

Clinical Report

Delayed ischaemia of the hand necessitating amputation after radial artery cannulation

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We present a case of ischaemic hand injury in a patient, who had 95% occlusion of both the ulnar and radial arteries, after atraumatic placement of a left radial artery catheter. The presence of cigarette burns on the dorsum of the hand was highly suggestive of vascular compromise. There were no signs of vascular compromise after placement of the arterial line which was removed 24 hr later. Ten days after placement the patient complained of pain with ensuing ischaemic changes resulting in necrosis of the finger tips and eventual amputation of the hand. We recommend using other sites of arterial access such as axillary or superficial temporal artery in patients with severe peripheral vascular disease.

Nous présentons un cas de lésion ischémique de la main survenue chez un patient qui a développé une occlusion à 95% des artères radiales et cubitales après l'insertion atraumatique d'une canule radiale gauche. La présence de brûlures de cigarettes sur le dos de la main suggérait déjà une atteinte vasculaire. On n'a pas noté de signes d'ischémie après l'installation de la canule qui fut retirée après 24 heures. Dix jours après l'insertion, le patient s'est plaint d'une douleur suivie de changements ischémiques évoluant vers une nécrose du bout des doigts et d'une amputation. Nous recommandons l'utilisation d'accès artériels différents comme les artères temporales superficielles ou axillaires chez les porteurs de maladies vasculaires périphériques.

Key words

ARTERIES: cannulation, radial;
COMPLICATIONS: ischaemia, thrombosis.

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Ischaemic injury to the hand after radial artery cannulation is rare, but can be devastating, especially if an extremity is amputated.¹⁻⁶ The overall rate of radial artery occlusion during or after cannulation is between 17 and 25%.⁷⁻¹² Although the incidence of thrombosis is high, serious ischaemic sequelae are rare. We present a case of hand ischaemia, necessitating amputation, in a patient after uncomplicated, atraumatic radial artery cannulation where Allen's test¹³ was equivocal.

Case report

A 35-yr-old 50-kg man was scheduled for right femoral-tibial bypass under general anaesthesia. Surgery was cancelled one day earlier because of an elevated serum potassium concentration of 6.6 mEq · L⁻¹ and a bleeding time > 14 min. He was subsequently dialyzed on the day before surgery via a right arteriovenous fistula. There was a past medical history of insulin-dependent diabetes mellitus for 25 yr, end-stage renal disease, coronary artery disease, silent myocardial infarction in 1988, peripheral vascular disease, hypertension, and left hemispheric cerebrovascular accident in 1987. Surgical history included aorto-bifemoral bypass, left above knee amputation, functional right forearm arteriovenous fistula, clotted left forearm arteriovenous fistula, occluded right axillo-femoral bypass, aortocoronary artery bypass in 1988, and right femoral-popliteal angioplasty in 1992. He had smoked 2-3 packs of cigarettes per day for the last 20 yr. Medications included diltiazem, isordil, temazepam, minoxidil, clonidine, and insulin. Laboratory evaluation on the day of surgery revealed Na 131 mEq · L⁻¹, K 4.7 mEq · L⁻¹, haematocrit of 35.4, bleeding time > 14 min, PT 12.6 sec, and PTT 41.3 sec. Electrocardiogram showed a sinus tachycardia of 101 bpm, left atrial enlargement, left anterior hemiblock, old inferior wall myocardial infarction, and nonspecific ST and T wave changes. Persantine-thallium test performed one week prior to surgery showed no evidence of reversible ischaemia. Chest roentgenogram was normal. After an equivocal Allen's test (12-15 sec return

of blood after ulnar artery release with palmar blush return to baseline), the left wrist was taped hyperextended, and a left radial artery catheter was placed atraumatically on the first attempt using a 20-gauge, 1.75-inch catheter over a 22-gauge, thin-walled needle (Arrow International, Inc., Reading, PA) with a guide-wire. A continuous infusion of heparinized 0.9% normal saline ($2 \text{ units} \cdot \text{ml}^{-1}$) was maintained at a rate of $3 \text{ ml} \cdot \text{hr}^{-1}$ with an intraflow system (Transpac II, Abbott Critical Care Systems, North Chicago, Illinois). The patient underwent an uneventful general anaesthetic. There was one litre of blood loss, and two units of packed red cells were transfused. A pulmonary artery catheter was placed, postoperatively, via the left subclavian vein by the surgeon to manage the patient's fluids. The transduced radial artery tracing was observed continuously without variation in the quality of the oscilloscopic tracing. The following morning, the radial artery catheter was accidentally pulled out by the patient, and the pulmonary artery catheter was removed. There was no evidence of ischaemia or haematoma in the left hand. Ten days later, the patient complained of pain, coldness, and discoloration in his left hand. No further blood had been drawn for blood gases analysis from the left radial artery. He was started on heparin, 5000 units *iv* followed by an infusion of $1000 \text{ u} \cdot \text{hr}^{-1}$, which produced slight subjective improvement. Stellate ganglion block was not performed. He was seen by a vascular surgeon, on the eleventh day after placement of the radial artery line, who recommended anticoagulation therapy. Two weeks after the first surgery the patient underwent right, below knee amputation. One week later he had a right, above knee and left hand amputation (Figure 1).

Discussion

The most common complication from catheterization of the radial artery is thrombosis without ischaemic injury.¹⁻⁶ The reported incidence of this complication varies from 0 to 75%, depending on the size, shape, and composition of the catheter used and the duration of cannulation.¹⁴⁻¹⁶ Slogoff *et al.*⁷ demonstrated that Allen's test did not predict ischaemia and they subsequently cannulated the ulnar or brachial artery of 83 patients when the ipsilateral radial artery could not be cannulated. Also they reported that radial artery catheters were placed in 68 patients, of 1699, who did not have ulnar collateral flow to the hand without ischaemia. Perhaps assessment of adequate collateral by pulse oximetry may be more sensitive and at least guarantee patency of the ulnar artery.

In our patient, gross pathological examination revealed that both the ulnar and radial arteries were calcified with up to 95% occlusion. Microscopic examination showed severe obliterative atherosclerotic peripheral vascular dis-



FIGURE 1 Ischaemic changes in hand prior to amputation.

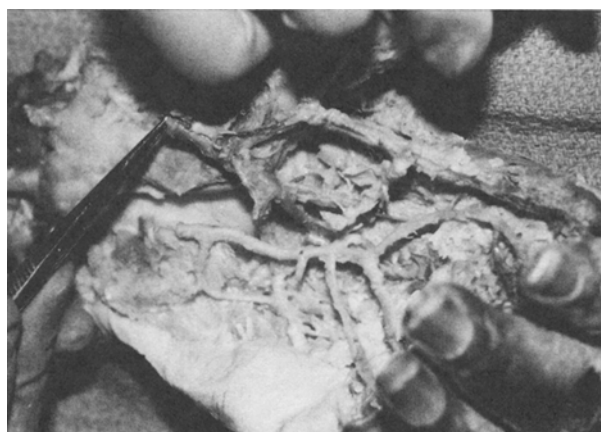


FIGURE 2 Dissection of arterial system showing radial artery (forcep), and ulnar artery below.

ease with extensive calcification and focal organizing thrombosis. Further dissection of the arterial system to the digital arteries showed similar pathology (Figure 2). It seems that the cannulation process may have caused enough intimal injury to the radial artery which compromised flow and caused the ensuing ischaemia.

Patients may develop ischaemic injury if adverse conditions are present for long enough, that is, sustained hypovolaemic shock, use of vasopressor, Raynaud's phenomenon, and multiple particulate emboli arising from within the heart. Fogarty¹⁷ and Bedford¹⁸ both reported thrombus formation initiated by injury to the arterial intima. According to Fogarty¹⁷ the cause of vascular insufficiency may be mechanical, either in the form of acute vascular thrombosis at the puncture site, arterial embol-



FIGURE 3 Dorsum of the hand showing cigarette burns indicating signs of ischaemia.

ization, or intimal dissection and sub-adventitial haematoma formation. Unfortunately, it is generally impossible to know which type of injury or injury combinations contribute to occlusion in a particular artery. These changes do not recede rapidly after the catheter is removed. In radiological studies in children, irregularities in the walls of previously catheterized femoral arteries were present six months later.¹⁹ Once thrombosis has occurred, it may take days, weeks, or months for flow to resume to previous levels.

Our patient had peripheral vascular disease. He continued to smoke, and had vascular compromise to his left hand as indicated by cigarette burns, which he had never felt, in the dorsum of the hand (Figure 3). Flow to his hand may have been further compromised by the occluded left forearm arteriovenous fistula. The pathology report identified severe calcific changes and 95% narrowing of both radial and ulnar arteries. There was no blanching or signs of vascular compromise with the catheter in place. Neither was there any change in the pressure waveform. Intimal injury may have precipitated the formation of thrombus or spasm causing vascular compromise to the hand.

Therapy for ischaemia, especially in children, includes removal of the catheter. If all or part of the hand develops signs of ischaemia including cold, cyanosis, pain, lack of sensation, or lack of capillary refill, the catheter must be removed. In recalcitrant cases, sympathectomy, heating of the hand, intra-arterial flushing of the catheter with either lidocaine or heparin have been tried but generally had no effect.

Our patient required continuous blood pressure monitoring and blood sampling in view of his past medical history. The choices were limited in that the right radial

artery could not be used because of the fistula, and the femoral artery was not usable because of the grafts. The ulnar and radial arteries were both patent, albeit 95% occluded. A clue that severe compromise was present was the cigarette burns, and another site should have been used such as the superficial temporal or axillary artery. The same disease state that resulted in bilateral lower extremity amputation may have contributed to the hand ischaemia, albeit aggravated by the arterial line.

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