Accepted April 2015

CASE REPORT

Upper arm amputation after radial arterial cannulation. What did we learn?

M.H. Kuut[1], T. Frenzel[2], J.G. van der Hoeven[2]

Department of [1]Anesthesiology, [2]Intensive Care, Radboudumc, Nijmegen, the Netherlands

Correspondence

M.H. Kuut – marieke.kuut@radboudumc.nl

Keywords - **arterial cannulation, radial artery, ischaemia, intensive care**

Abstract

Indwelling arterial catheters are used routinely for continuous haemodynamic monitoring and obtaining repetitive blood samples. The radial artery is the most common site for cannulation. We report a case of forearm ischaemia after radial artery cannulation, which probably went unnoticed for several hours. The ischaemia resulted in an upper arm amputation. The use of a 22 gauge cannula and the use of ultrasound for cannulation may reduce the risk of this complication. We also emphasise the importance of good physical monitoring of patients who are under our care in the intensive care unit.

Introduction

In 1949, Peterson described a method for recording arterial blood pressure, by introducing a small plastic catheter through a needle.[1] In contemporary medicine indwelling arterial catheters are used routinely for continuous haemodynamic monitoring and obtaining repetitive blood samples. The radial artery is the most common site for arterial cannulation. Complications of radial artery cannulation include pseudoaneurysm formation (0.1%), infection (0.7%), and temporary arterial occlusion (20%).[2] For these reasons careful consideration is indicated before placement.[3] Permanent occlusion of the radial artery appears to be rare, with a mean incidence of 0.09%.[2] Permanent ischaemia after radial artery cannulation can extend from a single digit to an entire hand.[4] The optimal method to assess adequacy of collateral blood flow to the hand before radial artery cannulation is controversial and the necessity is questioned.[5] The major argument against the routine use of Allen's test or the modified Allen's test is the lack of evidence that it can predict hand ischaemia after radial artery cannulation.[6,7] We describe a patient who developed ischaemia of the forearm after radial artery cannulation.

Case report

A 76-year-old male patient was admitted to our intensive care unit after a coiling procedure for subarachnoid haemorrhage of the anterior communicating artery. The patient had a history of cardiovascular disease and a previous ischaemic cerebrovascular accident. After the coiling procedure his Glasgow coma score was E4M6V4 and he was extubated a few hours after admission. One day after admission he was transferred to the medium care unit. Because he was unable to clear his secretions he was readmitted from the medium care unit to our ICU to be reintubated three days after first admission. After intubation we cannulated the left radial artery using a Seldinger technique with a 5 cm 20 gauge arterial line (Arrow REF SAC 00520). The first attempt was unsuccessful because we were unable to insert the guide wire. The second attempt was successful and the arterial catheter was introduced without resistance. Blood could be withdrawn and a normal pulse tracing was shown on the monitor. No discoloration of the hand was noted. After two hours the attending nurse noted a flat pulse wave tracing and blood could no longer be aspirated. The arterial catheter was promptly removed. After six hours, the nurse noticed a pale and cold forearm and pulsations at the wrist were absent. A combined Doppler and ultrasound study showed signs of a thrombus in the brachial artery extending from the antecubital fossa to both radial and ulnar arteries (*figures 1 and 2*). The consulted vascular surgeon considered surgical thrombectomy infeasible, because of the late discovery and the long extension of the thrombus from the original puncture site in the radial artery into the brachial and ulnar artery. General and catheter directed thrombolysis was considered contraindicated because of the recent history of subarachnoid haemorrhage. The patient received conservative treatment with intravenous heparin and nitroglycerine. He also received supraclavicular brachial plexus block for vasodilation and to prevent further pain. On the sixth day after the arterial occlusion, a guillotine amputation of the upper arm was performed. Closure of the stump was carried out on the ninth day. After a second unsuccessful extubation

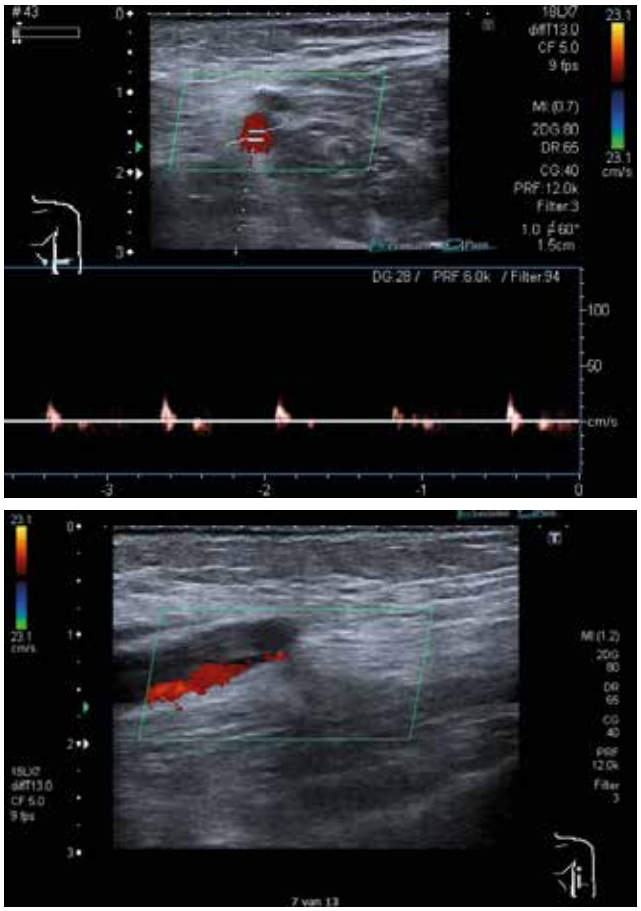

Figure 1 and 2. Combined Doppler and ultrasound study of flow in the distal brachial artery in the transversal (figure 1) and longitudinal plane (figure 2)

attempt a percutaneous tracheotomy was carried out. The patient showed a gradual recovery of mental function and was discharged from our intensive care unit to another hospital for further rehabilitation.

Discussion

We report a case of ischaemia of the forearm after radial artery cannulation, resulting in an upper arm amputation. We were unable to find an identical case in the current literature. Although extremely rare, the severity of this case underscores its importance. We hypothesise that there was an unnoticed thrombus formation in the radial artery, eventually occluding the full radial artery and extending into the brachial artery. It is impossible to know if the ulnar artery was already occluded previously. Possibly a small dissection after the first attempt to introduce the guide wire promoted thrombus formation. Our patient had a history of cardiovascular disease and was using acetylsalicylic acid and a prophylactic dose of low-molecular-weight heparin. Known patient-specific risk factors for radial artery thrombosis after cannulation are the use of vasopressors, hypotension, disseminated intravascular coagulation and a hyper coagulable state.[4] None of these were present in our patient.

We cannulated the radial artery of this patient with a 5 cm 20 gauge catheter using the Seldinger technique. Cannulation was successful at the second puncture attempt. One small randomised trial comparing 22 and 20 gauge catheters for radial artery cannulation suggests a decrease in complications and a smaller number of puncture attempts using the 22 gauge catheter. [8] A recent meta-analysis demonstrates an increased likelihood of first-attempt success when using ultrasound guidance for cannulation of the radial artery. Although complication rate was not addressed in this meta-analysis, it probably increases with the number of puncture attempts. [9]

Optimal treatment of patients who develop ischaemia after radial artery cannulation is controversial. [4] The guideline on antithrombotic therapy in peripheral arterial occlusive disease of the American College of Chest Physicians (ACCP) suggests that acute limb ischaemia resulting from iatrogenic vascular trauma requires early surgical thrombectomy or the use of a Fogarty balloon catheter for removal of thrombi. [10] The late discovery of ischaemia made our patient ineligible for these treatment options. Other suggested treatment options, systemic or catheter directed thrombolysis, were contraindicated due to his recent subarachnoid haemorrhage. Our patient did receive prompt anticoagulation with a therapeutic dosage of unfractionated heparin in order to prevent clot propagation. [10]

Before the introduction of balloon catheter, embolectomy patients with acute arm ischaemia received conservative treatment with chemical vasodilation, stellate ganglion block or surgical sympathectomy. Although these treatments have never been studied in a randomised way, older case series show a reasonable outcome. [11] This gave the rationale for treatment with intravenous nitroglycerine and the brachial plexus block given to our patient.

Patient safety is a top priority in our hospital. Critically ill patients are exposed to a higher number of invasive procedures and are at greater risk of adverse events then patients in a general ward. Our patient was sedated, mechanically ventilated and suffered from disorientation. This made it impossible for him to express pain or changes in sensation after insertion and removal of the radial artery catheter. Since rigor of the forearm was already present when this complication was discovered, the occluded brachial artery probably went unnoticed for hours. In intensive care medicine there are many devices used for continuous monitoring of vital signs. New devices for cardiac output monitoring have been developed in the last decade. Through the electronic patient record, there is access to patient data throughout the hospital. Despite this technical progression, the most important monitoring is still at the bedside. Physically examining the patient for changes in skin temperature, colour, capillary refill et cetera remains the cornerstone of good clinical practice. This should be carried out in a standardised fashion, on

a fixed number of occasions throughout the day. This provides essential information that can only partly be computerised.

Conclusion

We report a case of forearm ischaemia after radial artery cannulation, resulting in upper arm amputation. Although this complication is rare, it has a major impact on patient outcome. The use of a 22 gauge cannula and the use of ultrasound for cannulation may reduce the patient's risk of complication. We also emphasise the importance of good physical monitoring of the patients who are under our care in the intensive care unit. After the removal of an arterial line, monitoring of the limb should be carried out every 15 minutes within the first hour after removal. This is also stated in our nursing protocol addressing the procedure 'removal of an arterial line'. Physical examination should focus on skin colour, temperature, swelling and haematoma formation. If there are any changes in colour or temperature, additional diagnostic tests should be performed and a vascular surgeon should be consulted.

No financial support.

References

1. Peterson LH, Dripps RD, Risman GC. A method for recording the arterial pressure pulse and blood pressure in man. Am Heart J. 1949 Apr 15;37(5):771-82
2. Scheer B, Perel A, Pfeiffer UJ. Clinical review: complications and risk factors of peripheral arterial catheters used for haemodynamic monitoring in anaesthesia and intensive care medicine. Crit Care. 2002 Jun;6(3):199-204.
3. Garland A, Connors A. Indwelling Arterial Catheters in the Intensive Care Unit. Necessary and Beneficial, or a Harmful Crutch? Am J Respir Crit Care Med. 2010 Jul 15;182(2):133-4.
4. Valentine RJ, Modrall JG, Clagett GP. Hand ischemia after radial artery cannulation. J Am Coll Surg. 2005 Jul;201(1):18-22 5. Brzezinski M, Luisetti T, London MJ. Radial artery cannulation: a comprehensive review of recent anatomic and physiologic investigations. Anesth Analg. 2009 Dec;109(6):1763-81.
6. Kohonen M, Teerenhovi O, Terho T, Laurikka J, Tarkka M. Is the Allen test reliable enough? Eur J Cardiothorac Surg. 2007 Dec;32(6):902-5.
7. Slogoff S, Keats AS, Arlund C. On the safety of radial artery cannulation. Anesthesiology. 1983 Jul;59(1):42-7.
8. Eker HE, Tuzuner A, Yilmaz AA, Alanoglu Z, Ates Y. The impact of two arterial catheters, different in diameter and length, on postcannulation radial artery diameter, blood flow, and occlusion in atherosclerotic patients. J Anesth. 2009;23(3):347-52.
9. Shiloh AL, Savel RH, Paulin LM, Eisen LA. Ultrasound-guided catheterization of the radial artery: a systematic review and meta-analysis of randomized controlled trials. Chest. 2011 Mar;139(3):524-9.
10. Clagett GP, Sobel M, Jackson MR, Lip GY, Tangelder M, Verhaeghe R. Antithrombotic therapy in peripheral arterial occlusive disease: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy. Chest. 2004 Sep;126(3 Suppl):609S-626S. Review.
11. Eyers P, Earnshaw JJ. Acute non-traumatic arm ischaemia. Br J Surg. 1998 Oct;85(10):1340- 6.