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Case Report

Delayed rupture of extensor indicis proprius (EIP) and extensor pollicis longus (EPL) following volar plating of distal radius fracture: A case report ☆,☆☆

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ABSTRACT

Distal radius fractures are the most common upper limb fractures, with volar plating being the preferred surgical approach, particularly for intra-articular and unstable fractures. While complications primarily involve flexor tendon irritation or rupture, extensor tendon injuries associated with volar plating are rare. This report discusses a 23-year-old male who experienced limited active range of motion (ROM) in the thumb and index finger of his right hand 2 years after volar plating for a distal radius fracture. Imaging studies, including radiography and MRI, confirmed satisfactory fracture healing. However, 2 screws were found protruding beyond the dorsal cortex of the distal radius. One screw extended over the Lister's tubercle, and another occupied the fourth compartment of the wrist. MRI also revealed the absence of the extensor indicis proprius (EIP) and extensor pollicis longus (EPL) tendons at the wrist level, suggesting tendon rupture. The plate and screws were removed via a palmar approach, and a 2-stage tendon graft procedure was performed to restore function. At the 1-year follow-up, the patient demonstrated excellent functional recovery, with no deficits in extending the thumb and index finger. This case highlights the risk of delayed

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multirupture of extensor tendons following volar plating of distal radius fractures, even after prolonged intervals postsurgery. Such complications, though rare, necessitate early recognition and management to prevent long-term functional impairments. Orthopedic and hand surgeons should consider this possibility during follow-ups and take preventive measures, such as ensuring screw lengths do not exceed the dorsal cortex during the initial procedure. By presenting this case, we aim to raise awareness of this potential complication and provide insights into its diagnosis, management, and prevention.

Introduction

Distal radius fractures are the most common fractures of the upper limb. They are estimated approximately 17, 5% of fractures in the adult population, according to the statistical analysis of many variable reports [1–4]. The most common treatment methods varied from closed reduction and splint, closed reduction and pinning to intramedullary fixation, external fixation, and open reduction and internal fixation, in which volar plating has been the most preferred procedure over the last decades, particularly in the case of intraarticular and unstable fractures [2,4]. The most generally recognized complications of this intervention may be distributed into the main categories: peripheral nerve concerned, tendon concerned, and hardware concerned. The rest of the postoperative complication of the palmar approach consists of infection, hematoma, and wound dehiscence which can occur with any surgical one. Most complications have been related to flexor tendon irritation or rupture, while extensor tendon injuries associated with volar plating are uncommon. The incidence of extensor tendon injury has been estimated to be 3% to 5% of the distal radius fractures plated on the palmar side. The EPL is the most commonly damaged extensor tendon [1,5].

In this article, we present a case of delayed rupture of the extensor pollicis longus (EPL) tendon and that of the extensor indicis proprius (EIP) tendon following volar plating of distal radius fracture. The main goal of our article is to alert orthopedic and hand surgeons that multirupture of extensor tendons do occur after volar plating of distal radius fracture, even after a long duration, and the secondary outcome is to confirm the diagnosis, management, and prevention of this serious complication.

Case report

Patient information

A 23-year-old man went by himself to the hospital because he presented a limit of active range of motion (ROM) of the thumb and index finger of the right hand.

The patient is a right-handed farm worker. He had no history of hand or wrist arthritis, any peripheral nerve disease, or any medical history. He underwent surgery on the right distal radius 2 years ago with volar plating of fracture after a traffic accident.

Table 1 – Type of fracture, the procedure of osteosynthesis, DASH index.

Type of fracture		Unstable and reducible
Fixation		ORIF – volar plating with LCP
DASH (Sup. 1, 2)	*1st month*	20
	24th month	57, 5

Clinical findings, diagnostic assessment, interventions, follow-up, and outcomes

The timeline of a patient's disorder can be briefly and carefully summarized as follows:

- At the time of 2 years before he came to our hospital, the patient had injured his right wrist caused by a fall onto an outstretched hand (FOOSH) due to a motorcycle accident. He was diagnosed with a distal radius fracture, which was unstable and reducible, was opening reduced, and was kept the reduction by volar plating with a locking compression plate. The affected hand was immobilized with a short arm splint for 2 weeks, took a passive movement in the third week, and then moved onto an active movement in the fourth week.
- The patient was reassessed in the first month of postoperative follow-up. Measurement with a goniometer showed that the patient's right wrist and hand had a full range of motion (Table 2). He had no pain in his wrist and a Disabilities of the Arm, Shoulder, and Hand (DASH) score of 20 (Sup.1) (Table 1) [6]. A radiograph in anterioposterior and lateral view confirmed adequate plate positioning and evidence of bony healing.
- However, 3 months after surgery, he developed functional impairment of EPL of the right thumb and EIP of the right index finger. He came back to the hospital, whose doctors operated on him to consult, but he was just explained inadequately and was instructed to physical therapy.
- After a long duration of physical therapy, he came to our hospital in the 24th month due to an uncomfortable right hand, though his right wrist could move seemingly normally. He was unable to extend his right thumb at the level of the interphalangeal (IP) joint and his right index finger at the metacarpophalangeal (MCP) joint (Table 2) (Fig. 1). He could comfortably abduct and adduct the right thumb. He presented a tenderness over the third dorsal compartment of the wrist at the Lister tubercle and the Disabilities

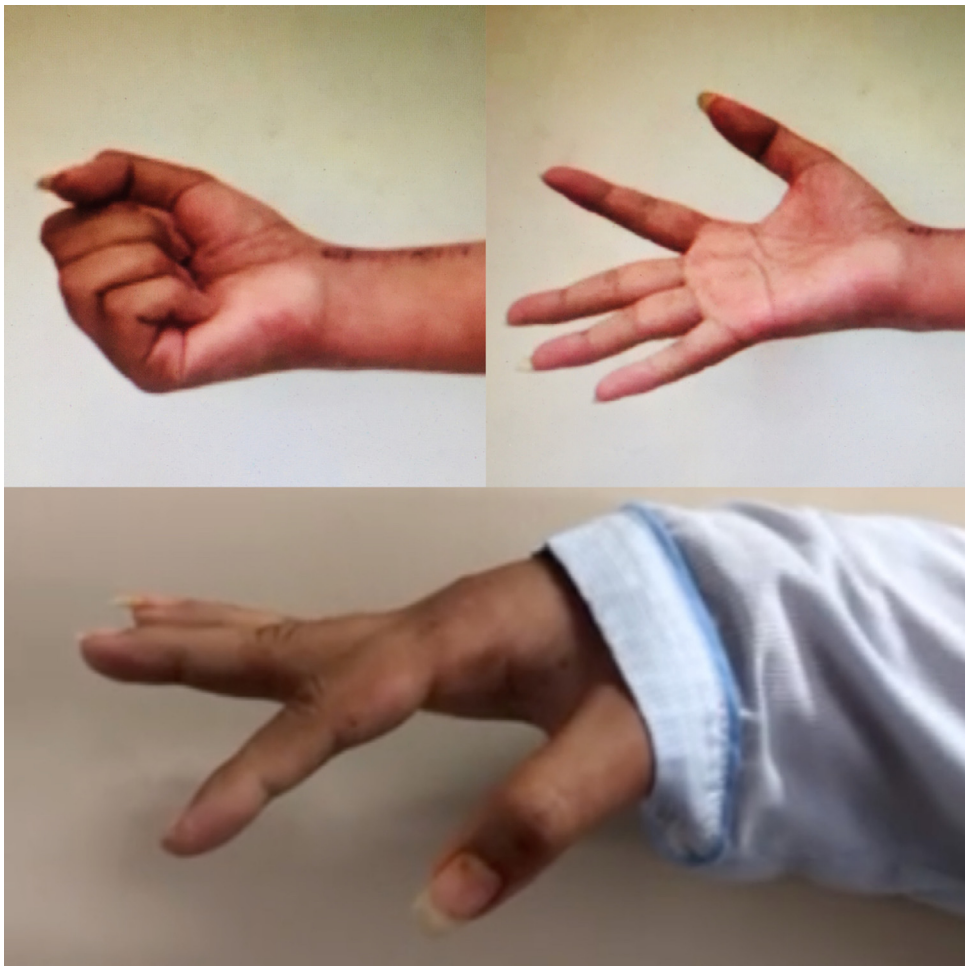

Fig. 1 – Clinical examination of the patient's right hand in the 24th month after the volar plating when arriving at our hospital: ROM of the wrist was normal, but it's unable to extend at the MCP joint of the index finger and the IP joint of the thumb.

Table 2 – Range of motion of the affected hand.

		1st month	24th month
Right wrist[a]		20/ 10/ 50/ 50	30/ 20/ 60/ 60
Right thumb[b]	*MCP*	60/ 0	60/0
	IP	80/ (80)	80/ (−80)
Right index[b]	*MCP*	90/ 40	90/ (−20)
	PIP	90/ 0	90/ 0
	DIP	90/ 0	90/ 0

[a] Flexion – extension – abduction – adduction.
[b] Flexion – extension.

of the Arm, Shoulder, and Hand (DASH) score of 57, 5 (Sup. 2) (Table 1).

He was taken an AP and lateral radiography (Fig. 2) and magnetic resonance imaging (MRI) on the right hand (Fig. 3) to confirm an appropriate diagnosis. Radiography showed that the fracture was healed in a satisfactory position, but 2 screws were passing over the dorsal cortex of the distal radius approximately 3 thread steps. We considered applying ultrasound to the wrist region to detect soft tissue injuries, particularly extensor tendon damage. The imaging findings revealed signs of inflammation and peritendinous fluid accumulation around the wrist, making it challenging to identify complete tendon rupture accurately. Therefore, MRI was subsequently selected for further evaluation. The preoperative MRI revealed that a screw over the Lister tubercle was protruding outside the dorsal cortex of the distal radius, and another proximal screw was located at the fourth compartment of the wrist. In addition, there was no evidence of the existence of the EIP and the EPL on MRI at the wrist level. He underwent exploration of the third and fourth extensor compartments of the dorsal side of the right wrist, in which we found a rupture of the EIP and the EPL with the fibrosis surrounding the 2 screws protruding outside on the course of the tendons (Fig. 4) . The plate and screws were removed by palmar approach. The first stage of tendon graft was set up by 2 silicone rods simultaneously. In the second stage, after 3 months, through the pseudosheath formed around the silicone, the fourth and fifth extensor digitorum longus tendons through tendon tunnels were

Fig. 2 – The anteroposterior and lateral radiographs of the right wrist show complete bony healing, with screws protruding beyond the dorsal surface of the distal radius.

realized by the same team. We did the sutures at each end of the tendon anastomoses by the modified Pulvertaft 3-weave technique. The patient was asked to bend his fingers on the first day after surgery and to start to move actively in the third week. At 1 year follow-up, the patient was assessed to have a very good function, and no further deficit of extending the right thumb and index finger had been observed (Vedio). No remaining tenderness over the third dorsal compartment of the wrist, and the Disabilities of the Arm, Shoulder, and Hand (DASH) score of 12, 5 (Sup. 3). He was very happy that it's able to grip, pinch, and write for his daily life and his work.

Discussion

Distal radius fractures are contemporarily one of the most popular upper limb traumas. The choice of an optimal surgical option for distal radius fractures is based on age, a serious level of injury, fracture grade, degree of stability, associated injury, and facility availability. However, there is no consensus about the best treatment strategy. Closed reduction followed by the cast, closed reduction with percutaneous pinning, intramedullary, or external fixation with K-wire, and different open reduction and internal fixation (ORIF) are recently the most common options in this fracture. Volar plating has become the preferred method for surgically stabilizing unstable or displaced distal radius fractures owing to its biomechanical benefits, procedural efficiency, and potentially lower complication rates when compared to dorsal plating. Palmar plating is recorded to decrease the risk of tendon irritation, which is one of the major complications following dorsal plate fixation [3,4,7,8].

Extensor tendon injuries following volar plating of distal radius fractures can include irritation, adhesion formation, tenosynovitis, laceration, or rupture. Two main theories have been proposed to explain the etiology of tendon rupture: the mechanical theory and the vascular theory. Common causes of tendon injury include friction with the plate or prominent screws, sharp cortical bone, and screw or drill penetration. The incidence of extensor tendon injuries after ORIF with a volar plate is reported to be 3%-5%, with the extensor pollicis longus (EPL) tendon being the most frequently affected. Tendon damage may occur due to drill penetration, excessively long screws from a volar plate, or prominent bone edges, particularly near or distal to Lister's tubercle. The fourth compartment extensor tendon can still be injured almost exclusively after ORIF with the volar approach because of the impingement on prominent screw tips. In our case, there was no evidence proving that tendon rupture was damaged by displaced fracture patterns or

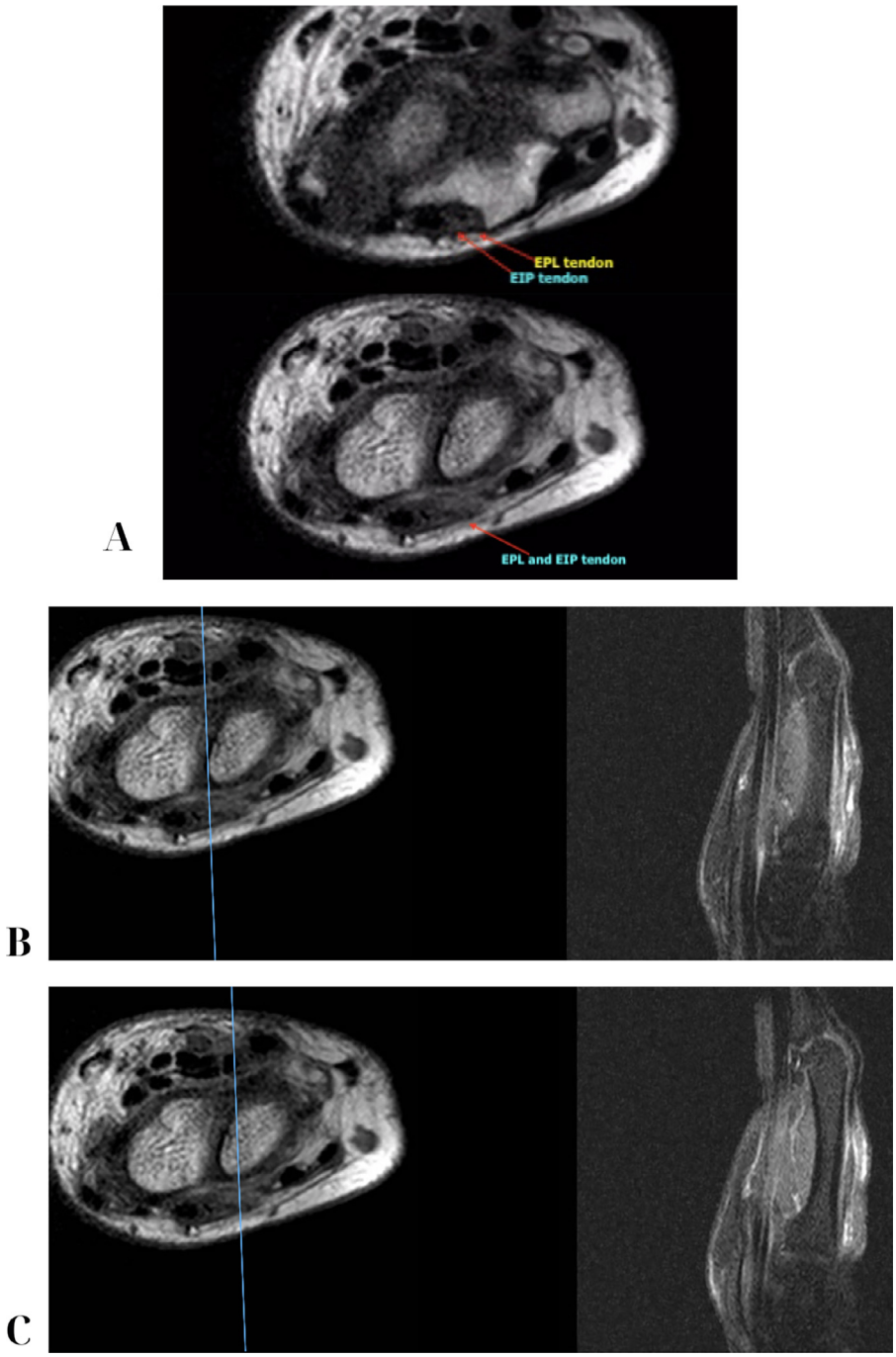

Fig. 3 – The MRIs at the level of Lister's tubercle in the right wrist reveal complete disruption of both the extensor pollicis longus (EPL) and extensor indicis proprius (EIP) tendons. (A) The T1W-TSE axial MRI images show the signal loss of EIP and EPL tendons; (B) The T1W-TSE axial and PDW Spair sagittal images show the signal loss of EIP; (C) The T1W-TSE axial and PDW Spair sagittal images show the signal loss of EPL.

the entrapment between the extensor tendons and the fracture surface with volar displaced fractures. Through the clinical examination, traditional radiograph images, and MRIs, it's visible that the extensor pollicis longus and the extensor indicis proprius were found to be ruptured due to the screw's penetration into the third and fourth extensor compartments. When there are die-punch bone blocks in clinical distal radius fractures, we may use longer screws to cause tendon rupture. If the metacarpal bone block is difficult to fix, sometimes we choose the dorsal approach to insert the implant, which is also the cause of tendon rupture in the later stage. In this case, we expected that we had applied subjectively the longer screws without the control under the fluoroscopy.

Measurement of the appropriate length of the screws during surgery is frequently difficult. Traditional radiographs, including anteroposterior and lateral views, may fail to accu-

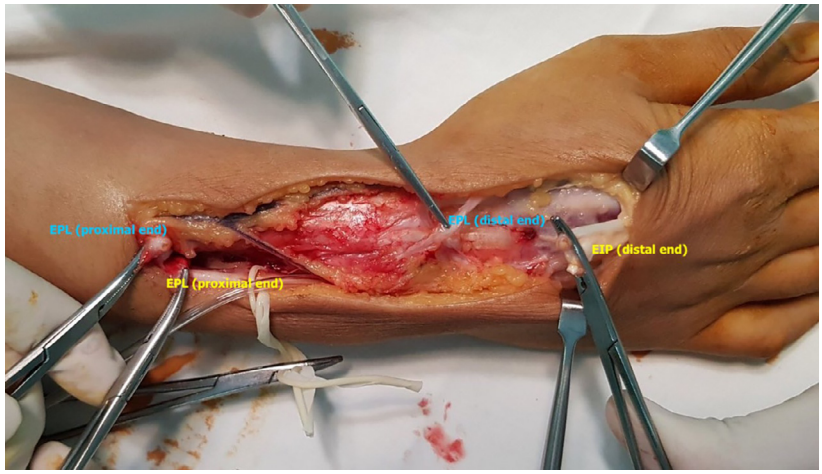

Fig. 4 – Intraoperative images present the loss of the EPL and EIP tendons requiring the tendons graft.

rately depict the screw length along the dorsal rim of the distal radius [1,5]. Recent studies have confirmed that the position of the volar plate relative to the watershed line is a key predictor of flexor pollicis longus tendon complications [9]. However, the length of radial-sided screws near Lister's tubercle or the management of dorsal comminution in this area may serve as stronger predictors of tendon-related complications, particularly those involving the extensor tendons. The protruding screw tip with one or 2 millimeters may be acceptable to prevent the irritation of extensor tendons. But we don't need to penetrate the dorsal cortex because it accounts for 75% screw length strong construct, especially in extra-articular fracture [14]. Lateral radiographs which evaluate the length or the placement of the screw may be difficult because Lister's tubercle may hide the prominent screw tips dorsally. In this situation, the dorsal tangential fluoroscopy is a better method to determine the length of screws. The skyline view is more effective than the lateral fluoroscopic view in detecting screw protrusion in the distal fracture fragment after volar locked plate fixation [12]. A multislice CT scan will also be a useful option to measure the appropriate screw length and to detect the fragment arrangement at the post-operation and follow-up duration. [1,5] CT scans don't have the value to suspect tendon irritation or rupture, so we need to take an ultrasound or MRI to detect the reactive inflammation or the sign of tendon discontinuity. Ultrasound and MRI are both crucial for assessing tendon and ligament abnormalities. Ultrasound offers dynamic imaging capabilities, allowing for the assessment tendon movement under stress, but it is limited by its inability to penetrate bone and requires an optimal probe orientation to avoid anisotropy artifacts [17]. MRI, on the other hand, provides comprehensive imaging of deeper structures and is better suited for detecting complex tendon tears or associated injuries, though it may not offer the same dynamic assessment as ultrasound [18]. In our study, ultrasound was used to assess a suspected extensor tendon injury in the wrist, but definitive rupture could not be confirmed due to operator dependency [19] and significant soft tissue swelling. The close proximity of the tendons to osseous structures and their compartmentalized positioning further limited optimal imaging [17,20]. These factors made it challenging to distinguish true pathology from normal anatomical variations. Given these limitations, MRI was performed to more precisely evaluate tendon integrity. However, a CT scan and MRI may not be applied during operation so we need to remind that a dorsal tangential x-ray is a good option.

In our case, the excessively long screw was a significant factor. We suggest that the prominence of Lister's tubercle and the depth of the EPL groove may obscure the surgeon's ability to accurately evaluate distal screw protrusion during volar plating, as it is not clearly visualized under fluoroscopy. Furthermore, the close proximity of the tendons to the radius, combined with their confinement within compartments, increases the likelihood of tendon irritation or injury [10,11].

Concerning an anatomy study, some authors assumed that the Watershed line is the limited distal margin for plating of the distal radius fracture to minimize tendon complications because this line is the closest point to the tendons [15,16].

Regarding the management as soon as we detected the damage of the extensor tendon, we made 2 volar and dorsal approaches to look for the position of the injury and to remove the osteosynthesis materials. The optimal technique for managing tendon rupture following volar plating of the distal radius remains a topic of debate. Tendon transfers is widely regarded as a dependable approach for addressing both flexor and extensor tendon injuries. However, it is employed more frequently for extensor tendon ruptures (88%) than for flexor tendon issues (36%), owing to the consistent success and reproducibility of the extensor indicis proprius (EIP) to extensor pollicis longus (EPL) transfer. [3] In clinical practice, EIP and EPL play an important role. If a simple EPL rupture occurs, EIP transposition can be chosen as compensation. The principle is that the 2 have continuous nerve innervation and can compensate for each other. However, in our case, there was a complex injury with the loss of long segments of both EPL and EIP tendons, so we did not have enough long tendons to transfer. In addition, there appeared to be too many fibrotic and scar tissues in the wrist area, which may cause secondary peritendinous adhesion. Therefore, we applied the 2-stage tendon graft with the donor tendons from the fourth and fifth exten-

sor digitorum longus tendons of the left foot to restore both of them.

Regarding the suture technique, we chose the modified pulvertaft 3-weave technique for each end of the tendon anastomoses. This technique, potentially allows it to be used with early active motion protocols after tendon transfers [13].

Conclusion

The volar approach remains a widely utilized technique for the reduction of distal radius fractures, requiring meticulous attention to minimize complications. Intraoperative oblique fluoroscopic views, particularly the dorsal tangential view, are essential for assessing fracture alignment and the positioning of plates and screws. Postoperative CT scans should be considered when radiographs fail to confirm accurate screw placement and length. Key technical considerations include careful drilling to avoid breaching the dorsal cortex and preventing iatrogenic extensor tendon injury. In osteoporotic bone with dorsal comminution, unicortical epiphyseal screws or screws shorter by at least 2 mm are recommended. If extensor tendon injury is suspected due to screw prominence, hardware removal, clinical examination, and wrist MRI are advised for diagnosis. In cases where primary tendon repair is unfeasible, tendon transfer or grafting may be appropriate alternatives.

Ethical approval

Ethical approval for this study was not applicable to my institution's ethical review board. The study protocol adhered to the ethical standards outlined in the 1964 Declaration of Helsinki and its later amendments. All procedures performed in this study involving human participants were in accordance with these standards.

Author contributions

Nhat Dang Huy Nguyen: Conceptualization, Methodology, Software, Data curation, Formal analysis, Investigation, Writing—Original Draft, Writing—Review and Editing, Project administration, Supervision. **Huy Anh Pham:** Visualization, Investigation, Writing—Review and Editing. **Phi Duong Nguyen:** Supervision.

Patient consent

Complete written informed consent was obtained from the patient for the publication of this study and accompanying images.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.radcr.2025.03.028.

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