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Treatment of supracondylar fractures of the humerus in adults using a novel anatomical locking plate on the anterior distal humerus: a case report

Baoxin Zhang[1†], Wanxiong He[2†], Hao Wu[1], Ting Hao[1], Xiaolong Yang[1], Jie Cheng[1], Chao Ma[1], Guanghui Liu[1*] and Jianzhong Wang[1*]

Abstract

Background Due to its unique anatomical characteristics, supracondylar fractures of the humerus are often difficult to achieve firm fixation with internal fixation equipment, resulting in delayed functional exercise, often leaving cubitus varus deformity, elbow stiffness, contractures, and other complications. Here, we report an adult patient with a supracondylar fracture of the humerus who underwent internal fixation through an anterior median incision in the humerus with our self-developed anterior anatomical locking plate of the distal humerus.

Case presentation A 29-year-old male patient of Chinese ethnicity with trauma-induced right supracondylar fracture of the humerus and multiple soft tissue contusions, without nerve damage, blood vessel damage, or other injuries, underwent an internal incision in our hospital using a new anatomical locking plate for the anterior distal humerus fixed treatment. During the 16-month follow-up period, the patient's elbow range of motion was almost completely restored, functional scores were excellent, and there were no minor or major postoperative complications.

Conclusion In this study, we propose a surgical reconstruction strategy for adult patients with supracondylar humeral fractures. Through the anterior median incision of the humerus, open reduction and internal fixation were performed with an anatomic locking plate on the anterior side of the distal humerus to restore and fix the structure of the distal humerus, and satisfactory clinical results were achieved in our case.

Keywords Supracondylar fracture of humerus, Fracture of distal humerus, Open reduction and internal fixation, Locking plate, Case report

Introduction

Supracondylar fractures of the humerus are one of the most common types of fractures in the clinic. The clinical manifestations are elbow swelling, severe pain, and limited mobility. Some patients may have vascular and nerve damage [1, 2]. Due to the unique anatomical characteristics of the humeral condyle, it is often difficult to achieve firm fixation with internal fixation equipment, resulting in delayed functional exercise and often left cubitus varus deformity [3–5], elbow stiffness, contractures, and

†Baoxin Zhang and Wanxiong He are co-first authors.

*Correspondence:
Guanghui Liu
lgh13947162884@yeah.net
Jianzhong Wang
wjzwan@126.com
[1] The Second Affiliated Hospital of Inner Mongolia Medical University, Hohhot 010000, China
[2] Inner Mongolia Medical University, Hohhot 010059, China

other complications [6, 7]. At present, clinical treatment is more inclined to surgical treatment, mainly to achieve reduction and fixation, avoid complications, and restore upper limb motor function [8, 9].

The previous internal fixation methods include Kirschner wire tension band fixation, traditional "Y"-shaped steel plate fixation, single steel plate, double steel plate fixation, and so on [1]. However, the Kirschner wire tension band fixation method is simple and inexpensive, but the fixation strength is poor [10]. In addition, plaster external fixation is required after surgery, which is prone to loosening and fracture of internal fixation, and it is difficult to ensure the smooth healing of fractures and the recovery of elbow joint function [11]. The traditional "Y"-shaped plate cannot conform to the anatomical relationship of the distal humerus due to its fixed bifurcation angle and can only be placed in the rear, which cannot form effective compression for complex intercondylar fractures. Single-plate fixation does not conform to the double-column fixation theory for supracondylar intercondylar fractures of the humerus [8]. Internal fixation with a double plate, especially double-locking plate, is currently recognized as an ideal method for the treatment of supracondylar and intercondylar fractures of the humerus [12]. Especially suitable for C-type fractures of the distal humerus [13, 14], it can achieve the purpose of strong internal fixation and early functional exercise. The disadvantage is that it is difficult to prebend the steel plate, the operation is relatively complicated, and the range of soft tissue stripping around the fracture is relatively wide, which affects the blood supply around the fracture end to a certain extent [1, 15].

In this study, our self-developed anatomical locking plate for the anterior distal humerus (Figs. 1, 2A) was used for internal fixation of adult humeral supracondylar fractures through the anterior median incision of the humerus.

Case presentation

Medical history information

A 29-year-old Chinese ethnicity man suffered an accidental fall that resulted in a right supracondylar fracture of the humerus with multiple soft-tissue contusions and no nerve, vascular, or any other injuries. Within 24 hours after injury, open and internal fixation was performed in our hospital using a new anatomical locking plate on the anterior distal humerus. Preoperative X-rays (Fig. 2B, the patient was unable to cooperate due to severe pain, and no lateral radiographs were taken) and CT–3D scans (Fig. 2C, D) showed a supracondylar fracture of the humerus with a clear fracture line and significant displacement.

Surgical procedure

After successful brachial plexus block anesthesia, the patient was placed supine on the operating table, the shoulder joint was abducted, and the upper limb was placed on the side table of the operating table. Routine disinfection with iodophor was used to disinfect the upper part of the affected limb and the affected side of the neck, above the central axis of the thorax and the level of the nipple, and below the wrist joint. A sterile surgical drape was placed in the operating area, the trunk was covered with a sterile surgical drape, and the affected hand was tightly wrapped with a sterile surgical drape.

The surgical approach takes the fractured end as the center, and the skin and fascia layer are longitudinally incised along the anterior side of the upper arm, and the distal end of the incision reaches the cubital crease. Expose the biceps humeri and pull it medially with a retractor to expose and protect the musculocutaneous nerve. Along the middle of the brachialis the muscle belly was split longitudinally to expose the fracture and extended to the distal end to reach the coronoid fossa of the distal humerus. Continue to expose the front of the medial and lateral columns of the distal humerus down to the joint capsule. After the bone holder is reduced to the fractured end, the plate is flattened. When the anatomical locking plate on the anterior side of the distal humerus is placed, the bifurcation of the plate should be at the coronoid fossa. After it is attached to the bone surface, the sliding hole is first fixed and the position of the plate can be adjusted up and down. The end is pressurized and fixed. The screw holes were locked at both ends of the fracture, a 3.2 mm diameter drill was used to guide the drilling, and the locking screws were respectively screwed in to fix the double cortex. Fixed locking screws can be selected for the medial and lateral columns of the distal humerus, up to a maximum of 4.

Intraoperative X-ray films (Fig. 3A, B) showed that the fracture was well reduced and fixed. An indwelling drainage tube was inserted, an 8-shaped suture splitting of the brachial muscle belly was added, the biceps belly was reduced, the fascia layer and skin were sutured, a sterile gauze bandage was applied, and the patient was returned to the ward.

The drainage tube was removed 48 hours after the operation, and the active exercise of the hand and wrist, the isometric contraction of the biceps and forearm muscles, and the active elbow flexion and extension exercise were performed on the second day after the operation.

Follow-up results

Routine follow-up was performed, and the fracture was healed 3 months after the operation, and the X-ray

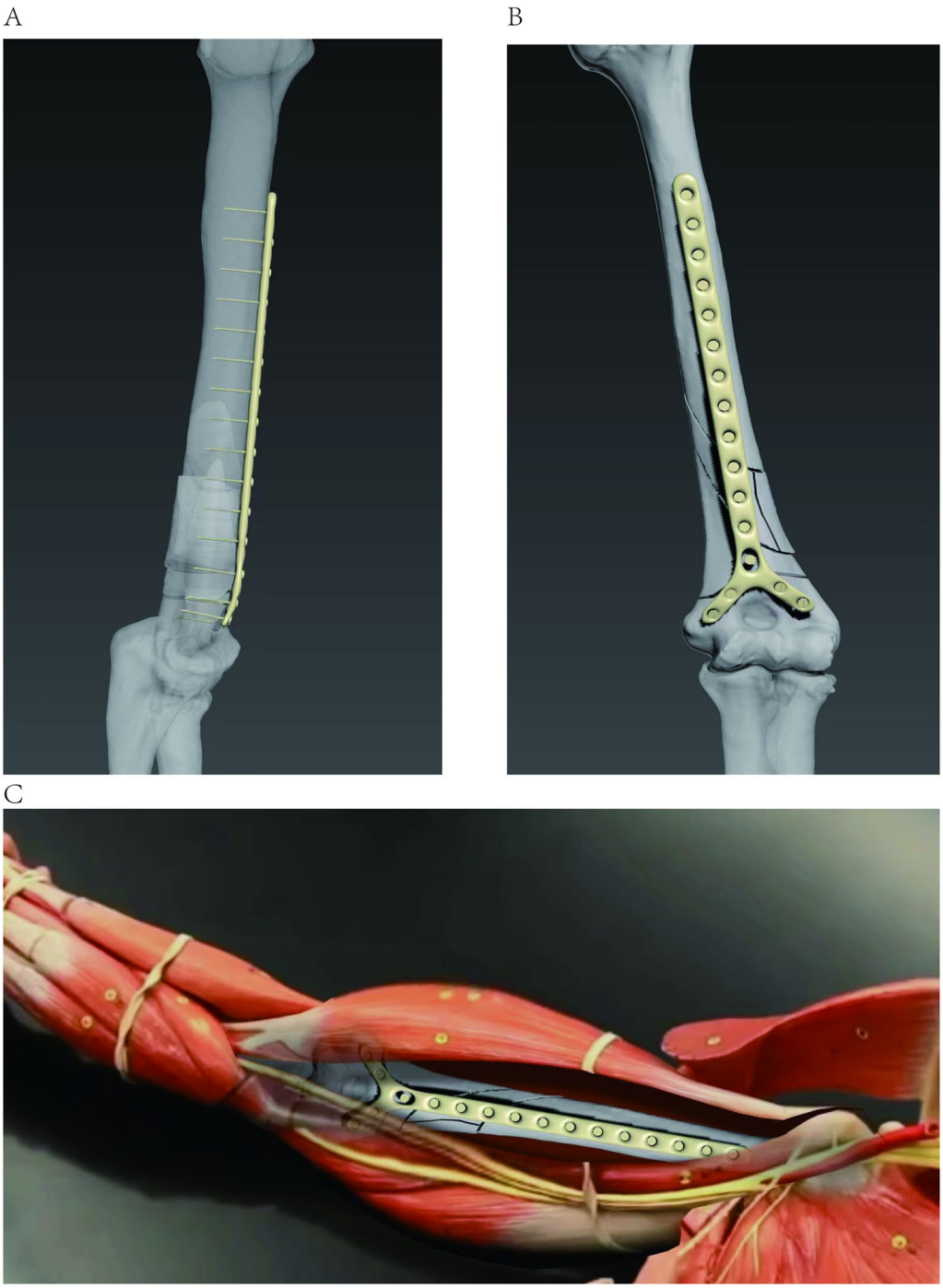

Fig. 1 Schematic diagram of anatomical locking plate for distal humerus anterior side. **A** Lateral view. **B** Orthogonal view. **C** Schematic diagram of intraoperative anatomical position

photograph (Fig. 4A) showed a continuous callus crossing the fracture line. A total of 9 months after the operation, the X-ray photograph showed the recanalization of the medullary canal at the fracture site. After 12 months, the patient's elbow was pain-free and almost fully recovered (125° elbow flexion, 0° elbow extension, 90° supination of the forearm, 65° pronation), and the Mayo Elbow Performance Score (MEPS) was 100 points (excellent).

A total of 14 months after the operation, the patient came to our department for implant removal due to

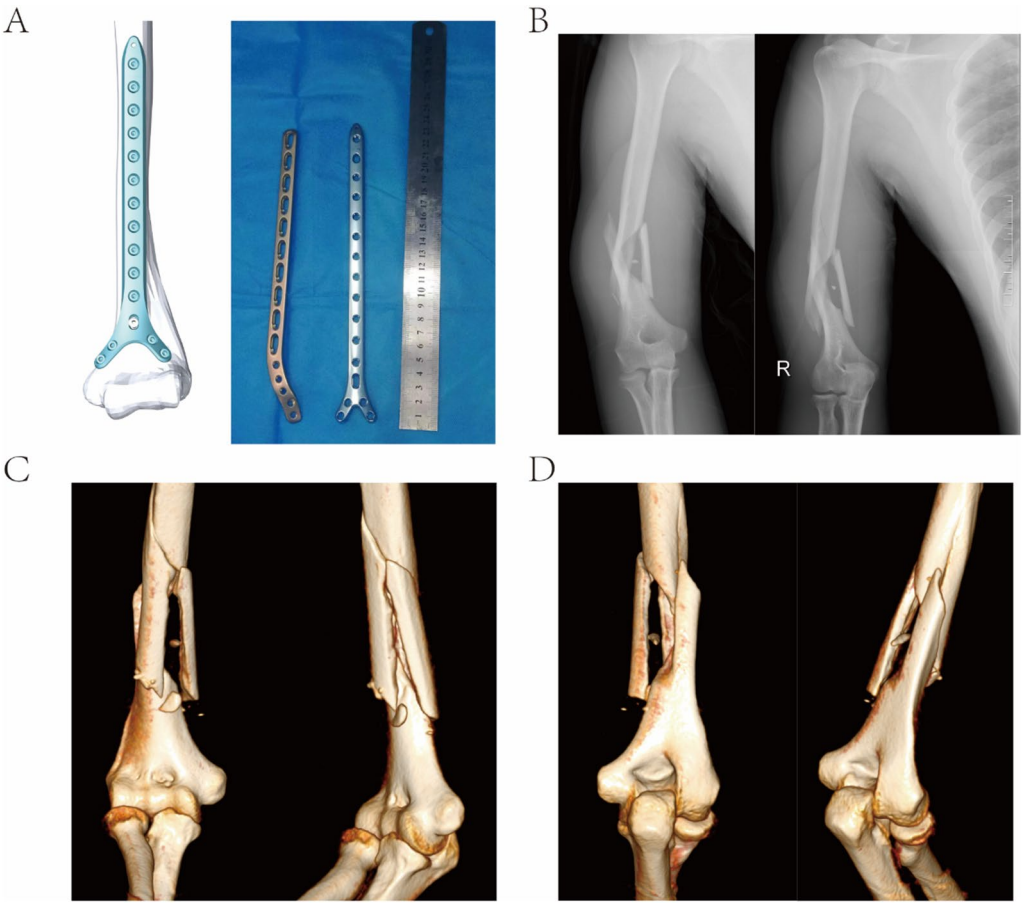

Fig. 2 Patient plate with preoperative X-ray and computed tomography (CT) 3D pictures. **A** Anterior anatomical locking plate of distal humerus; width: 13 mm, thickness: 3 mm, distal angle: 60°, length: 136 mm, 152 mm, 168 mm, 184 mm, 200 mm, and 232 mm (option of six models). **B** Anteroposterior radiographs of the distal humerus of the patient within 6 hours after injury. **C**, **D** CT–3D scan pictures of the patient within 6 hours after injury

psychological factors. He had no pain in the elbow on the injured side, with a range of flexion–extension motion of 130°–0° and a supination–pronation rotation range of 90°–80°. The MEPS score was 100 and the patient was very satisfied.

No secondary displacement or loss of reduction, implant loosening or internal fixation rupture, and significant joint degeneration were observed after 16 months of routine follow-up. After the initial fixation procedure, no other postoperative complications such as infection, nonunion, delayed union, ulnar nerve symptoms, or donor site pain occurred. After hardware removal, the overall bony structure of the affected elbow joint remained intact and function recovered well.

Discussion and conclusions

Our self-developed anterior anatomical locking plate for distal humerus is suitable for fractures from the middle and lower humerus to 2 cm above the coronoid fossa of the humerus. Anterior median incision of the humerus can be used, blunt longitudinal median separation of the brachialis muscle is performed, and a retractor is used to pull it medially to protect the radial nerve, median nerve, and brachial artery. The radial nerve does not need to be exposed during the operation. When drilling, it is recommended to limit the length of the drill bit to the length that just breaks through the contralateral cortex, so as to avoid damage to the contralateral blood vessels and nerves by the drill bit too long.

Advantages of this study

(1) Simplify the surgical process: supracondylar humerus fracture treatment requires two plates [1], now using the distal humerus anterolateral anatomical locking splints, only one plate can be fixed, the operation is more simple, and at the same time the operation time can be shortened;

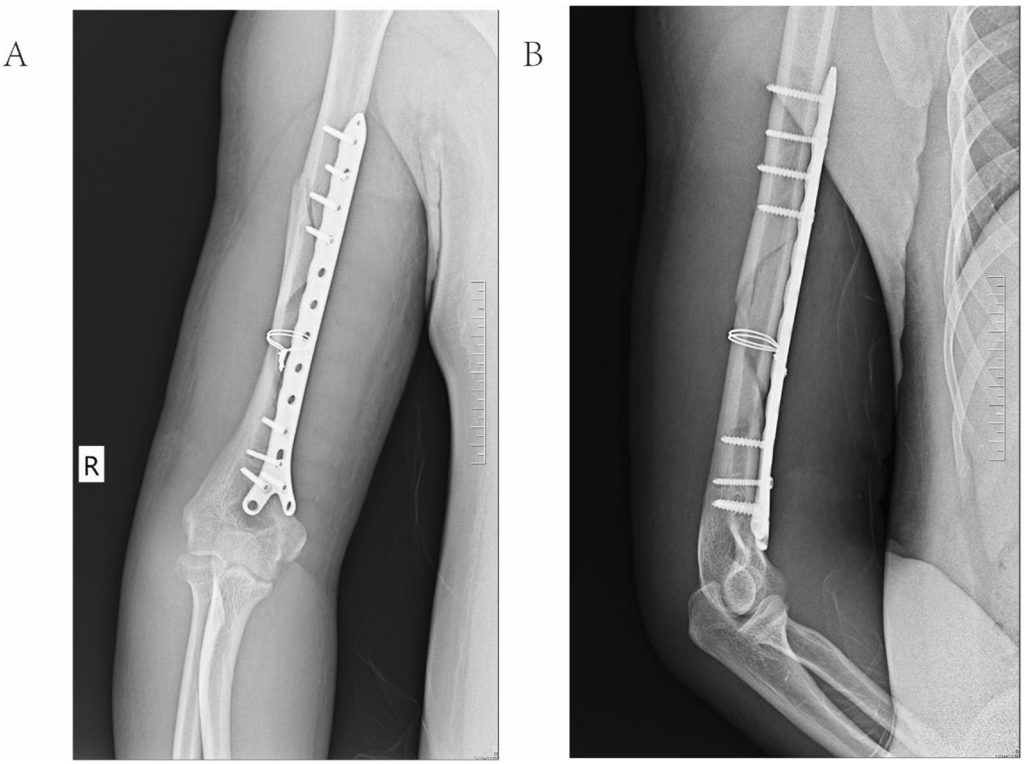

Fig. 3 Intraoperative X-ray evaluation of the patient. **A** Frontal radiograph of the patient after intraoperative plate placement. **B** Lateral radiograph of the patient after intraoperative plate placement

(2) Reduced risk of nerve injury: the radial nerve is often exposed during supracondylar humerus fracture surgery. When fixation is performed with an anterior anatomical locking splint of the distal humerus, an anterolateral incision can be made, which eliminates the need to expose the radial nerve and reduces the risk of injury to the radial nerve;
(3) Promoting early recovery: the distal end of the anterior anatomical locking plate of the distal humerus is laid flat on the medial and lateral columns of the humerus, avoiding the coronoid fossa and the olecranon fossa, and promoting the early exercise of the flexion and extension of the elbow joint, which is beneficial to the patient. The recovery of bone and joint function shortens the fracture healing time. The distal end of the plate can be fixed with four screws and the screws can be fixed to a length of about 20 mm without hurting the distal blood vessels and nerves, resulting in a safer and more reliable fixation;
(4) Safe and reliable: anatomical locking splint for distal humerus anterior side was designed with a width of 13 mm, thickness of 3 mm, distal pinch angle of 60°, and the option of six different lengths, 136 mm, 152 mm, 168 mm, 184 mm, 200 mm, and 232 mm, to be used in different cases. Our splints are more in line with the anatomical features of the distal humerus, and are capable of fixing the inner and outer columns of the distal humerus, which can maximize the stability of the triangle of the distal humerus and achieve firm fixation.

In conclusion, we propose a standardized surgical approach for adult patients with fractures of the middle and lower humerus, especially those located 2 cm above the proximal humeral coronoid fossa. Am anterior median incision of the humerus, open reduction, and internal fixation with an anatomic locking plate on the anterior side of the distal humerus was used to restore and fix the structure of the distal humerus. Satisfactory clinical results have been achieved in our case, and it is worthy of clinical promotion and use. Although we are only reporting on this patient, we have performed this procedure on over 50 patients with excellent results. However, studies with longer follow-up periods are still needed to further assess long-term clinical outcomes, especially with regard to the development of post-traumatic osteoarthritis.

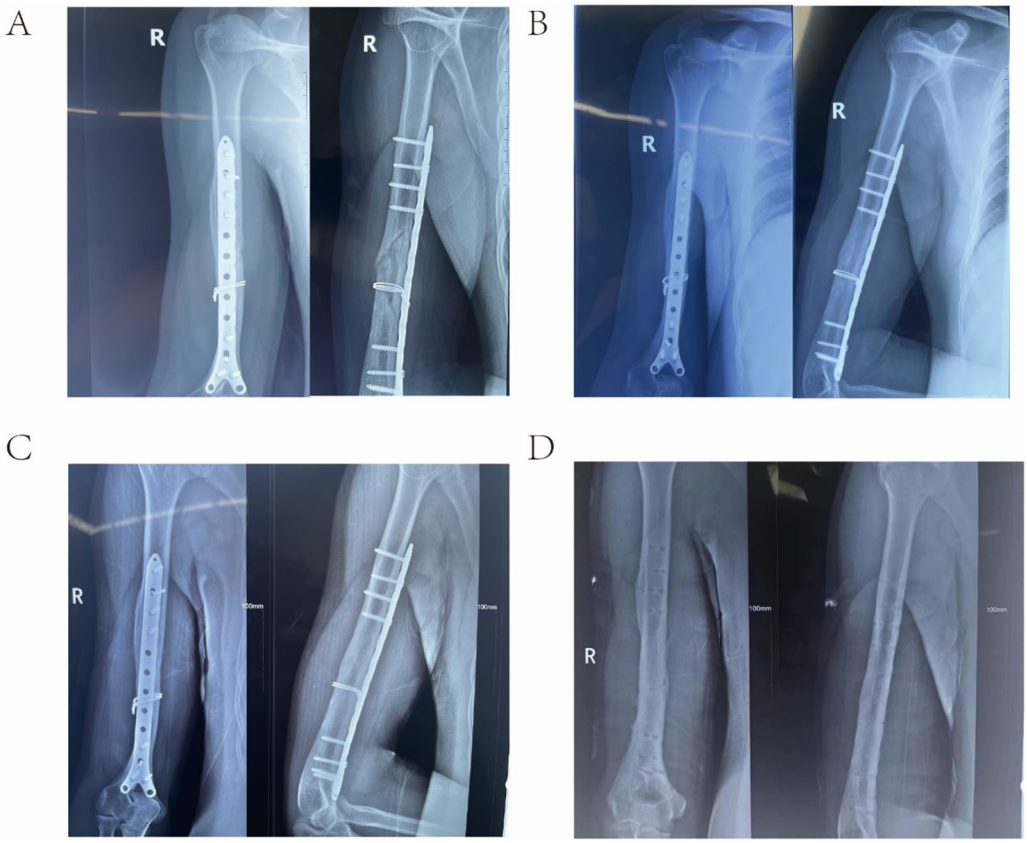

Fig. 4 Postoperative X-ray follow-up results of the patient. **A**–**C** X-ray pictures of the patient at 3 months, 6 months, and 12 months after operation. **D** X-ray pictures of the patient after removal of implants such as plates and screws at 14 months after operation

Abbreviation
MEPS Mayo Elbow Performance Score

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Author contributions
All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by GL, JW, HW, TH, XY, JC, and CM. The first draft of the manuscript was written by BZ and WH, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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

Declarations

Ethics approval and consent to participate
The research methods related to humans in this institute have been approved by the Ethics Committee of the Second Affiliated Hospital of Inner Mongolia Medical University (Ethics Review No. EFY20240013). Informed written consent was obtained from the participant included in the study.

Consent for publication
Written informed consent was obtained from the patient to publish this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Competing interests
The authors declare that they have no conflict of interest.

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