Cervical cannulation for resternotomy in pediatric patients

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Resternotomy is a common, albeit challenging, component of many current cardiac operations and remains a source of morbidity and mortality.¹⁻³ Despite the recent emphasis on primary repair for congenital heart defects, complete repair or palliation often requires multiple operations. In the vast majority of cases, sternal reentry can be performed without difficulty. However, a small number of patients have anatomic configurations that make sternal reentry particularly hazardous. Potentially difficult sternotomies on occasion require alternate cannulation sites. Typically the femoral vessels are used in larger patients, but these vessels are often unavailable in pediatric patients because of multiple previous cardiac catheterizations, cutdowns, and, in pretoddler infants, inadequate size. The aim of this report is to describe our experience with cervical cannulation in infants undergoing resternotomy.

Methods

Patients. Six patients have undergone cervical cannulation at two different institutions (2 at University of California Davis Medical Center, Sacramento, Calif, and 4 at Children's Hospital of Michigan, Detroit, Mich). One child had only the common carotid artery cannulated, with venous drainage from the right atrium. The remaining patients had both the right common carotid artery and right internal jugular vein cannulated. The diagnoses and indications for an alternative cannulation site are shown in Table 1.

Technique. Patients were placed on the operating room table in a supine position, with the head facing to the left. A bump was placed under the shoulders to increase cervical extension, and surgical drapes were placed slightly cephalad.

A transverse cervical incision was made over the right sternocleidomastoid muscle, parallel to and approximately 1 to 2 cm above the clavicle (Figure 1, A). The dissection was performed between the sternal and clavicular heads of the sternocleidomastoid muscle. A Weitlander retractor was sufficient for exposure (Figure 1, B). The internal jugular vein and the common carotid

artery were dissected out. After heparinization, polypropylene (5-0 or 6-0) purse-string sutures were then placed on both the internal jugular vein and common carotid artery (Figure 1, C). Our preference is to cannulate the common carotid artery first, followed by internal jugular venous cannulation, but some groups prefer to perform the venous cannulation first. The venous cannula was positioned so that the tip lay within the right atrium. Once bypass was established and the chest was opened, a second venous cannula was usually placed into the inferior vena cava or within the right atrium to augment venous return. Decannulation was performed by tying the purse-string sutures.

Results

All 6 patients survived the operation. Three patients underwent cervical cannulation prophylactically before resternotomy because of particularly hazardous anatomy. The remaining 3 patients were placed on bypass after bleeding was encountered during sternal opening. In each case, the bleeding was controlled by digital pressure by the assistant while the surgeon cannulated the cervical vessels. Three patients have had a follow-up Doppler study of their cervical vessels from 6 months to 2 years after surgery. In each case, all vessels were patent. No complications have been attributed to cervical cannulation.

Discussion

Sternal reentry remains a challenging problem confronting the surgeon who corrects congenital heart conditions. The vast majority of resternotomies are performed without incident. Nevertheless, a small subgroup of patients have problems with sternal reentry, such as those with a substernal homograft or shunt, a markedly dilated right atrium, or aneurysms of the right ventricular outflow tract.¹⁻³ In larger patients femoral cannulation provides ready access for cardiopulmonary bypass, but in younger patients the femoral vessels are too small to cannulate. The iliac vessels are suitably sized but require a retroperitoneal approach. Cervical cannulation was championed by pioneers of extracorporeal membrane oxygenation because of the ready accessibility and satisfactory size for cannulation of this vessel. Concerns about cerebral injury as a result of common carotid ligation in patients undergoing extracorporeal membrane oxygenation are probably not applicable in this case, because the common carotid artery is not ligated, as is frequently done in extracorporeal membrane oxygenation, but rather is cannulated through a purse-string suture, which should allow antegrade flow around the cannula. If the potential need for cervical cannulation is identified before the operation, patency of the right and left internal jugular veins should be confirmed by Doppler study before surgery. Cannulation of the right internal jugular vein in the presence of an occlusion of the left internal jugular vein could lead to cerebral venous hypertension and im-

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Figure 1. A, Position of patient and site of incision for cervical cannulation. B, Completed dissection before cannulation. C, Cannulation of internal jugular vein. Vascular clamp is omitted for better visualization.

TABLE 1. Clinical summaries

Case	Diagnosis	Operation	Indication
1	Truncus arteriosus; right ventricle to pulmonary artery conduit pseudoaneurysm	Repair pseudoaneurysm; replace right ventricle to pulmonary artery conduit	Prophylactic
2	Hypoplastic left heart syndrome, status post Norwood procedure	Hemi-Fontan	Bleeding—aorta adherent to sternum
3	Pulmonary atresia with intact ventricular septum; discontinuous pulmonary arteries	Pulmonary artery angioplasty	Bleeding—previously placed anterior shunt
4	Pulmonary atresia with ventricular septal defect; right ventricle to pulmonary artery conduit pseudoaneurysm	Repair pseudoaneurysm; replace right ventricle to pulmonary artery homograft	Prophylactic
5	Truncus arteriosus; right ventricle to pulmonary artery conduit obstruction	Replace right ventricle to pulmonary artery homograft	Bleeding—homograft adherent to sternum
6	Transposition of the great arteries, status post arterial switch; pulmonary artery aneurysm	Repair pulmonary artery aneurysm; bilateral pulmonary angioplasty	Prophylactic

paired cerebral perfusion. Complete cannulation of the cervical vessels can be performed in approximately 10 to 15 minutes. Potential complications, such as late vessel occlusion, were not seen in this small series of patients.

Alternative cannulation sites should rarely be needed during resternotomy. However, cervical cannulation provides several advantages relative to femoral cannulation in smaller patients. Risk associated with this cannulation technique appears to be low.

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