How To Do It

Treatment of Malperfusion during Surgery for Type A Aortic Dissection

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Abstract: During surgery for acute type A aortic dissection, malperfusion may occur during cardiopulmonary bypass. Antegrade perfusion through femoral cannulation is considered a predisposing factor. However, this may occur even with antegrade perfusion, because of the presence of multiple flaps or compression of the true lumen by the false lumen. In this particular setting, the aim is to reach a perfusion of the true lumen of the dissected aorta. A technique of epicardial ultrasound-guided direct cannulation of the dissected aorta's true lumen by a Seldinger technique may help in those cases. We describe the technique with particular interest to the epicardial ultrasound control and the type of arterial cannula to be inserted by the Seldinger technique.

Keywords: aortic dissection cardiopulmonary bypass perfusion ultrasound.

TECHNIQUE

We used this technique first in a 50-year-old man transferred from another hospital to our institution with a diagnosis of type A aortic dissection. The patient complained of chest pain irradiating to the back and shoulders for 5 hours. No neurologic symptoms were present. The limbs appeared perfused, but hyposphygmia was present on the left arm. A computed tomography (CT) scan showed aortic dissection involving the ascending aorta extending down to the iliac arteries. ECG was normal, and myocardial-specific enzymes were also normal. Diuresis was impaired. The patient was transferred to the operating room for replacement of the ascending aorta and arch and re-implantation of supra-aortic vessels.

The patient was monitored using bilateral radial lines, a left femoral line, trans-esophageal echocardiography (TEE), and cerebral oximetry.

After a median sternotomy, the supra-aortic vessels were exposed before opening the pericardium. CPB was established through right atrium cannulation and arterial return through direct right subclavian artery cannulation (DLP 18-Fr; Medtronic, Minneapolis, MN), from inside the sternal access, just after bifurcation of the innominate artery. There was no dissection of the subclavia artery, and there was sufficient flow of blow out from this artery. The right femoral artery was also cannulated (DLP 21-Fr cannula; Medtronic) and connected to the main arterial line by a Y connector.

However, soon after, it was evident that we had difficulty maintaining normal flow. We had high resistance in
the subclavian arterial line, and low systemic arterial blood pressure was measured on the left radial and left femoral lines. Near infrared spectroscopy (INVOS; Somanetics, Troy, MI) showed cerebral oxygen desaturation in both hemispheres (value <50% from baseline).

We did not see improvement after we switched to femoral perfusion. To treat the malperfusion, we decided to insert a third arterial cannula. This third line, an EOPA DLP cannula (Medtronic) (Figure 1) was inserted into the distal aortic arch at the level of the left subclavian artery with the help of an epiaortic ultrasound scan. We placed a purse string suture in the distal aortic arch, using 6/0 polypropylene suture (Prolene; Ethicon, Livingston, UK), reinforced by pericardial pledgets. The ultrasound cardiac probe M4S 4.3 MHz (GE Medical Systems, Milwaukee, WI) was inserted into a sterile plastic sleeve with a small volume of ultrasound gel (EcoGel; Gurò-sas, Enna, Italy). A Seldinger steel needle was inserted into the true lumen of the dissected aorta (Figure 2). We guided the needle with the help of an epiaortic ultrasound scan and digital palpation. A guide wire was passed directly into the true lumen of the dissected aorta (Figure 3), and the cannula (DLP 22-Fr EOPA; Medtronic) mounted on its introducer was passed on it (Figure 4), positioning the cannula tip in the descending aorta. Once this cannula was connected to the CPB by another arterial Y connection, we obtained rapid perfusion improvement with an increase in arterial blood pressure both on the left radial and left femoral arteries and a decrease in arterial line resistance. The patient was rapidly cooled down to a tympanic temperature of 22.5°C (Mon-a-therm Thermistor YSI 400 Series tympanic temperature probe; Mallinckrodt, St. Louis, MO); rectal temperature measured 24.3°C. Then we opened the aorta. At the opening, multiple flaps were evident at the level of the arch. This was thought to be the cause of the malperfusion. Antegrade cerebral perfusion was obtained by direct cannulation of the left and right carotid arteries (DLP Retrograde Coronary Sinus Perfusion Cannula with manual Inflating Cuff; Medtronic). To perfuse the lower part of the body, we used retrograde perfusion from the femoral cannulation, occluding the thoracic aorta just below the arch with an aortic balloon occluder (Equalizer Balloon Catheter; Boston Scientific, Natick, MA). The procedure was completed with the replacement of the aortic arch, ascending aorta, and separate re-implantation of each supra-aortic
vessel on the branches of a 28-mm-diameter Gelweave four-branched vascular graft (Vascutek; Terumo Gelweave, Ann Arbor, MI).

**COMMENT**

During surgery for type A aortic dissection, it sometimes may be difficult to obtain good uniform organ perfusion during CPB. Malperfusion is not an infrequent problem and can occur at any time throughout the case (4) This is usually because of the presence of multiple flaps inside the aorta or the compression of the true lumen by the false lumen.

To detect malperfusion, recent evidence has suggested that a combination of monitoring modalities is optimal. The detection of malperfusion during operative repair of acute type A dissection has been described with transesophageal echocardiography (5,6), transcranial Doppler (7), electroencephalogram (8,9), regional cerebral oximetry (10,11), and transcutaneous ultrasound carotid imaging (4).

Keeping a low flow during CPB will prolong the time to reach the temperature chosen for circulatory arrest and will predispose to malperfusion of vital organs and incidence of acidosis. Retrograde perfusion through the femoral artery
is considered by some authors to predispose to this problem (2,12,13), and because of this, many groups have moved to axillary cannulation and antegrade perfusion.

However, not everyone agrees with this. For example, Fusco et al. (14), presenting a large series of surgeries for aortic dissection, considered retrograde perfusion using femoral artery cannulation as safe.

Shimokawa et al. (2), as well, reporting on 107 patients, considered femoral cannulation to start CPB “under appropriate intraoperative monitoring,” as appropriate. However, they reported an incidence of “4.1% of malperfusion in classical dissection patients” after starting retrograde perfusion. He emphasized the utility of intraoperative monitoring to diagnose malperfusion as soon as possible and therefore change the type of perfusion.

Gulbins et al. (1), in their comparison review, concluded that the superior results of axillary cannulation compared with femoral cannulation seem to be caused by the maintenance of antegrade cerebral blood flow through the whole procedure, and “the avoidance of complete circulatory arrest reduces neurologic events.” However, complications of innominate artery dissection and malperfusion may also occur with axillary cannulation (1).

Good perfusion may be obtained through the return of blood from the arterial line into the true lumen of the aorta.

Jacob et al. (15) reported the use of an open direct cannulation of the ascending aorta after exsanguination of the patient through the venous line.

There are also reports (16) on transapical left ventricular cannulation across the aortic valve.

Augoustides et al. (4) reported on a case where malperfusion was treated by direct surgical intimal fenestration above the aortic cross-clamp. This intimal fenestration re-established perfusion of the right carotid through the false lumen.

Totaro and Argano (12) reported on complete antegrade perfusion, using selected cannulation of the epiarterial vessels and perfusion of the thoracic aorta through an endotracheal tube, with its tube cuff inflated and connected to a standard arterial cannula.

In our institution, we use the same protocol of cannulation for all major surgery on the aortic arch and for the dissections. We cannulate the subclavia artery either directly or by a site branch, and the cannulate the femoral artery as well. With double cannulation sites, we can move from antegrade to retrograde (and vice versa) perfusion during surgery without the need of further insertion of cannulae. During open aortic arch surgery, we use retrograde perfusion from the femoral cannulation, occluding the thoracic aorta just below the arch with an occlusive balloon (17,18). Double cannulation in our experience does not interfere with perfusion through a single arterial cannula. Actually, we usually perfuse the body antegrade through the subclavian line, and retrograde perfusion is used when the arch is opened or in rare cases when antegrade perfusion is not sufficient. In the case we described, we encountered difficulties in maintaining normal flow during CPB, both with antegrade and retrograde perfusion. In that case, we therefore cannulated the real lumen of the dissected aorta with another cannula, aided by ultrasound scan.

Intraoperative imaging assessment of the true lumen and false lumen is accomplished by epiaortic echocardiography (19); an ultrasound-aided technique has also been suggested by Yavus (20).

Therefore, use of an epiaortic ultrasound scan will help in passing a guide wire using the Seldinger technique into the true lumen of the aorta. On the guide wire, we can pass the DLP EOPA arterial cannula with its flexible introducer. At the end of the procedure, the correct position of the cannula can be checked by ultrasound scan.

After this successful case, we used the same technique in two other patients with type A aortic dissection from the beginning of surgery and therefore without malperfusion syndrome during CPB.

In conclusion, we believe that, during surgery for extended type A aortic dissection, ultrasound-guided direct cannulation of the dissected aorta’s true lumen allows good uniform organ perfusion, when, for particular anatomical settings, malperfusion could occur. Further control studies with a larger number of cases would be beneficial to improve the technique and to show its real advantage.

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REFERENCES


