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Clinical Protocol

CP.XX.xxx

The objective of this document is to be a resource, not a replacement for institutional specific protocols. It is intended as a template for your perfusion team to edit and adapt into a resource that fits your institutional specific needs. These Clinical Protocols may also be superseded by the judgment of the healthcare professional considering the facts and circumstances of the individual case.

SUBJECT/TITLE: **RETROGRADE CEREBRAL PERFUSION (RCP)**

PURPOSE: To provide a guideline and resource to describe the technique for Retrograde Cerebral Perfusion (RCP).

TARGET POPULATION: Adult patients requiring RCP to provide cerebral protection during aortic arch surgery or as a modality to treat arterial air embolism.

DEFINITIONS: The use of RCP has been shown to provide cerebral protection during aortic surgery. It is also used as a modality to treat arterial air embolism. RCP can be performed via the superior vena cava (SVC) either by using a single venous cannula or using a retrograde cardioplegia cannula.

The described benefits of RCP are as follows:

1. To provide oxygen and nutrient delivery to the brain.
2. Provides an uncluttered field for surgical correction.
3. No need to snare arch vessels.
4. Flush embolic debris from arch vessels.
5. Maintains intracranial hypothermia.

Potential disadvantages as follows:

1. May cause cerebral edema thus exacerbating cerebral injury.
2. Possible inadequate flow to meet cerebral metabolic demand.[7]
3. Possible inadequate flow throughout brain microvasculature.[7]

POLICY: Perfusionists shall maintain close communication concerning patient hemodynamics with Surgeons and Anesthesiologists throughout the entirety of procedure requiring RCP.

PERFUSION PUMP CONSIDERATIONS:

RCP can be performed via the SVC as described below:

1. Single venous cannula (size range from 24 Fr to 32 Fr).
2. Retrograde cardioplegia cannula in addition to standard circuit.

3. Male to male pressure line if using retrograde cardioplegia cannula.
4. 3/8 x 3/8-inch tubing if cannulation strategy is an arterial venous shunt.

PROCEDURE:

1. Cannula selection and cannulation technique will need to be determined prior to initiation of Cardiopulmonary Bypass (CPB) and should be discussed within the team preoperative huddle. As with all forms of cannulation, pay specific attention to the risk of dissection.

2. After circulatory arrest and exsanguination, a single venous cannula or retrograde cardioplegia cannula can be inserted into SVC.
3. The single venous cannula is connected either to the arterial line with perfusion occurring through the arterial line **OR**
    a. It can also be connected to the venous line which will require a 'shunt-line' between the arterial and venous lines.
    b. The shunt-line is opened while the arterial line clamped.

<u>Cerebral Protection utilizing Retrograde Cardioplegia Cannula</u>

1. Discuss the target blood temperature and set heater-cooler accordingly.
2. The cardioplegia line is disconnected from the cardioplegia cannula.
3. The additional retrograde cardioplegia cannula is inserted into the SVC.
4. The cardioplegia delivery system is configured to deliver cold blood only. DO NOT DELIVER K TO THE BRAIN.
    a. Be sure if you are using the cardioplegia circuit, you increase the temperature to <u>not deliver</u> at standard cardioplegia temperature. Maintain the temperature of the blood perfusate at the predetermined temperature (usually 18℃) or surgeon's requested target temperature
5. The cardioplegia line is flushed and reconnected to the retrograde cardioplegia cannula in the SVC.
6. The monitoring line is flushed and zeroed for monitoring of the CVP or jugular pressure.
7. Once RCP has begun, make sure the surgeon verifies that RCP blood is flowing out of the open aorta.

A. <u>Flow</u>

1. **Maintain blood flow at 300-500 ml/min to maintain jugular pressure.**

B. <u>Pressure</u>

1. Maintain the jugular pressure or SVC pressure at about 20-25-mm Hg. This is the pressure monitored off the pressure port of the retrograde cardioplegia cannula.

****** Do not exceed 25-mm Hg********

C. Temperature

1. Maintain the temperature of the blood perfusate at the predetermined temperature (usually 18ºC) or surgeon's requested target temperature by setting the oxygenator heater-cooler accordingly.

D. Fluid Volume Replacement

1. **Avoid making large volume additions without ascertaining the cause of blood loss.**

E. Charting

1. Chart the RCP flow, CVP/jugular pressure, and temperatures on the perfusion record at 15-minute intervals or at prescribed intervals per hospital policy. Record the beginning and end of RCP flow, the duration of RCP and circulatory arrest on the perfusion record.

RCP for Arterial Air Embolism

1. Because of the high risk of stroke, myocardial infarction, or death after massive gas embolism, this complication must be treated without any delay and should be instituted immediately. ***See Air Embolism protocol.***

A. Flow

1. Maintain a higher blood flow rate between 1-2 L/min to ensure adequate flushing of emboli. Continue to flow until no more air is seen exiting from the open aorta.
2. Cannulation positioning can have an effect on your flows. You always want to maintain flows that keep your pressure below 25 mmHg. This may mean that you have to flow between 300-500 mL/min to maintain pressure below the 25 mmHg threshold.
    a. For example, SVC cannulation allows higher flows, due to retrograde flow down the arms, whereas a retrograde cannula inserted into the Jugular Vein demonstrates lower flows. It is important to discuss your Surgeon's cannulation technique, and flow appropriately based on the pressure at the cannula.

B. Pressure

1. Since SVC pressure is usually not available, maintain circuit pressure no more than 100 mmHg. If using a retrograde cardioplegia cannula measure the pressure off the pressure port of the cannula and do not exceed 25 mm Hg.

C. Temperature

1. Consider cooling the patient's blood temperature to moderate hypothermia (28ºC).

CLINICAL ASSESSMENT/SCREENING:

A. Contraindications: None.

RELATED DOCUMENTS:

A. Deep Hypothermic Circulatory Arrest Clinical Protocol.
B. Massive Air Embolism Clinical Protocol.

REFERENCES:

1. Lau C, Gaudino M, Iannacone EM, et al. retrograde cerebral perfusion is effective for prolonged circulatory arrest in arch aneurysm repair. Ann Thorac Surg. 2018;105:491–7.
2. Appoo JJ, Augoustides JG, Pochettino A, et al. Perioperative outcome in adults undergoing elective deep hypothermic circulatory arrest with retrograde cerebral perfusion in proximal aortic arch repair: evaluation of protocol-based care. J Cardiothorac Vasc Anesth. 2006;20:3-7.
3. Leshnower BG, Rabgaraju S, Allen JW, et al. Deep hypothermia with retrograde cerebral perfusion versus moderate hypothermia with antegrade cerebral perfusion for arch surgery. Ann Thorac Surg. 2019;107:1747-54.
4. Tanaka, Akiko, and Anthony L. Estrera. "Simple retrograde cerebral perfusion is as good as complex antegrade cerebral perfusion for hemiarch replacement." *Journal of Visualized Surgery* 4 (2018).
5. Ueda, Y., et al. "Surgical treatment of aneurysm or dissection involving the ascending aorta and aortic arch, utilizing circulatory arrest and retrograde cerebral perfusion." *The Journal of cardiovascular surgery* 31.5 (1990): 553-558.
6. Mills, Noel L., and John L. Ochsner. "Massive air embolism during cardiopulmonary bypass." *The Journal of Thoracic and Cardiovascular Surgery* 80.5 (1980): 708-717.
7. Gravlee, et al. "Chapter 32: Perfusion for Thoracic Aortic Surgery. Proximal Aortic Operations. Hypothermic Circulatory Arrest and Antegrade Cerebral Perfusion." *Cardiopulmonary Bypass: Principles and Practice*, 3rd ed., Lippincott, Williams & Wilkins, 2008; pp. 648–648.

IMPORTANT INFORMATION ABOUT THESE PROTOCOLS:

If this protocol/process is adopted as is, the AmSECT logo must be removed and replaced with an institution specific logo.

This protocol/process encourages high quality patient care but observing it cannot guarantee any specific patient outcome.

This protocol/process should be reviewed or revised as warranted by institutional specific protocol, taking into account the evolution of technology and practice.

Review period: Review as changes occur or per institutional protocol.
Original hard copies and/or computer copies of this protocol are stored under the supervision of the Chief Perfusionist, Department of Cardiovascular Perfusion.

APPROVED BY: *(signature of CMO and CNE only required)*

Source:	*(originating department/committee)*
Effective Date:	*(can use 'created date' for this)*
Version Number:	*(should match # of revisions, use 1.0 if new document)*
Date Revised:	*MM/YYYY; all dates any content changes were made*
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	Date:
<*Insert Name,* Chief Medical Officer >	
	Date:
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