Critical hand ischaemia after transradial cardiac catheterisation: an uncommon complication of a common procedure

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Abstract We describe a case of critical hand ischaemia after transradial cardiac catheterisation. The patient presented with hand ischaemia 5 days after transradial coronary angiography. Urgent angiography demonstrated radial artery occlusion with embolisation to the palmar arch and digital arteries. The ischaemia was refractory to an extensive thrombolytic regimen, and subsequently, the patient was referred to the vascular surgeon for urgent thrombectomy and patch angioplasty. The patient recovered slowly and no amputation was necessary, but complaints of right hand numbness and paresthesia of all digits remained.

Keywords Transradial catheterization · Cardiac angiography · Cardiac catheterization · Hand ischemia · Complication

Introduction

In 1989, Campeau et al. were the first to describe radial artery access for coronary angiography [1]. Several years later, Kiemeneij et al. reported on the feasibility and safety of transradial coronary balloon angioplasty and coronary stent implantation in 100 patients [2, 3]. In the hands of experienced operators success rates are excellent. Transradial cardiac catheterisation (TCC) has been associated with

a lower incidence of major access site related complications (e.g. bleeding) compared with the transfemoral route [4, 5]. A recent study showed an incidence of major access site vascular complications of 0.6 % with the transradial approach vs. 3.7 % with the transfemoral approach [6]. Major bleeding complications may cause premature cessation of antiplatelet therapy, thereby increasing the risk of cardiovascular thromboembolic events [7] and excess mortality [8]. Additional advantages of TCC include improved patient comfort and early ambulation, which may shorten hospital length of stay and reduce healthcare costs [9]. Therefore, several centres have adopted the radial artery as the preferred access site, both for diagnostic and interventional procedures. However, with the increased adoption of TCC, it is important to be aware of its potential complications. We describe a patient who suffered from critical hand ischaemia after TCC refractory to thrombolytic regimen, ultimately requiring urgent vascular surgery.

Case

A 44-year-old Caucasian woman without a cardiovascular history presented to our emergency department with acute substernal chest pain. Risk factors of atherosclerosis included smoking (30 pack-years) and a family history of cardiovascular disease. Her blood pressure on admission to our emergency department was 110/70 mmHg. The initial and consecutive ECGs demonstrated normal sinus rhythm without ST-T segment abnormalities. Consecutive blood sample analyses showed normal troponin levels with a normal creatine kinase and MB fraction. During an exercise stress test, she experienced substernal chest pain, whereas the ECG showed non-significant ST-segment changes during maximal exercise. Subsequently, she was sent to the catheterisation laboratory

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for (transradial) coronary angiography. The radial artery could be palpated easily while the Allen test revealed absence of digital ischaemia, as evidenced by presence of an ulnar pulse with a sufficient palmar arch.

After local anaesthesia with 1–2 ml lidocaine subcutaneously, the radial artery was punctured approximately 3 cm proximal to the base of digit I using a 22-gauge needle and a 0.018 in stainless steel guide wire, and a 7 cm, 6-Fr sheath (Radifocus Introducer II, Terumo Europe, Belgium) was introduced. In addition to heparin (5000 IU), verapamil (5 mg) was given through the sheath, the latter to minimise the risk of radial artery vasospasm. 5-Fr left and right Judkins diagnostic catheters (Super TorquePlus, Cordis Corp., Miami, FL) were used for engaging the left and right coronary ostium, respectively. During introduction and manipulation of the catheters the patient complained of pain in the forearm, which was attributable to vasospasm of the radial artery. Additional 3 mg dinitrate were given through the sheath and thereafter, the procedure could be continued without complaints. After the procedure, the sheath was removed immediately and haemostasis was achieved by radial compression with an artery compression device (TR band 18 ml, Terumo Europe, Belgium). Coronary angiography demonstrated non-obstructive coronary atherosclerosis, and the patient could be discharged 1 day later, free from complaints.

Five days after discharge, the patient presented to our emergency department with complaints of right hand numbness, pallor, paresthesias, and sensitivity of the hand to touch. No tissue necrosis was present. Doppler evaluation confirmed occlusion of the radial artery, while the brachial and ulnar arteries were patent. Urgent angiography with selective injection of the right brachial artery was performed from a left femoral approach using a diagnostic microcatheter (150 cm, 2.5-F tipped Renegade microcatheter, Boston Scientific, Natick, MA), and revealed total occlusion of the radial artery whereas the ulnar artery was patent (Fig. 1). The superficial and deep palmar arch showed thrombolysis in myocardial infarction (TIMI) grade II flow whereas the digital arteries showed distal embolisation (Fig. 2).

The patient was treated with low-molecular-weight heparin and urokinase (bolus of 100,000 IU, followed by continuous administration of 400,000 IU at 100,000 IU/hour). Subsequent angiography did not show significant improvement in peripheral flow and the patient remained symptomatic. After administration of additional urokinase (2,500,000 IU at 100,000 IU/hour) there was still no clinical and angiographic improvement. Therefore, the patient was referred to the vascular surgeon for thrombectomy and patch angioplasty. There was a gradual recovery without the need for digital amputation. Nevertheless, complaints of numbness and paresthesia of all digits remained.

Fig. 1 Angiogram of right forearm demonstrating a total occlusion of the radial artery (a) and a patent ulnar artery (b)

Discussion

We report on a case of critical hand ischaemia after transradial coronary angiography refractory to extensive thrombolytic treatment, ultimately requiring urgent thrombectomy and patch angioplasty. We hypothesise that hand ischaemia was the result of thrombus embolisation from the occluded radial artery to the palmar arch and digital arteries.

Although postprocedure radial artery occlusion is a common complication, which occurs in 2–18 % of patients, it

Fig. 2 Angiogram of right wrist and hand demonstrating thrombus particles in the palmar arch and distal thrombus embolisation of the digital arteries (arrows)

seldom leads to clinical events because of the protecting dual collateral perfusion of the hand [10]. Even though hand ischaemia with necrosis after transradial interventions is rare, its devastating nature underscores the importance of this complication. The incidence of critical hand ischaemia after prolonged radial artery cannulation for haemodynamic monitoring approximates 0.09 % [11]. There is only one documented case of hand necrosis after a transradial cardiac procedure; this patient had an occlusion of the radial artery postprocedure with a pre-existent occluded ulnar artery, however [12]. In retrospective experience of more than 10,000 patients who underwent transradial cardiac procedures, Ludwig et al. did not report a single case of critical hand ischaemia [13]. Nevertheless, the incidence of hand ischaemia after transradial cardiac procedures may be difficult to estimate because cases are probably not reported.

It has been suggested that local injury induced by a radial artery catheter and radial artery constriction at the time of decannulation may promote thrombus formation, and thereby occlusion of the radial artery [14]. Hand ischaemia may be caused by two events: (a) digital embolisation of radial artery thrombus [15, 16] and (b) *in situ* thrombosis of

collateral vessels [17], which is most likely induced by severe vasospasm. Both events may lead to irreversible digital ischaemia requiring amputation, even in a setting of macroscopically and microscopically normal radial, ulnar, and superficial palmar arteries [16].

There is controversy about reliable predictors of radial artery occlusion and hand ischaemia after radial artery cannulation. Profound circulatory failure, hypotension, and high-dose vasopressor therapy may increase the risk of hand ischaemia [15, 18, 19], although these conditions may not be applicable to the majority of patients undergoing transradial coronary interventions. Other factors, such as the number of puncture attempts, artery size, the composition of the catheter (teflon vs. polypropylene), catheter diameter, and female gender are even more controversial [18–20].

Vasospasm, one of the suggested key players in thrombotic radial artery occlusion and hand ischaemia, can be prevented safely and effectively by intra-arterial administration of vasodilators (e.g., nitrates or calcium channel blockers) during transradial artery cardiac catheterisation [21].

There is no consensus on the best treatment strategy for hand ischaemia after radial artery catheterisation. Early recognition (e.g. absent pulse, pallor skin, painful and cold hand or fingers, hand numbness) is important in reducing permanent injury [15]. Arterial Doppler ultrasound or angiography may be used to evaluate arterial flow in the vasculature of the affected arm. Thrombus aspiration at the catheter tip may restore arterial pulsation in approximately 60 % of patients with suspected thrombosis, and intra-arterial verapamil, prilocaine, and phentolamine have been successful in reversing ischaemic symptoms [20, 22]. Other options include low-molecular-weight dextran or low-dose heparin treatment [15, 16]. Geschwind et al. demonstrated angiographic flow restoration with 20 % residual thrombus leading to clinical improvement in 5 of 7 patients treated with intra-arterial urokinase for radial artery occlusion [23]. Nevertheless, although not convincingly superior to medical therapy, surgical exploration is often necessary for patients with absent radial artery blood flow and severe hand ischaemia. In a retrospective analysis of treatment of 8 patients with hand ischaemia after radial artery cannulation, surgical revascularisation was attempted in 5 patients [15]. Of the 5, 1 patient died; all patients who survived developed gangrene of the first or second digit, with 2 patients requiring finger amputation.

In conclusion, we report a case of critical hand ischaemia due to thrombus embolisation after a transradial cardiac catheterisation, refractory to extensive thrombolytic regimen and ultimately requiring vascular surgery. Although critical hand ischaemia after transradial cardiac interventions is rare, its poor outcome underscores the importance of being aware of this complication.

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