

Case Reports

Below Elbow Amputation Due to Ischemic Complications after Radial Artery Cannulation: A Case Report

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The patient is a 57 year old male with peripheral vascular disease and a non-healing thumb wound. After radial artery catheterization (RAC), he developed pain and numbness in the radial-sided 3.5 fingers and pulse oximetry readings <80%. With a possible diagnosis of carpal tunnel syndrome due to increased pressure, the patient underwent a carpal tunnel release (CTR) one week after the catheterization and reported immediate pain relief. Unfortunately, his wound failed to heal, and his pain returned one week later. Another operation was performed to decompress the carpal tunnel; however, the pain worsened, and fingertip necrosis progressed, including the thumb, index, and middle fingers. An angiogram showed arterial calcifications, ruling out reperfusion of the hand. A trans-forearm amputation was performed. This case highlights overlapping symptoms of ischemia and median nerve compression as well as the risk of hand ischemia after RAC in those with circulatory compromise.

INTRODUCTION

The radial artery is the preferred vessel for cardiac catheterization, generally providing safe access to perform cardiac procedures with an overall complication rate from vascular access of 0.59%.^{1,2} Complications can include radial artery spasm, occlusion, perforation, pseudoaneurysm, and arteriovenous fistula formation.²⁻⁴ Very rarely, circulatory compromise can lead to hand ischemia following radial artery catheterization (RAC).⁵ Another rare complication is acute carpal tunnel syndrome (ACTS), which is a progressively worsening median nerve neuropathy stemming from escalating pressure within the restricted confines of the carpal tunnel.⁶ This paper discusses a case in which a patient developed both ACTS and hand ischemia, leading to amputation.

CASE REPORT

A 57-year-old male presented to the orthopedic clinic following pain and numbness in the fingers of his right hand five days after a complicated radial artery catheterization. The patient complained of diminished sensation in the radial 3.5 fingers consistent with median neuropathy with

pronounced pain in the index and middle fingers, swollen right forearm and hand, dusky fingertips involving the 3.5 radial fingers, positive Tinel's test, and inability to move fingers due to pain. The patient's medical history included peripheral vascular disease, coronary artery disease, cerebral vascular accident, diabetes, stage 5 chronic kidney disease on chronic dialysis, hyperlipidemia, and hypertension.

The patient was diagnosed with acute carpal tunnel syndrome (ACTS) and underwent urgent carpal tunnel release (CTR) surgery. During CTR, the median nerve was slightly pale at the carpal tunnel level and was congested proximally. No hematoma within the carpal tunnel and the deep compartment was visualized. However, clear fluid was evident, discharging constantly into the carpal tunnel. A Penrose drain was placed to drain residual oozing within the deep compartment and maintain carpal tunnel decompression. Immediately after surgery, pain resolved, and loss of sensation diminished, although pulse oximetry was still 80% and unchanged from before CTR.

Within three weeks, he presented with recurrent and aggravated pain and numbness in the median nerve distribution again. The patient's pulse oximetry was consistently reading low at 80%. In addition to pain, he had a limited range of motion, cold fingers, and poor wound heal-

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Figure 1. 6 weeks after the initial carpal tunnel release with worsening of finger cyanosis involving the thumb, index, and middle fingers due to compromised circulation.

ing, which are signs of vascular compromise. The vascular surgery service also saw the patient, which recommended no surgical intervention. Given this constellation of symptoms, the patient underwent repeat CTR along with fasciotomy of the distal forearm extending to the palmar arch and exploring any evolving hematoma. Wound dehiscence was noted during the second surgery.

The patient did not report any relief after the second surgery, and the pain progressively worsened. He continued to show signs of limited perfusion with dusky fingers and dry gangrene of the thumb, index, and middle fingers ([Figure 1](#)). An angiogram was performed to assess for reconstructive options to restore circulation and salvage the hand in hopes of avoiding amputation; however, diffuse calcification was present throughout the arteries ([Figure 2](#)). Plastic and vascular surgery consults confirmed amputation was the only option as reperfusion was nonviable. The hand was amputated through a trans-forearm approach due to recalcitrant progressively worsening pain with limited residual hand function.

The patient expressed substantial pain relief, allowing him to sleep the day after amputation.

DISCUSSION

Hand ischemia and ACTS are two of the most morbid complications of RAC, leading to amputation and permanent neurologic deficits, respectively.^{5,7} Prompt diagnosis and management are essential when either condition is suspected.

Acute carpal tunnel syndrome usually presents with symptoms of median nerve neuropathy within hours to days after an injury to the wrist.⁷ ACTS commonly occurs in the setting of trauma⁸ but has also been reported as a complication of RAC.⁹ The theoretical reason is that spasms in the radial artery lead to muscle ischemia and subsequent tissue swelling, leading to median nerve compression in the carpal tunnel.¹⁰ This mechanism is consistent with the dusky fingertips and swelling observed in this patient. Another theory is that the position of the wrist during RAC may contribute to the development of ACTS.¹¹ Although wrist flexion is believed to produce the greatest median nerve compression, as demonstrated by Phalen's sign, hyperextension, which is the position used for RAC, can also cause median neuropathy.¹¹ Another cause can be hematoma within the carpal tunnel, leading to a situation analogous to compartment syndrome where high intracarpal pressure cuts off vascular supply to the nerve.¹² Regardless of etiology, the treatment for ACTS is urgent surgical decompression.^{13,14} Compared to elective CTR for chronic CTS, a longer incision is required to thoroughly assess the soft tissues surrounding the carpal tunnel that may be causing the compression.⁶

Twenty-five to thirty three percent of patients experience reduced blood flow or thrombosis in the radial artery after RAC.¹⁵ However, in most cases, the ulnar artery and the complete palmar and dorsal carpal arches are able to maintain blood supply to the hand,¹⁶ and cases of hand ischemia occur in 0.09% of patients.^{17,18} In this case, our patient had a history of vasculopathy and a non-healing wound in his thumb. Hypercoagulable states, which can occur due to chronic kidney disease,¹⁹ has also been listed as a risk factor⁵ although our patient has been taking anticoagulation medication. Upper extremity angiography performed three months before his RAC indicated stenosis of the radial artery and complete occlusion of the ulnar artery at the wrist. This lack of collateral circulation placed him at high risk of ischemia, making RAC inappropriate in this patient.

In patients with symptomatic radial artery thrombosis and severe vasospasm in the ipsilateral hand, nonoperative treatment involving anticoagulation and vasodilators is often suitable; however, those with hand ischemia and absent arterial flow typically need operative thrombectomy and radial artery repair.⁵ Unfortunately, arterial calcifications made our patient a poor candidate for revascularization, and his intractable pain and progressive finger necrosis left no other option but amputation.

This case underscores the serious risks of RAC, like acute carpal tunnel syndrome and hand ischemia, which in severe cases, can lead to amputation. Physicians should consider RAC alternatives when treating patients with peripheral vascular disease, as they're at a higher risk for these complications. Additionally, ischemia and median nerve compression may present together, and promptly addressing both issues with revascularization and decompression respectively may lead to better outcomes. Unfortunately, even with proper treatment, some cases will progress to amputation.



Figure 2. Right upper extremity angiogram showing a short segment of occlusion of the distal radial artery (blue arrow). The ulnar artery tapers distally (red arrow). Right hand run-off demonstrates a single supply via the radial artery and tiny collaterals arising from the interosseous artery. The radial artery ultimately supplies the hypothernar region with sluggish flow to digits 2 and 3 and the base of the thumb. No significant arterial supply to digits 4 and 5.

DECLARATION OF CONFLICT OF INTEREST

The authors do NOT have any potential conflicts of interest for this manuscript.

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