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Deep hypothermic total circulatory arrest for internal carotid artery aneurysm extending into the cranium: experience from a developing country

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Abstract

Cardiopulmonary bypass is commonplace for acquired and congenital cardiac procedures. It has also stretched to facilitate complicated non-cardiac operations. Carotid artery aneurysms are treated both with surgical repair without cardiopulmonary bypass (CPB) and, occasionally, by utilizing CPB perfusion techniques. We have successfully repaired an internal carotid artery aneurysm, extending into cranium in a 30-year-old woman, by establishing deep hypothermic circulatory arrest on cardiopulmonary bypass.

Keywords

cardiopulmonary bypass; carotid aneurysm; intracranial; deep hypothermic circulatory arrest; Pakistan.

Introduction

Cardiopulmonary bypass (CPB) circuits are used, quite routinely, during the surgical repair and management of congenital, valvular and other acquired heart diseases. However, the application of cardiopulmonary bypass technique stretches across other disciplines of surgery, e.g., neural, vascular, liver transplants, isolated limb perfusion and lung transplant surgeries. Aneurysms of the carotid artery are rare. Successful surgical treatment with reconstruction is a valid option in an extracranial aneurysm.[1] However, for intracranial aneurysms, it is possible to use CPB with deep hypothermic total circulatory arrest (DHTCA) and facilitate the surgical repair.[2]

We report a large, internal carotid artery aneurysm which, although it was extracranial, extended into the cranium in a young, 30-year-old female patient treated by bypass grafting under deep hypothermia and circulatory arrest with the help of CPB.

Case presentation

The patient was a 30-year-old woman with a history of neck swelling for the past 15 years, that was initially smaller, but recently grew enlarged and became tense. Following a clinical and radiological evaluation, on carotid angiogram, she was diagnosed to have a left internal carotid artery aneurysm. It showed a large, fusiform, aneurysmal dilatation of the left internal carotid artery at its origin with the intraluminal thrombus and extending up to the junction of the first and second cervical vertebrae. It measured approximately 6.8 × 5.6 cm (Fig.1). There were no co-morbid factors. After the preoperative work-up, including neurological and otolaryngological examinations which were unremarkable, she was scheduled for surgical repair. In view of the distal extension of the aneurysm into the cranium, it was decided to have the heart-lung machine available for establishment of cardiopulmonary bypass and cooling to achieve deep hypothermic circulatory arrest.

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Figure 1. Aneurysm of Internal Carotid Artery.

The surgical site was prepared, including neck and anterior chest, for possible sternotomy. After initial dissection and having achieved proximal control, it was acknowledged that distal clamping was not possible, so partial median sternotomy was performed and cardiopulmonary bypass CPB was established via an aortic cannulation with a 24French (FR) angle-tip cannula and a right atrial 36/46 FR two-stage venous cannula. The patient was gradually cooled down from an initial body temperature of 35°C to a depth of hypothermia at 18°C in 25 minutes, using a temperature gradient of 7 – 8°C. At this point, DHTCA was instituted and the aortic line clamped after 2500ml of blood were collected in the venous reservoir. The arterial and venous lines were clamped. Thirty minute duration of DHTCA was instituted at 18°C. The body temperature was monitored using a nasopharyngeal probe. Blood in the venous reservoir was circulated in the oxygenator at 5-10 rpm and 5000 IU of heparin added to it. Fifty milliequivalents of bicarbonate and one unit of packed blood cells were also added. The Alpha-stat strategy was used for blood gas management**.** During this arrest time, the aneurysm was opened and a polytetrafluoroethane (PTFE) graft was interposed. The total circulatory arrest time was 30 minutes. Re-establishment of CPB was performed by first opening the arterial clamp and filling the circulatory system and heart, gradually, with an infusion of 1200ml of blood which raised the central venous pressure to 12mmHg. Then, the venous clamp was released to allow for CPB to re-establish. The patient was gradually re-warmed to 37°C, with a temperature gradient of 7°C for 50 minutes. After re-warming, the patient was weaned off CPB and the aortic and atrial cannulae removed. The total cardiopulmonary bypass time was 120 minutes, inclusive of the circulatory arrest time. Protamine was infused to reverse the effects of heparin, followed by haemostasis and routine closure, with insertion of drains. Postoperatively, the patient was transferred to the cardiac Intensive Care Unit (CICU). She was extubated on the first postoperative day and transferred out of CICU on the second postoperative day. Her postoperative neurological examination was unremarkable. She was discharged home after an uncomplicated hospital course on the sixth postoperative day.

Discussion

The surgical management of an extracranial internal carotid artery aneurysm is challenging, especially when they are huge and extend high up into the cranium. There are reports regarding their management using deep hypothermic arrest.[3] In this report, we have highlighted the extension of the scope of CPB beyond routine cardiac surgery in a tertiary care centre in a developing country. The application of CPB with DHTCA is a novel strategy to facilitate such a procedure which, otherwise, would have been almost impossible to carry out without resulting in morbidities such as cranial nerve damage along with embolization of thrombus in the aneurysm. Complex otological procedures that may lead to adverse outcome may be avoided by safe utilization of this strategy, which requires vigilance and expertise from perfusionists. They play a key role in taking care of the disadvantages of rapid cooling and rewarming, such as acidosis and cardiac arrhythmias, and the risk of systemic microembolization and hypoperfusion of the body tissues.[4] This includes perfect maintenance of homeostasis by correcting arterial blood gases and electrolytes and the management of flow in relation to changing body temperature. Some authors prefer groin cannulation with assisted venous return.[5] We used the mini-sternotomy approach and used central cannulation in order to achieve adequate venous return and avoid distension of the heart while establishing DHTCA. However, groin cannulation is associated with less surgical trauma and allows for a wider gap between the two operating fields.

Conclusion

The safety of the patient depends upon a team effort by surgeons, perfusionists and anaesthetists. This approach may be preferable to other alternatives for two reasons. Firstly, in patients with high and large aneurysms, distal

carotid artery clamping is a great challenge without dividing and resecting adjacent bony and soft tissues, with an inherent risk of jeopardizing cranial nerves. Secondly, the risk of thrombus embolization is a major consideration for opting for DHTCA.

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