Complications of Arterial Lines

ASHER HIRSHBERG, MD
SANDIE R. THOMSON, CM, FRCS
WILLIAM K. J. HUIZINGA, FRCS (Ed) 
Surgical I.C.U., Department of Surgery, University of Natal and King Edward VIII Hospital, Durban.

SUMMARY
Complications of arterial monitoring lines are uncommon but can produce serious morbidity. Constant awareness and early recognition are the key to reducing this morbidity. The various complications of arterial lines discussed in this review should be incorporated into management algorithms for critically ill patients.

Introduction
Arterial cannulation for pressure monitoring and blood gas analysis is a common procedure in critically ill patients. The radial artery is the most frequently used, but other arteries are also used.

Arterial line insertion is usually safe and complications are discussed briefly.

Hand Ischaemia Following Radial Artery Cannulation
Thrombosis of the radial artery follows 25-38% of cannulations (1,2, but is asymptomatic and recanalization is the rule. Clinical evidence of some degree of palmar or digital ischemia has been reported in 1.5-4% of cannulations, but usually resolves after removal of the offending cannula (1, 3).

Severe hand ischaemia leading to tissue loss is rare (4, 5, 6). Only five patients with this complication were encountered during a twenty month period in a large US medical centre (4).

This low incidence of ischemic complications is explained by ample collateral blood supply to the hand via the superficial palmar arch, which is perfused mainly through the ulnar artery. An incomplete palmar arch or a dominant radial artery occur in less than 2% of hands and were thought to predispose to severe ischemia in the event of radial artery cannulation. This prompted the use of Allen's test (7) to clinically demonstrate an incomplete palmar arch. This test is routinely employed to identify patients in whom radial artery catheterization is more likely to cause severe ischemia. However, the validity and usefulness of this test has recently been questioned. A negative test (implying a normal palmar arch) is not a guarantee against digital gangrene after insertion (4), and radial artery cannulation can be performed in patients with a positive test with impunity (2). Thus, Allen's test can no longer be considered a useful predictor of the safety of radial artery cannulation.

Catheter size and material (8) and the insertion technique (9) have been implicated as predisposing to ischemia. However, a large prospective study (2) failed to verify these factors, and others have corroborated this view (10). Prolonged cannulation, however, may predispose to ischemia (1), as it is interesting to note that in most reports of tissue loss, the catheter was left in situ for more than 24 hours (4, 5, 6). Thus, the femoral artery has been recommended for prolonged catheterization (11). In the shocked patient on vasoactive drugs, where radial artery catheterization carries a high risk of ischemia (4, 5), the femoral artery may also prove safer.

Whenever the question of ischemia arises, prompt removal of the catheter is mandatory, as these changes are often reversible after decannulation (3). Treatment recommendations for severe acute ischemia following insertion of radial arterial lines are based on a small number of reported cases in which treatment was not always successful. The usual tendency is to temporize and treat the patient conservatively because spontaneous recanalization of the thrombosed artery can be expected. Proximal intra-arterial injection of papaverine or reserpine (4, 5) and sympathetic ganglion blocks (4) have been tried in attempts to overcome peripheral vasoconstriction which is believed to contribute to ischemic damage. Intravenous heparin and dextran have also been used (4, 5). It is unclear whether these empirical measures are of any benefit.

Surgical intervention has been reported in a few cases (4, 6, 12, 13). Thrombectomy may occasionally be successful, but microvascular reconstruction at the wrist has been attempted sporadically, and reported with inadequate documentation (12). In our view, removal of the offending catheter and improving the hemodynamic status of the patient are more practical alternatives than an attempted lengthy and complicated microvascular reconstruction in a critically ill patient (4).

Other Complications of Radial Arterial Lines
Pseudoaneurysm
A radial false aneurysm presents as a pulsatile mass or a wrist abscess at the puncture site. It can occur from 3 days to 18 months after decannulation (14, 15). Thrombectomy, infection and distal embolism are all potential hazards. Resection of the pseudoaneurysm is therefore indicated with subsequent repair of the artery, or ligation when repair is impossible (3, 14).

Infection
Arterial line-related sepsis results from infusate contamination, and is propagated by the static fluid column of the line, as well as by frequent manipulation. Although two large studies failed to demonstrate even one case of arterial line-related sepsis in more than 2500 cannulations (2, 12), another study reported a sepsis rate of three percent in attempts to overcome peripheral vasoconstriction (14, 15). In the shocked patient on vasoactive drugs, where radial artery catheterization carries a high risk of ischemia (4, 5), the femoral artery may also prove safer.

Whenever the question of ischemia arises, prompt removal of the catheter is mandatory, as these changes are often reversible after decannulation (3). Treatment recommendations for severe acute ischemia following insertion of radial arterial lines are based on a small number of reported cases in which treatment was not always successful. The usual tendency is to temporize and treat the patient conservatively because spontaneous recanalization of the thrombosed artery can be expected. Proximal intra-arterial injection of papaverine or reserpine (4, 5) and sympathetic ganglion blocks (4) have been tried in attempts to overcome peripheral vasoconstriction which is believed to contribute to ischemic damage. Intravenous heparin and dextran have also been used (4, 5). It is unclear whether these empirical measures are of any benefit.

Surgical intervention has been reported in a few cases (4, 6, 12, 13). Thrombectomy may occasionally be successful, but microvascular reconstruction at the wrist has been attempted sporadically, and reported with inadequate documentation (12). In our view, removal of the offending catheter and improving the hemodynamic status of the patient are more practical alternatives than an attempted lengthy and complicated microvascular reconstruction in a critically ill patient (4).

Other Complications of Radial Arterial Lines
Pseudoaneurysm
A radial false aneurysm presents as a pulsatile mass or a wrist abscess at the puncture site. It can occur from 3 days to 18 months after decannulation (14, 15). Thrombectomy, infection and distal embolism are all potential hazards. Resection of the pseudoaneurysm is therefore indicated with subsequent repair of the artery, or ligation when repair is impossible (3, 14).

Infection
Arterial line-related sepsis results from infusate contamination, and is propagated by the static fluid column of the line, as well as by frequent manipulation. Although two large studies failed to demonstrate even one case of arterial line-related sepsis in more than 2500 cannulations (2, 12), another study reported a sepsis rate of three percent in attempts to overcome peripheral vasoconstriction (14, 15). In the shocked patient on vasoactive drugs, where radial artery catheterization carries a high risk of ischemia (4, 5), the femoral artery may also prove safer.

Whenever the question of ischemia arises, prompt removal of the catheter is mandatory, as these changes are often reversible after decannulation (3). Treatment recommendations for severe acute ischemia following insertion of radial arterial lines are based on a small number of reported cases in which treatment was not always successful. The usual tendency is to temporize and treat the patient conservatively because spontaneous recanalization of the thrombosed artery can be expected. Proximal intra-arterial injection of papaverine or reserpine (4, 5) and sympathetic ganglion blocks (4) have been tried in attempts to overcome peripheral vasoconstriction which is believed to contribute to ischemic damage. Intravenous heparin and dextran have also been used (4, 5). It is unclear whether these empirical measures are of any benefit.

Surgical intervention has been reported in a few cases (4, 6, 12, 13). Thrombectomy may occasionally be successful, but microvascular reconstruction at the wrist has been attempted sporadically, and reported with inadequate documentation (12). In our view, removal of the offending catheter and improving the hemodynamic status of the patient are more practical alternatives than an attempted lengthy and complicated microvascular reconstruction in a critically ill patient (4).
atherosclerosis, especially if unrecognized, the danger of thrombosis or distal embolism with irreversible worsening of the ischemia should be borne in mind.

The direct access to the aorta afforded by the umbilical artery catheter is extremely useful in the hemodynamic monitoring of the newborn infant. However, it is also a cause of major vascular complications. Asymptomatic mural thrombosis occurs in almost all neonates (19, 20), but occasional occlusive thrombosis or embolism results in serious visceral complications. Umbilical artery catheter-associated renal artery occlusion is today the most common cause of neonatal hypertension (21), and delayed lower limb ischemia (20) has also been described. Gangrene of the lower half of the body, mesenteric artery occlusion and hemoperitoneum associated with this monitoring technique (22, 23).

Attempts to reduce the incidence of these complications focused on variations in catheter positioning (above the diaphragm or at the aortic bifurcation). These manoeuvres, however, failed to significantly reduce the rate of thrombosis (19, 23).

Transient blanching and cyanosis of the lower extremities are the most common ischemic manifestations and should serve as a warning sign and an indication for catheter removal (24). When visceral ischemia is suspected, aortography via the catheter is useful. Lower extremity ischemia and renal artery thrombosis are managed conservatively, but failure of the ischemia to improve, aortic thrombosis and bilateral renal artery occlusion call for surgical intervention (21, 24).

Conclusion

The potential for serious complications associated with the widespread use of arterial monitoring in ICU patients should be constantly borne in mind. Though uncommon, these complications should be incorporated, with realistic probabilities assigned to them, into critical care algorithms which employ this invasive monitoring modality.

References