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Case Report

Acute Compartment Syndrome as a Complication of Radial Artery Catheterization

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Acute compartment syndrome is a rare complication of radial artery catheterization. If not identified and treated emergently, it can lead to profound disability or limb loss. Here, we discuss a rare case of acute compartment syndrome in the forearm of a 54-year-old man after transradial catheterization and anticoagulation for myocardial infarction, which ultimately required emergent fasciotomies and prolonged hospital care. The benefits of a percutaneous intervention performed through radial artery catheterization will almost always outweigh the risks of the catheterization itself; however, the serious complication of forearm hematoma leading to acute compartment syndrome should be discussed with patients as a potential procedural risk. The signs and symptoms of acute compartment syndrome should be reviewed by perioperative staff and physicians to rapidly identify the evolving condition and initiate appropriate treatment. This case report follows CARE guidelines.

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The transradial approach to cardiac catheterization is commonly preferred to the transfemoral approach due to lower risks of access site bleeding and major vascular complications and to lower morbidity and cost overall.^{1,2} Known risks of the transradial approach include radial artery spasm, radial artery occlusion, and forearm access site hematoma.¹ The incidence of compartment syndrome in the forearm or hand following transradial catheterization is less than 0.01% and is generally not a complication discussed with patients prior to the procedure.³ However, a simple forearm hematoma may quickly progress to acute compartment syndrome, especially in the presence of anticoagulation.

Acute compartment syndrome is characterized by an increase in pressure within a fascial compartment. As pressure increases, venous outflow decreases, and eventually arterial inflow may be prevented, leading to ischemia and necrosis. This progression occurs quickly, typically within the course of a few hours, and permanent necrosis of nerve and muscle tissue may occur within

4-6 hours. The hallmark early signs and symptoms of acute compartment syndrome include swelling and pain out of proportion to the injury, with pain on passive stretch of the muscles within the compartment, followed by numbness and/or weakness in the distribution of nerves and muscles that lie within the affected compartment.⁴ A diagnosis is made clinically based on the prompt recognition of those signs, and may be confirmed with the measurement of compartment pressures in equivocal cases.³ Treatment is emergent fasciotomy of the affected compartments to reduce intracompartmental pressure. Failure to emergently identify and appropriately release the affected compartments may lead to ischemic necrosis of muscle and nerve, the development of ischemic contractures, and potentially infection through hematogenous seeding of the necrotic tissue, which can require amputation.

Rare cases of acute compartment syndrome of the forearm after transradial catheterization have been reported in the cardiology literature, with an incidence of <0.01%.³ Acute compartment

syndrome isolated to the hand is even more rare.^{1,5} Hadad and colleagues² discussed compartment syndrome as a possible sequela of transradial catheterization and cannulation but, other than a single figure within their review, no cases have been published in the past within the orthopedic or hand surgery literature. The administration of supratherapeutic anticoagulation and the

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presence of atherosclerosis may represent additional risk factors in the cardiac catheterization population, which could lead to an increased risk of hematoma progressing to compartment syndrome.¹ The reported incidence of compartment syndrome after transradial catheterization is too low to discern absolute risk factors; however, complications are dangerous and patient care teams should be well versed in proper protocol to avoid detrimental outcomes.

Case Presentation

A 54-year-old man with a history of hypertension and diabetes mellitus and a family history of heart disease presented to the emergency department at Virginia Hospital Center with complaints of intermittent midsternal chest pain radiating into the upper back and down both arms for 1 day. The patient self-reported a normal nuclear stress test 1 year prior. The patient presented with blood pressure of 163/110 mm Hg but a normal heart rate and respiratory rate. The patient appeared diaphoretic and reported shortness of breath, chest pain, and back pain. A STAT Troponin I of 0.57 was indicative of myocardial infarction. An electrocardiogram was suggestive of acute anterior wall ST-elevation myocardial infarction.

The patient underwent coronary angiography and percutaneous coronary intervention through the right radial artery under local anesthesia and using a modified Seldinger technique and a 6 French vascular access sheath. A 5 French JR4 catheter was used for angiography of the right coronary artery. An extra back-up 3.5 Guide 6 French catheter (Medtronic; Minneapolis, MN) was engaged in the left main, supplementary heparin was administered, and a 0.014-in coronary wire was used to traverse the lesion. A 2.5- x 15-mm balloon was delivered and deployed to regain distal flow. Complete resolution of stenosis and distal debris was obtained, and the patient was treated with nitroglycerin and intravenous heparin. A ventriculography was performed. Finally, all catheters were removed and a VascBand (TeleFlex; Morrisville, NC) was applied at the right radial artery to achieve hemostasis. There were no reported complications, and the patient returned to his intensive care unit room in stable condition.

Ninety minutes later, a possible right radial hematoma was identified by the nurse. The VascBand had been removed. The dressing was left in place and the hand was slightly elevated. The patient rated discomfort at 4 out of 10, with swelling of the hand and firmness to the forearm. The patient's interventional cardiologist instructed the manual cuff to be inflated on the forearm, and manual pressure was held at the radial site and forearm while maintaining elevation. The patient reported increasing pain to 7 out of 10 and numbness in his fingers after 15 minutes but could move his fingers on command. The nurse performed a Doppler on the right radial artery, which was audible.

The cardiologist's subsequent examination revealed a tense forearm and mild pain on passive extension. There was numbness in the fingertips. Motor function was noted to be intact. No obvious ongoing bleeding was noted. Postoperative treatment with eptifibatidate for 4 hours was stopped immediately. The Hand Surgery service was contacted and arrived within the hour. An examination of the right upper extremity revealed preserved thenar strength and intact radial and ulnar nerves but decreased sensation to light touch in median nerve distribution. There was pain with passive stretch. The volar forearm compartment was very tense to palpation. The hand compartments were soft. There was notable ecchymosis near the distal radial artery. Using a Stryker needle (Stryker; Kalamazoo, MI), the forearm compartment pressure

measured 88 mm Hg. The patient was taken to the operating room within 30 minutes for an emergent forearm fasciotomy.

Extensive hematoma was visualized adjacent to the radial artery. The volar forearm compartment was extremely tense and was decompressed via a longitudinal fasciotomy. Superficial and deep flexor compartments were released, and the hematoma was evacuated. The extensor compartment and mobile wad were also released through a separate incision. The median nerve was markedly swollen, with surrounding, extensive hematoma, and a carpal tunnel release was performed. The patient's cardiologist, who performed the catheterization, was present during the surgery and suspected a proximal radial artery laceration during catheterization may have been the source of bleeding. This was not encountered. The wound was irrigated, the tourniquet was let down, and there was blood pumping from the radial artery distally at the site of the catheterization, with a long oblique tear of the artery identified. Preoperative Allen testing had ensured a complete arch, and the radial artery was ligated with good perfusion of the hand. Hemostasis was subsequently excellent. A preliminary vacuum-assisted closure was performed due to swelling. A second surgery was performed 3 days later to irrigate and debride the wound, remove the vacuum dressing, and definitively close the wound. The patient was discharged on postoperative day 4 and underwent an extensive course of postoperative hand therapy, eventually regaining full function without sensory or motor deficits after 3 months.

Statement of consent

Written informed consent was obtained from the patient for publication of this case report.

Discussion

In this case of transradial catheterization leading to acute compartment syndrome of the forearm, the patient did not have any clear risk factors other than the procedure itself and subsequent anticoagulation. The source of bleeding was determined to be the access site. A previously described protocol, including inflation of the blood pressure cuff at the site of induration to 15 mm Hg below systolic pressure for 15 minutes, was followed by hospital staff prior to the hand surgery consultation.¹ Surgical treatment, followed by hand therapy, restored full function of the extremity. While the incidence of compartment syndrome as a complication of radial artery catheterizations is low, it may quickly lead to devastating complications if not immediately recognized and treated surgically. Even with prompt recognition, the development of compartment syndrome in this patient required multiple surgeries and prolonged rehabilitation.

In the setting of suspected postprocedure hematoma or increasing pain or swelling after transradial catheterization, an immediate and emergent hand surgery or orthopedic consultation is mandatory. Cardinal signs of acute compartment syndrome are pain out of proportion to the injury, pain on passive stretch, and swelling, typically with numbness and loss of motor function as later findings.⁴ Compartment syndrome is a clinical diagnosis, with compartment pressure measurement a useful adjunct, but not necessary to confirm the diagnosis. Compartment pressures may be measured using an arterial line setup or pressure monitoring systems specifically designed for that purpose but are typically measured by the orthopedic or hand surgery consultant. If the difference between the diastolic blood pressure and compartment pressure is less than

30 mm Hg, then compartment syndrome is diagnosed.⁴ Treatment of acute compartment syndrome is immediate surgical fasciotomies of all affected compartments. Within the forearm, this includes the superficial and deep volar compartments, extensor compartment, and mobile wad. Carpal tunnel release is typically performed at the time of volar compartment release.

Currently, there are not enough reported cases to reliably identify risk factors for acute compartment syndrome after transradial catheterization. Thus, early recognition is crucial on the part of nursing staff and treating physicians. While it is unclear whether this complication can be avoided, prompt recognition and early, emergent consultation of the orthopedic or hand surgery service may improve outcomes and prevent the most devastating complications, which include loss of limb,

ischemic contracture, and permanent loss of motor and sensory functions.

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