

Forearm Compartment Syndrome in a Patient On Hemodialysis Following Failure Of an Arteriovenous Fistula

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Compartment syndrome is a surgical emergency requiring rapid diagnosis and fasciotomy. The diagnosis can be established with clinical signs, including pain out of proportion to injury, pain on passive muscle stretch, swelling, sensory changes, and later, paralysis. This diagnosis may be confirmed by percutaneous pressure monitoring, which may be used to monitor a suspicious compartment after the development of soft tissue swelling (McQueen, Christie, & Court-Brown, 1996).

Compartment syndrome is associated with a complication rate of up to 42%, including Volkman's ischemic contracture, loss of function, neurologic deficits, delayed fracture union, and chronic pain (Duckworth et al., 2012). Compartment syndromes not managed emergently may cause extensive muscle damage and even loss of limb (Brown, Greenhalgh, Kagan, & Warden, 1994). Although forearm compartment syndrome is well-documented, compartment syndrome in adults most commonly occurs following distal radius fractures. It may also take place following supracondylar fractures of the elbow in children (Kalyani, Fisher, Roberts, & Gianoudis, 2011).

Arteriovenous (AV) fistulae are used in patients for whom long-term hemodialysis is necessary and is associated with increased survival for patients with chronic renal failure with a reported complication rate of 16% (Fokou et al., 2012). Although rare, a case report of a patient who developed compartment syndrome following an attempted puncture of a radio-cephalic AV fistula for hemodialysis is presented here. We would like to draw attention to the possibility of this event to raise clinical suspicion by the hemodialysis team in patients who develop swelling post-puncture of an AV fistula by the hemodialysis team. With rapid recognition and treatment, major muscle ischemia can be avoided, and future function of the forearm can be salvaged.

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Callahan, C., Anderson, C.I., & Clarkson, J.H.W. (2013). Forearm compartment syndrome in a patient on hemodialysis following failure of an arteriovenous fistula. *Nephrology Nursing Journal, 40*(5), 457-460.

Key Words: Compartment syndrome, surgical emergency, percutaneous pressure monitoring.

Patient Case Presentation

A 66-year-old Caucasian male with renal failure was undergoing regular hemodialysis with a radiocephalic AV fistula in his left arm. The AV fistula had been in place and functional for approximately one month at this time. The patient had a history of coronary artery disease, arrhythmias, hypertension, and diabetes mellitus. His current medications include aspirin 81 mg once a day and clopidogrel 75 mg daily.

During his dialysis session, there was difficulty in gaining access via the AV fistula, and a double lumen central venous catheter (CVC) had to be used. Despite some mild initial swelling, the patient was discharged home. Within two hours, he noticed increasing swelling and pain in his arm, and returned to the Emergency Room. Upon presentation, his forearm was noted to be swollen and painful with clear subcutaneous blisters. Laboratory values included a white blood count (WBC) 7.6 K/uL, hemoglobin 10.4 g/dL, hematocrit 28.9%, platelets of 151, a PT of 13.2 seconds, and INR of 1.2. Electrolytes were in the

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normal range. A computed tomography (CT) scan without contrast of the left forearm showed numerous vesicular-type lesions all over the forearm, with soft tissue thickening and stranding and edema. No abscess was identified. Duplex ultrasound showed the AV fistula to be patent in the left forearm.

Within four hours of dialysis, the patient was evaluated by plastic surgery. The forearm was noted to have tense swelling with the hand and wrist held in a flexed posture, and pain on passive extension of the fingers (see Figure 1). The patient was in extreme discomfort. A clinical diagnosis of compartment syndrome was established followed swiftly by fasciotomy in the operating room. Operative findings included active bleeding from the radiocephalic fistula into both the subcutaneous space and the flexor compartment that was released by fasciotomy. The fascia was observed to spring open under tension. No skin or

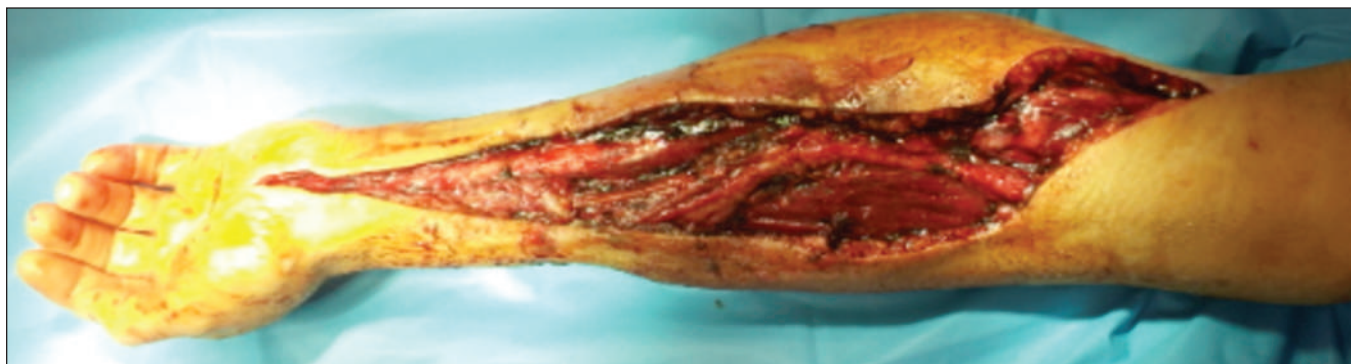
muscle necrosis had yet developed (see Figure 2). The fistula was ligated, the wound left open, and a negative pressure dressing was placed.

After a period of three days, the patient was taken back to the operating room. There was minimal muscle and skin necrosis found, and a split-thickness skin graft closure was achieved. Two days later, the patient was discharged. At five days, he had complete graft take. His hand and elbow function has been managed in the clinic producing satisfactory rehabilitation. He has a full range of motion at the wrist and hand with slight loss of extension at the elbow with 10 degrees of contracture. He has been followed for one year. He has not required further surgery and has been managed with pressure garments, silicone sheeting, and splinting with occupational hand, elbow, and scar therapy (see Figure 3).

Figure 1
Patient Upon Presentation to the Emergency Department Two Hours Following Dialysis Treatment

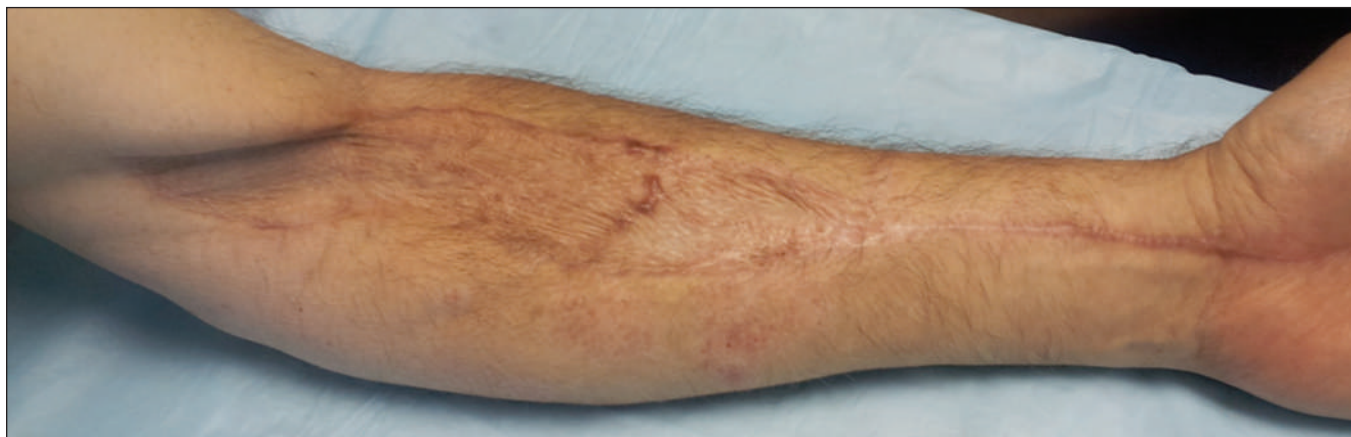


Figure 2
Operative Findings Following Volar Fasciotomy



Note: Active bleeding was found in both the subcutaneous and flexor compartment without evidence of muscle necrosis.

Figure 3
Patient's Arm One Year Following Compartment Syndrome and Volar Fasciotomy with Split-Thickness Skin Graft



Note: The patient has slight loss of extension yet has not required any subsequent surgeries.

Discussion

Forearm compartment syndrome is a rare but serious complication of hemodialysis even when promptly recognized and treated. The most common problems reported in AV fistulas are aneurysms, primary failure or failure to mature, and thrombosis (Fokou et al., 2012). Compartment syndrome has been identified as a rare complication of the puncture of a hemodialysis AV fistula (Reddy, Matta, & Handa, 2002). The anatomy of the radiocephalic fistula passes from the flexor compartment to the subcutaneous compartment. This patient had bleeding into both compartments, which would suggest the injury was at the junction between these spaces or that there were two separate vascular injuries on either side of the fascia. The complications of compartment syndrome of the forearm, such as muscle necrosis, forearm contracture, loss of function, and neurological deficits, are well documented (Duckworth et al., 2012). While not applicable for this patient with renal disease on hemodialysis, rhabdomyolysis secondary to compartment syndrome may lead to acute kidney injury in patients with renal function (Sofat, Bell, Turner, & Warrens, 1999).

Early recognition of forearm compartment syndrome can be critical to the prevention of complex surgical complications and may reduce long-term functional deficits of the affected limb. Nurses play a critical role during this crucial phase. First, they must maintain a high level of suspicion for compartment syndrome if they observe difficulty with cannulation, including the need for multiple attempted punctures to achieve access. If the patient describes increasing pain, the nurse's physical assessment

must include the patient's description of pain on passive extension. It is important for the nurse to recognize if the reported pain is out of proportion to the venipuncture. Finally, the nurse should note any firmness of the surrounding skin or underlying compartment compared to the other side. Although these are subjective findings, the surgical team should be immediately notified to assess the patient in the presence of these findings. Once the diagnosis of forearm compartment syndrome is made, the standard management of forearm compartment syndrome should be initiated. This involves fasciotomy of the involved compartments and delayed closure of the wound with possible split-thickness skin grafting if direct closure is not possible (Kalyani et al., 2011).

Conclusion

AV fistulae have become a common and safe means of access for patients on hemodialysis. They have a relatively low complication rate, and compartment syndrome is a rarely reported problem. Compartment syndrome is a surgical emergency with greatly improved outcomes by rapid diagnosis and treatment. Nursing care of the patient with an AV fistula or graft should include assessment of the access site after any unsuccessful cannulation attempt. If swelling develops, examination for signs of compartment syndrome is appropriate. If there is difficulty gaining access to the AV fistula during dialysis, there should be a heightened suspicion for the complication of compartment syndrome. Nurses can evaluate a patient for whom they have heightened clinical suspicion of compartment

syndrome every one to two hours, examining for three additional findings: pain out of proportion to the injury, pain on passive stretch or extension, and possible swelling or firmness compared to the other side. This will ensure these patients receive the emergent surgical intervention of fasciotomy to preserve limb function.

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