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## Case Report

## Closed Ring Avulsion Injury With Isolated Arterial Insufficiency

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Ring avulsion injuries are an uncommon, often catastrophic, pattern of digit injuries that result from sudden traction onto a ring-bearing digit. The reconstructive treatment of these injuries can be complex because of the characteristic involvement of nerves, muscles, vasculature, and bone. There is paucity of literature describing isolated arterial injuries in the absence of overlying soft tissue and underlying bone involvement. We present an unusual case of a closed ring avulsion injury, wherein a patient initially presented to his local urgent care center with a cool and pale digit without wounds or fractures, and abnormal pulse oximetry readings prompted his transfer to a tertiary care center for further evaluation. Surgical exploration demonstrated isolated disruption of both digital arteries and the preservation of both digital nerves. The digit was successfully revascularized with venous autografting and stripping of arterial thrombi.

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Closed ring avulsion injuries with vascular compromise are a remarkably rare pattern of hand injuries. In patients with no skin discontinuity or an underlying fracture, the diagnosis of closed digital artery injuries can be overlooked and poses a diagnostic challenge to clinicians. The definitive treatment for dysvascular digits secondary to ring avulsion injuries is a prompt microsurgical intervention for revascularization. Delayed treatment can lead to irreversible ischemia, which may necessitate the amputation of the affected digits.<sup>1</sup> Although very few reports of closed digital vascular injury exist, the consequences of a missed diagnosis can be devastating.<sup>2–6</sup> We describe a unique case of a patient who experienced a traction injury to his left ring finger with minimal soft tissue injury and no underlying fracture; upon surgical exploration, he was found to have complete disruption of both the radial and ulnar digital arteries, whereas both digital nerves remained in continuity.

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**Written informed consent:** Written informed consent was obtained from the patient for publication of this case report and accompanying images.

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## Case Report

A 63-year-old otherwise healthy right-handed man presented with an injury to his left ring finger. The patient was working on his boat, when he slipped, and his wedding ring got caught on a part of the boat, leaving him suspended by only his finger for several seconds. He applied ice to his hand and immediately sought medical attention at his local urgent care center in Alaska. Initial evaluation was notable for a pale, edematous, and cool finger with loss of sensation distal to the proximal interphalangeal joint, without radiographic evidence of a fracture or dislocation (Fig. 1). Although there was some reported improvement in the appearance of the digit once heat was applied, pulse oximetry readings were consistently low, ranging from 55% to 73%; therefore, he was transferred to our institution for further evaluation.

Upon arrival at our facility over 7 hours later, the patient reported that his finger felt better and noted improvements in sensation at the distal fingertip. Clinical examination demonstrated a clearly demarcated level of injury just proximal to the proximal interphalangeal joint, with significant distal ecchymosis and poor tissue turgor (Fig. 2). There was diminished sensation on both the radial and ulnar aspects of the distal left ring finger. Attempted pulse oximetry reading measurements were unsuccessful because of a poor waveform. On pencil doppler examination of the radial and ulnar digital arteries, a strong arterial pulse was found at the base of the finger but was unable to be detected distal to the



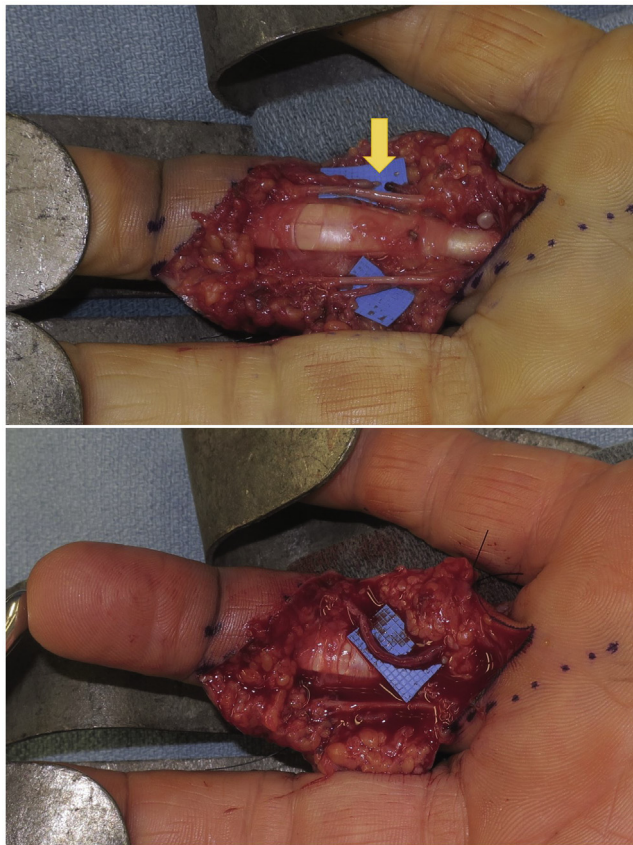
**Figure 1.** Photographs from the initial evaluation at the patient's local urgent care center showed a pale and edematous left ring finger with minimal soft tissue injury. The radiographs were negative for a fracture or dislocation.



**Figure 2.** Upon transfer to our institution, repeat examination revealed ecchymosis and dusky appearance of the left ring finger at the proximal interphalangeal joint.

proximal interphalangeal joint. A small, superficial abrasion was the only soft tissue injury. Moreover, he had full active range of motion of the digit.

The patient was taken to the operating room for surgical exploration within 4 hours of his arrival (Fig. 3). Both the radial and ulnar digital nerves were found to be in continuity at the level of



**Figure 3.** Intraoperative exploration of the left ring finger demonstrated complete transection of the ulnar digital artery (top; arrow), whereas both digital nerves remained in continuity. The digit was revascularized using a vein graft to bridge the gap in the ulnar digital artery (bottom).

the injury. The radial digital artery was intact but occluded with a thrombus. The ulnar digital artery was transected with a 1.5-mm gap. Reconstruction of the ulnar digital artery was performed with vein grafting from the distal volar forearm. Once the anastomoses were complete, the tourniquet was released, and there was immediate perfusion across the vein graft into the distal finger, with visible pulsatile flow across the area of the repaired ulnar digital nerve and improved capillary refill of the fingertip. Upon inspection of the radial digital artery, we discovered a complete obstruction due to the thrombus; therefore, the artery was stripped until flow was re-established. The patient was prescribed 81 mg of aspirin twice daily for 30 days. His hospital course was uncomplicated, and he was discharged on postoperative day 2. At subsequent follow-up, he did not have any issues with vascular perfusion to the digit, and his sensation had improved; he was noted to have some stiffness, for which he was referred to the hand therapy department. He worked closely with our hand therapists via telemedicine for 3 months after the surgery, until he regained excellent function of the digit. At 16 months after the surgery, he continues to do well, with full range of motion (Fig. 4).

## Discussion

Ring avulsion injuries encompass a broad spectrum of injury patterns, with presentations ranging from simple soft tissue compression to complete degloving or digital amputation. As such, several classification systems have been developed to standardize their reconstructive management based on specific

injury patterns. The initial classification system proposed by Urbaniak et al<sup>7</sup> in 1980 stratified ring avulsion injuries into 3 classes based primarily on the adequacy of vascular circulation and the extent of soft tissue and bone damage. Class I injuries were defined as those with preserved circulation, in which standard soft tissue and bone care were sufficient for the restoration of function. Class II injuries were defined as those with inadequate circulation, necessitating vessel repair for the preservation of digit survival and function. Finally, class III injuries were defined as those that resulted in the complete amputation or degloving of the involved digit, which require complex management. Nissenbaum<sup>8</sup> expanded upon the classification system established by Urbaniak et al,<sup>7</sup> introducing classes IIA and IIB; class IIA injuries have isolated arterial insufficiency, whereas class IIB injuries involve inadequate circulation plus a bone, tendon, or nerve injury.

The subtle presentation of class IIA injuries may lead to increased risk of missed diagnoses because patients initially present with near-normal range of motion and nonspecific symptoms, such as decreased temperature and mild loss of sensation in the affected digit.<sup>8</sup> Such injuries can be remedied using straightforward microvascular repair, with a reported average total arc of motion of 240° for class IIA injuries specifically and 187° for class II injuries, broadly, with a 91% success rate.<sup>1,8</sup> Recently, in a systematic review, Sears and Chung<sup>9</sup> reported a mean total arc of motion of 199° in patients who underwent revascularization for the treatment of incomplete avulsion injuries. The study defined incomplete avulsion injuries as those involving inadequate arterial or venous circulation without complete degloving or amputation.<sup>9</sup> Although a highly effective treatment for these injuries exists, missed diagnoses can be devastating, leading to total ischemia and the loss of the affected digit.

In our case, the patient presented with a classic history of a ring avulsion, with a forceful traction injury to his left ring finger; however, he had only a superficial skin abrasion, had no underlying fracture or dislocation, and had completely preserved range of motion. In our initial phone conversation with the referring provider in Alaska, the reported clinical examination was somewhat equivocal, especially in the description of the improvement during their period of observation. We requested that they send us photographs and measure the oxygen saturation of the digit using pulse oximetry, both of which raised concerns for a vascular compromise and prompted the patient's transfer for surgical exploration.

For emergency and urgent care providers in the community, the presentation of class IIA ring avulsion injuries might be ambiguous and at risk of misdiagnosis. Classically, a suspected isolated arterial insult to the digits is confirmed through doppler studies or intravenous digital subtraction angiography. More recently, the use of pulse oximetry for the quantification of vascular injuries in the hand has greatly simplified this diagnostic evaluation, especially because it is noninvasive and widely available. Tarabackar et al<sup>10</sup> demonstrated that digits with a pulse oximetry reading lower than 84% had an ischemic injury and required a surgical intervention, whereas readings of 95% or higher were not suggestive of ischemia. Hand surgeons must remain vigilant, particularly during phone consultations in which clinical decisions are often made with incomplete information provided by outside providers with varying degrees of expertise in hand injuries. In addition to radiographs, objective information including pulse oximetry and photographs are useful adjuncts for assessing a patient, and in this case, these resulted in the patient's appropriate transfer and the surgical management of his dysvascular finger secondary to a ring avulsion injury.



**Figure 4.** Sixteen-month postoperative examination of the range of motion demonstrates full flexion and extension of the metacarpophalangeal, proximal interphalangeal, and distal interphalangeal joints.

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