Arrest of the growth plate after arterial cannulation in infancy

M. F. Macnicol, J. Anagnostopoulos
From the Princess Margaret Rose Orthopaedic Hospital and the Royal Hospital for Sick Children, Edinburgh, Scotland

Seven children who had partial arrest of the growth plate after neonatal arterial cannulation, developed obvious skeletal changes in adolescence. Cannulation of the femoral artery produced ischaemia which led to four cases of ipsilateral shortening of the lower limb and one of partial arrest of the proximal femoral physis with subsequent coxa valga. The two arrests in the upper limb affected the humerus, ulna and radius, and the radius alone, after cannulation of the brachial and radial arteries, respectively. These late effects of cannulation are not widely appreciated, and may occur as a result of thrombosis rather than extravasation.

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Arrest of the growth plate (physis) may complicate arterial cannulation during infancy and childhood. The resultant discrepancy or deformity of the limb is not always recognised before skeletal maturity, by which time a relatively simple correction by epiphysiodesis is impossible. We describe seven cases of phyleal injury after arterial cannulation in which complications such as perforation of the vessel wall, aneurysm or extravasation were not sustained. Two cases involved the upper limb, producing shortening of the radius principally, but also of the ulna and the humerus. Four cases of femoral and tibial shortening occurred as a result of femoral cannulation. Although there has been debate in the literature about the cause of the resultant leg-length disparity, since an intrinsic mild discrepancy cannot always be ruled out in each of our patients, the ipsilateral leg had developed mild circulatory impairment after the cannulation. The last case involved the lateral portion of the proximal femoral growth plate.

Case reports

The clinical details of the seven cases are shown in Table I. The first four patients (cases 1 to 4) had cannulation of the femoral artery during the surgical correction of congenital heart disease. Reduced pulsation and decreased limb temperature were noted in each case which persisted in two after removal of the cannula and heparinisation. A representative scanogram is shown in Figure 1. This girl (case 4) is still aware of postexertional fatigue in the affected leg, but does not suffer pain from claudication.

Figure 2 shows deformity of the right hip as a result of arrest of the lateral proximal femoral growth plate (case 5). The legs had not been splinted for neonatal hip instability and there was no past history of trauma or sepsis. The right femoral artery was cannulated at the age of 24 months for monitoring of blood gases, and injury to the intima of the iliofemoral segment may have resulted in embolism to the circumflex femoral vessels supplying the proximal femur.

In a seven-day-old infant (case 6) an indwelling 22-gauge radial arterial line for monitoring of blood gases produced significant arrest of the distal growth plate of the radius (Fig. 3). Catheterisation of the brachial artery (case 7) to facilitate angiographic demonstration of a patent ductus arteriosus with possible aortic coarctation resulted in ipsilateral shortening of the humerus, radius and ulna (Fig. 4). Both patients (cases 6 and 7) developed a progressive Madelung deformity, and the resultant discrepancy was corrected by ulnar shortening.

Ischaemic changes were evident in both upper limbs at the time of cannulation and, in one patient (case 6), a Volkmann’s contracture was also present. The shortening of the lower limb was not treated surgically although contralateral epiphysiodesis could have been considered in one patient (case 4) if referral had been earlier.

Discussion

Successful treatment of the neonate or child with cardiovascular anomalies has brought with it the risks inherent in
arterial cannulation. These include thrombosis or stenosis of the vessel, compartment syndrome and the extravasation of infused fluids which may lead to skin breakdown, infection, and scarring. Ischaemia of the limb, with reduced pulses and temperature, occurs in 2% to 33% of children after arterial cannulation and impaired growth has been recognised for 30 years. Rosenthal et al considered that discrepancy of limb length was a rare complication and Hawker et al stated that clinical assessment of leg length and calf size agreed to “within 5%” after cannulation. These studies did not rely on orthoradiography (scano-grams) which had revealed, according to Bassett et al, shortening of the leg of 3.6 cm after femoral arterial catheterisation seven years previously in one child and in 24 of 28 cases, limb inequality and decreased peripheral pulses on the shorter side.

Most reported discrepancies have been between 0.4 and 1.8 cm, with both the tibia and the femur involved. In a few
Case 6. Radiographs of the forearm after cannulation of the radial artery in infancy. Shortening of the ulna improved function and cosmesis.

Case 7. Radiographs showing a) humeral and b) radial and ulnar shortening as a result of cannulation of the brachial artery in infancy.
instances the disparity lessened with time, but usually the shortening remained proportional or increased. When arterial occlusion or stenosis persists, with reduced distal arterial pressure and impaired exercise tolerance, surgical release of the arterial obstruction may be warranted. Lambert et al demonstrated by angiography that the overall rate of thrombosis, whether partial or complete, after arterial cannulation in adults, was approximately 50%. The duration of ischaemia is important and may account for shortening of the limb after poliomyelitis or ligation of the subclavian artery in the Blalock procedure.

Morgan summarised the acute complications of cannulation, including local injury to the intima of the vessel, perforation, thrombosis, embolism, local sepsis including the production of septic emboli and extravasation. Removal of the cannula may reverse the occlusion in all but 2.5% of cases, but we believe that distal thrombosis or emboli may produce a more persistent ischaemia, local to the growth plate.

Cannulation can be a traumatic procedure if the lumen of the vessel is small, and the practice of transfixing the artery is risky. Repeated attempts at cannulation increase the risk of intimal damage and thrombosis, as does the practice of prolonged compression of the vessel with a thumb on removal of an arterial line, a cannula of large diameter or a balloon catheter. Cannulation of the radial and brachial arteries should be avoided in the infant, and four or five French sheath sizes (up to 1.7 mm diameter) used for small vessels. If ischaemia is present in the limb after cannulation, the child should be anticoagulated and carefully followed up in case skeletal changes develop.

Guy et al described the importance of recognising the long-term complications of extravasation and ischaemia after cannulation of vessels in infancy. Two cases affected the forearm and two cases, subsequently described fully in the orthopaedic literature, involved the ankle. The disturbance of distal tibial growth, secondary to extravasational injury, was ascribed to occlusion of perichondrial vessels. A similar mechanism may account for the skeletal changes after burns, although tethering by a scar may be more important than ischaemia of the growth plate.

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References