable fragment fixation, preservation of delicate periosteal vascularity, and immediate post-reduction joint mobilization.^{3,6,8} Unstable or displaced phalanx fractures managed conservatively with prolonged cast or splint immobilization frequently develop malunion, apex volar/dorsal deformity, rotational scissoring, and disabling joint contracture.^{5,9} Indications for operative intervention include coronal angulation $>20^\circ$, sagittal angulation $>15^\circ$, cortical contact $<50\%$, rotational malalignment, and comminuted articular disruption.^{5,10} However, open reduction and internal fixation using micro condylar plates or micro condylar screws carries substantial risks like periosteal stripping, extensor tendon tethering, central slip disruption, and hardware prominence requiring secondary hardware removal.^{6,11–13}

Joshi's External Stabilization System, which functions via the fundamental principle of capsulo-ligamentotaxis, offers a dynamic solution.^{4,14} By applying longitudinal distraction forces across surrounding joint capsules and collateral ligaments, JESS pulls comminuted articular fragments into anatomical reduction while maintaining soft-tissue envelopes and fracture hematoma.^{3,4,14} This report presents the successful minimally invasive management of an isolated, comminuted bicondylar middle phalanx head fracture using a JESS construct, supplemented by a comprehensive literature review.

CASE REPORT

Patient information and clinical evaluation

A 29-year-old right hand dominant male software engineer presented to the Orthopaedic Department with severe pain, swelling, deformity, and restricted movement of the right little finger. The injury occurred on the evening of 18 January 2026 as a result of a road traffic accident involving a bike versus automobile collision. The patient had no medical comorbidities (non-diabetic, non-smoker), no history of prior hand trauma, and no associated systemic or musculoskeletal injuries.

Clinical examination revealed marked localized tenderness and diffuse fusiform swelling over middle phalanx of right little finger. It was a closed injury with intact skin envelopes. Distal neurovascular examination confirmed preserved digital sensation and normal capillary refill (<2 seconds). Active finger flexor and extensor movements were markedly restricted due to pain and mechanical block.

Radiographic assessment

Anteroposterior and lateral radiographs of the right hand showed a displaced, comminuted bicondylar intra articular fracture of the middle phalanx head of the little finger

(Figure 1). The articular surface showed comminuted fragmentation with articular incongruity. Anteroposterior and lateral radiographs of the right little finger demonstrated a displaced, comminuted bicondylar intra articular fracture of the middle phalanx head with loss of articular congruity.



Figure 1 (a and b): Pre operative radiograph.

Surgical technique

Definitive operative intervention was undertaken on 22 January 2026 (post-injury day 3) under brachial plexus regional anaesthesia. The patient was positioned supine with the right upper limb placed on a radiolucent hand table. A pneumatic tourniquet was applied to the upper arm but was not inflated during the procedure.

Reduction and fixator assembly

Ligamentotaxis reduction

Under continuous fluoroscopic image intensifier guidance, longitudinal traction was applied manually to the right little finger. Combined axial traction along with gentle manual manipulation utilized the intact capsulo-ligamentous attachments to pull the comminuted bicondylar articular fragments into anatomical reduction and restore phalanx length and rotational alignment.

Percutaneous K-wire placement

Two primary 2.0-mm Kirschner wires were inserted percutaneously across the fracture zone under C-arm guidance to secure primary bicortical purchase and maintain reduction. To augment construct stiffness and prevent micro-motion of the comminuted articular fragments, two additional supplementary 1.6-mm Kirschner wires were introduced in a crossed/supplementary configuration.

JESS construct assembly

A standard JESS mini-external fixator frame was constructed using four mini-fixator clamps attached to two connecting rods. Sequential tightening of the clamps under fluoroscopy allowed fine manual adjustments to optimize fracture distraction and maintain rigid reduction.

Skin clearance and joint assessment

A 5–7 mm skin-to-rod clearance was maintained to prevent skin necrosis and facilitate post-operative pin site hygiene. Passive flexion and extension of the proximal

interphalangeal and distal interphalangeal joints were done under real-time fluoroscopy, confirming smooth joint tracking and complete construct stability without fragment displacement.

Wound care

K-wire entry sites were dressed with sterile gauze. No formal surgical incisions or skin sutures were required. Total operative time was 30 minutes, and no intraoperative complications occurred.

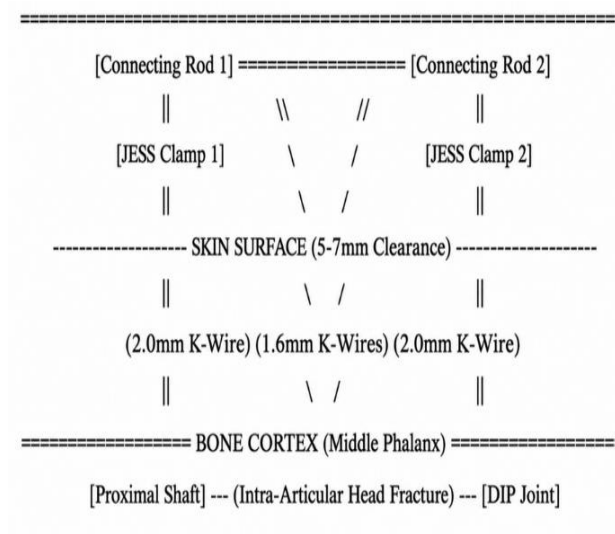


Figure 2: JESS frame construct diagram for middle phalanx head fracture.

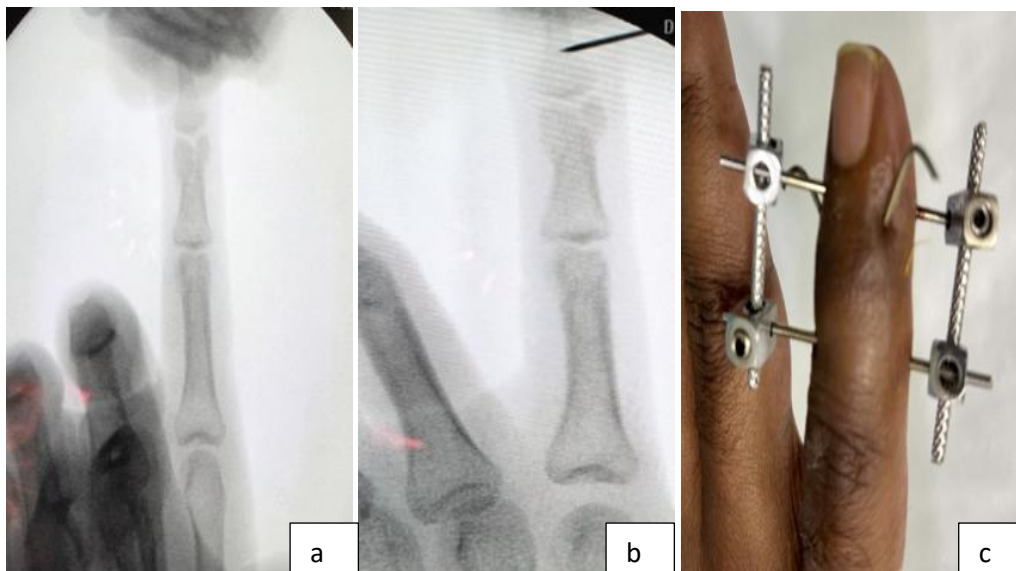


Figure 3 (a-c): Post-operative image showing JESS application.

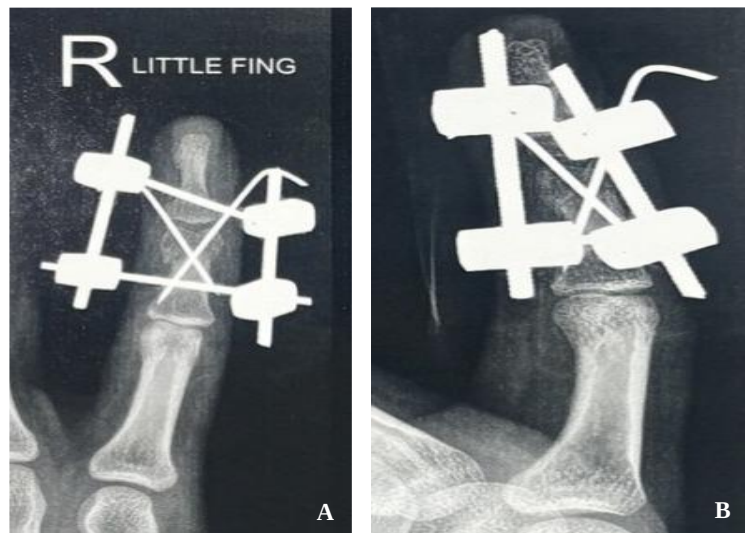


Figure 4: Post-operative clinical image & radiograph. (A) Post-operative clinical photo and fluoroscopic radiographs demonstrating stable JESS mini-external fixator frame in situ, maintaining anatomical reduction and articular congruity of the middle phalanx head. (B) Post-operative clinical photo and fluoroscopic radiographs demonstrating stable JESS mini-external fixator frame in situ, maintaining anatomical reduction and articular congruity of the middle phalanx head.

Post-operative protocol and results

Post-operative care and frame removal

The patient was administered immediate postoperative oral/IV antibiotics and analgesics. Daily pin-site cleansing with chlorhexidine solution and limb elevation were instituted. Immediate active mobilization of unfixed adjacent digits was encouraged. The patient was monitored weekly. At 4 weeks postoperatively, plain radiographs

demonstrated robust bridging callus with complete radiological fracture union and no loss of reduction. The JESS frame and K-wires were removed without complications, and a structured physical rehabilitation program was initiated.

Functional assessment and clinical outcomes

At the final follow-up, comprehensive functional outcome assessments were recorded.

Table 1: Digital range of motion (ROM) assessment at final follow-up.

Joint	Active flexion (Degrees)	Extension deficit (Degrees)	Net ROM
Metacarpophalangeal joint	90 degrees	0 degree	90 degrees
Proximal interphalangeal joint	100 degrees	0 degree	100 degrees
Distal interphalangeal joint	30 degrees	0 degree	30 degrees

Table 2: Clinical and functional outcome scores.

Functional parameter	Measured value	Standard clinical rading
Total active motion (TAM)	220°	Full active motion (MCP + PIP + DIP – Deficit)
Strickland–glogovac functional grade	Good	High functional recovery (>75% TAM)
Grip strength	95%	Measured against contralateral left hand
Visual analogue scale (VAS) pain score	1 / 10	Minimal residual discomfort
Time to radiological union	4 Weeks	Complete bony callus on AP/lateral X-rays
Time to return to work	4 Weeks	Full return to software engineering duties
Complications	None	No infection, malunion, stiffness, or non-union

Total active motion (TAM) calculation; TAM = MCP Flexion (90°) + PIP Flexion (100°) + DIP Flexion (30°) - Deficit (0°) = 220° (Achieving Excellent/Good Functional Classification.

DISCUSSION

Intra-articular fractures involving the middle phalanx head pose significant management challenges due to small fragment sizes, minimal soft-tissue coverage, and high

vulnerability to post-traumatic stiffness.^{1,5,6} The primary goal of intervention is restoring joint surface alignment while protecting the delicate extensor expansion, central slip, and lateral bands.^{6,11}

The choice of fixation for phalangeal fractures requires a balance between stable reduction and preservation of the surrounding soft tissues. Historical methods progressed from simple wire fixation to more rigid implants and external fixation constructs. Although open reduction and internal fixation can provide direct control of fracture fragments, dorsal plating has been associated with extensor tendon adhesion, reduced active flexion, and symptomatic hardware. Stern et al and Page and Stern described complications following plate fixation of hand fractures, while Hattori et al reported flexor tendon-related problems with volar plating in a different intra-articular phalangeal fracture pattern. These findings support careful consideration of the soft-tissue cost of open exposure in small-joint injuries.¹¹⁻¹³

Minimally invasive external fixation aims to maintain reduction while limiting additional injury to the periosteum, fracture haematoma, and tendon-gliding structures. Suzuki et al described the pins-and-rubbers traction system, which uses sustained traction and ligamentotaxis to improve articular alignment in comminuted hand fractures.¹⁵ Subsequent approaches have included dynamic interdigital fixation for proximal interphalangeal joint fracture-dislocations, modifications of the Suzuki frame, the Ichi-Fixator system, and low-cost constructs using readily available components.^{5,6,15-19} Much of this literature concerns proximal phalanx fractures or proximal interphalangeal joint fracture-dislocations rather than bicondylar fractures of the middle phalanx head; therefore, its application to the present injury should be interpreted with that distinction in mind.

Evidence specifically describing JESS in hand trauma includes the prospective series by Venkatesh and Ravi, which reported a 79% primary union rate and 77% good-to-excellent functional outcomes among 34 patients treated with JESS or mini-external fixators. Ravish et al reported satisfactory functional outcomes in all 20 patients in their series at 24 weeks, with 65% rated excellent and

35% good using the reported assessment criteria.^{3,4} Other reports and studies of external mini-fixation support the broader rationale of percutaneous stabilization, although differences in fracture pattern, patient selection, follow-up, and outcome measures limit direct comparison across studies.^{14,20,21} Against this background, the present case demonstrates that a modified JESS construct can maintain reduction of a selected comminuted bicondylar middle phalanx head fracture while allowing the frame to be removed at four weeks. The observed union, range of motion, grip strength, pain score, and return to computer work are encouraging for this individual patient, but a single case cannot establish superiority over plating, isolated K-wire fixation, or other external fixation methods.

Biological and biomechanical advantages of JESS

In this case, closed fluoroscopic reduction combined with JESS fixation provided several distinct advantages over traditional open plating and isolated K-wiring:

Capsulo-Ligamentotaxis is a continuous longitudinal distraction maintained by the two primary 2.0-mm K-wires and JESS rods utilized intact periosteal and ligamentous structures to realign bicondylar fragments without surgical dissection.^{3,4,14,15}

Enhanced construct rigidity is done by adding two supplementary 1.6-mm K-wires in a crossed configuration provided multi-planar rotational and anti-shear stability. This prevented fragment displacement during early passive digital motion.^{4,20}

Soft-tissue envelope and hematoma preservation is done by avoiding open surgical exposure, the local fracture hematoma and osteogenic growth factors were preserved, facilitating rapid bony union within 4 weeks.^{3,5,21}

Tendon gliding bed protection is an open plating of the phalanx frequently causes extensor tendon scarring and central slip tethering. 11–13 JESS percutaneous pin placement avoided tendon trans fixation, enabling the patient to achieve a TAM of 220° and return to computer work at 4 weeks.

Table 3: Comparative analysis of clinical outcomes across key series.

Rate	Series	Sample size	Primary modality	Union (%)	Good to excellent outcomes
77%	Venkatesh and Ravi ³	n=34	JESS/ Mini - Fix	79%	(Strickland-Glogovac)
100%	Ravish et al ⁴	n=20	JESS Frame	100%	(ASSH-TAF at 24 weeks)
Full	Hara et al ⁶	Case report	Ichi-Fixator	100%	ROM (5 months)
90%	Jha et al ⁵	Case report	Needle Cap Fixator	100%	Grip Strength
TAM - 220 degrees	Present study	Case report	JESS	100%	(Good / 95% Grip)

Comparison with published clinical literature

Our patient's functional recovery aligns closely with published prospective data. Venkatesh and Ravi reported 50% excellent and 27% good outcomes using mini-external fixators in 34 patients, noting that extra-articular and closed fractures achieved faster rehabilitation than severe open intra-articular injuries.³ Ravish et al demonstrated that JESS fixation yielded 65% excellent and 35% good functional outcomes at 24 weeks, emphasizing that JESS-treated digits recovered full motion significantly faster (6 months) than digits treated with isolated K-wires (9 months due to peritendinous stiffness).⁴

Furthermore, our construct utilized four K-wires (two 2.0-mm and two 1.6-mm), mirroring the structural stiffness principles described by Hara et al and Jha et al.^{5,6} While Hara et al. utilized the Ichi-Fixator System and Jha et al utilized a needle cap construct, the underlying biomechanical success in all cases stems from maintaining joint distraction and permitting early pin-site rehabilitation.

Safety and complication profile

Pin tract infection is the most common documented complication of external fixation, with incidence rates ranging from 8% to 18%.^{3,4,20,22} In our patient, maintaining a strict 5–7 mm skin clearance, respecting anatomical safe zones during pin placement, and enforcing routine chlorhexidine pin care successfully prevented pin-site infections, frame loosening, osteomyelitis, or neurovascular injury.

Clinical indications and limitations

JESS fixation is particularly useful in comminuted intra-articular fractures, open injuries, and fractures with compromised soft-tissue coverage, where open fixation may increase the risk of infection.^{3,4,6} Limitations of this report include its single-case design. Larger prospective randomized trials comparing JESS directly with locked micro-plating constructs in middle phalanx head fractures are recommended to establish standardized treatment protocols.

CONCLUSION

Joshi's External Stabilization System is a very safe, minimally invasive, highly effective, and economical technique for managing closed comminuted bicondylar intra articular fractures of middle phalanx head. By combining percutaneous K-wiring with capsulo-ligamentotaxis, JESS restores articular congruity, preserves fracture hematoma and soft-tissue envelopes, and prevents extensor tendon adhesion formation. This allows rapid bony union (4 weeks) and full functional restoration (TAM 220°, 95% grip strength) without complications. JESS should be strongly considered as a

primary surgical modality for complex intra-articular phalangeal fractures.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: Not required

REFERENCES

1. Díaz-García R, Waljee JF. Current management of metacarpal fractures. *Hand Clin.* 2013;29(4):507-18.
2. Fitoussi F, Ip WY, Chow SP. External fixation for comminuted phalangeal fractures: a biomechanical cadaver study. *J Hand Surg Br.* 1996;21(6):760-4.
3. Venkatesh V, Ravi GR. A rural perspective on the management of phalangeal and metacarpal fractures using mini external fixators/JESS: a prospective study. *J Popul Ther Clin Pharmacol.* 2025;32(1):303-12.
4. Ravish VN, Bharath Raju G, Yadrami SP. Functional outcome of fractures of the hand treated with Joshi's external stabilization system. *Int J Res Orthop.* 2026;12(4):1082-7.
5. Jha A, Dua A, Gadkari A, Yadav AK, Goyal N. Needle cap external fixator for proximal phalanx fracture: a case report. *J Orthop Case Rep.* 2022;12(10):107-9.
6. Hara A, Yokoyama M, Ichihara S, Maruyama Y. Treatment of an intraarticular comminuted fracture of the base of the proximal phalanx in a ring finger using the Ichi-Fixator external fixator system: a case report. *Int J Surg Case Rep.* 2020;68:12-7.
7. Naidu KVD. Management of metacarpal and phalangeal fractures with JESS fixator: a prospective study. *Int J Orthop Sci.* 2018;4(1):383-7.
8. Singh J, Jain K, Mruthyunjaya, Ravishankar R. Outcome of closed proximal phalangeal fractures of the hand. *Indian J Orthop.* 2011;45(5):432-8.
9. Gudmundsen TE, Borgen L. Fractures of the fifth metacarpal. *Acta Radiol.* 2009;50(3):296-300.
10. Kurzen P, Fusetti C, Bonaccio M, Nagy L. Complications after plate fixation of phalangeal fractures. *J Trauma.* 2006;60(4):841-3.
11. Stern PJ, Wieser MJ, Reilly DG. Complications of plate fixation in the hand skeleton. *Clin Orthop Relat Res.* 1987;(214):59-65.
12. Page SM, Stern PJ. Complications and range of motion following plate fixation of metacarpal and phalangeal fractures. *J Hand Surg Am.* 1998;23(5):827-32.
13. Hattori Y, Doi K, Sakamoto S, Yamasaki H, Wahegaonkar A, Addosooki A. Volar plating for intra-articular fracture of the base of the proximal phalanx. *J Hand Surg Am.* 2007;32(8):1299-303.
14. Joshi BB. Percutaneous internal fixation of fractures of the proximal phalanges. *Hand.* 1976;8(1):86-92.
15. Suzuki Y, Matsunaga T, Sato S, Yokoi T. The pins and rubbers traction system for treatment of comminuted intraarticular fractures and fracture-

- dislocations in the hand. *J Hand Surg Br.* 1994;19(1):98-107.
16. Badia A, Riano F, Ravikoff J, Khouri R, Gonzalez-Hernandez E, Orbay JL. Dynamic intradigital external fixation for proximal interphalangeal joint fracture dislocations. *J Hand Surg Am.* 2005;30(1):154-60.
 17. Finsen V. Suzuki's pins and rubber traction for fractures of the base of the middle phalanx. *J Plast Surg Hand Surg.* 2010;44(4-5):209-13.
 18. Sastravaha N, Limudomporn K, Taweewuthisub W. A novel technique for dynamic external fixation of proximal interphalangeal joint fracture-dislocations. *J Hand Surg Asian Pac Vol.* 2020;25(4):427-33.
 19. Kapur B, Paniker J, Casaletto J. An alternative technique for external fixation of traumatic intra-articular fractures of proximal and middle phalanx. *Tech Hand Up Extrem Surg.* 2015;19(4):163-7.
 20. Schuind F, Donkerwolcke M, Burny F. External minifixation for treatment of closed fractures of the metacarpal bones. *J Orthop Trauma.* 1991;5(2):146-52.
 21. Salunkhe RM, Joshi H, Pisal TK, Biswas SK, Patel JJ, Singh A. A prospective study of dynamic treatment of fracture phalanx and metacarpals of the hand with Kirschner-wire fixation/external fixator and finger splint: daycare management (30 cases). *Med J Dr DY Patil Univ.* 2016;9(6):708-13.
 22. Drenth DJ, Klasen HJ. External fixation for phalangeal and metacarpal fractures. *J Bone Joint Surg Br.* 1998;80(2):227-30.

Cite this article as: Sahuji S, Kanakam VR, Srinivas JV. Minimally invasive management of a comminuted bicondylar middle phalanx head fracture using Joshi's external stabilization system: a case report. *Int J Res Med Sci* 2026;14:5426-5432.