

# Myocardial Protection Strategy Utilizing Retrograde Cardioplegia for Neonatal Arterial Switch Operations

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## ABSTRACT

**Introduction:** Myocardial protection strategies are a central component of neonatal arterial switch operations. Traditionally antegrade cardioplegia through the aortic root has been the method of delivery, but use of retrograde cardioplegia via the coronary sinus has become the standard of practice by many in the field. **Methods:** After obtaining IRB approval and informed consent, a retrospective chart review was done to assess outcomes between 48 patients receiving antegrade (n= 5) and retrograde (n= 43) cardioplegia during neonatal switch operations. Preoperative demographics and postoperative outcomes were compared between the two groups and compared with historical studies. **Results:** Patients from the retrograde cardioplegia group demonstrated a trend towards shorter postoperative ventilation days (6.67 +/- 8.57 vs. 10.2 +/- 10.1) and hospital length of stay (18.3 +/- 15.3 vs. 24.8 +/- 11.8) which were not statistically significant. Patients receiving retrograde cardioplegia demonstrated a trend towards an increased incidence of postoperative arrhythmias which was not statistically significant. The retrograde group also demonstrated an increased cardiopulmonary bypass (CPB) time (95.6 +/- 36.59 vs. 146.74 +/- 44.26) and a trend towards an increased aortic cross clamp (ACC) time (74.4 +/- 24.42 vs. 101.30 +/- 29.56) which was not statistically significant. All patients survived to discharge in both groups. **Discussion:** With results trending towards shorter hospital length of stays, postoperative ventilation days and zero mortality in patients receiving retrograde cardioplegia, it can be utilized as a safe and efficacious strategy for myocardial protection during neonatal switch operations.

## INTRODUCTION

Transposition of the Great Arteries (TGA) is a neonatal congenital heart defect comprised of ventriculoarterial discordance of the pulmonary artery and aorta, resulting in parallel circulations and severe cyanosis

The arterial switch operation involves the transection and reanastomosis of the great arteries to their appropriate chambers as well as the transposition of the coronary arteries to the neo-aortic root.

Cardioplegia (stopping of the heart) was traditionally done in an antegrade fashion during this operation. By this method an aortic cross clamp (ACC) is placed and then a cardioplegic solution is injected into the aortic root and flows into the coronary ostia.

Retrograde cardioplegia is the administration of cardioplegia into the coronary sinus. The advantages of this approach include the ease of repeat doses while the aorta is open and the avoidance of direct cannulation of the coronary ostia.

We conducted a retrospective chart review comparing the short-term postoperative outcomes in patients who received antegrade vs. retrograde cardioplegia during arterial switch operations.

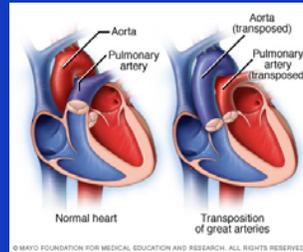


Figure 1: Anatomical comparison of normal heart & d-transposition of great arteries; Adapted from www.mayoclinic.com

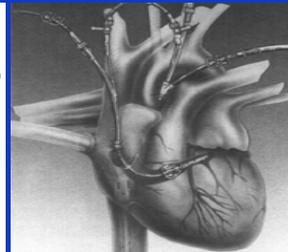


Figure 2: Antegrade cannulae are placed within the aortic root while retrograde cannulae are placed transatrially into the coronary sinus; Adapted from the Journal of Cardiac Surgery



Figure 3: View of right atrium showing the orifice of coronary sinus in relation to tricuspid valve and AV Node

## METHODS

The study protocol was approved by the institutional review board at St. Joseph's Hospital and Medical Center in Phoenix, Arizona and 48 patients who underwent neonatal arterial switch operations were enrolled.

All 48 patients were given an initial loading dose of 4:1 blood cardioplegic solution through the aortic root.

Forty-three patients were given subsequent doses through retrograde coronary sinus perfusion every 20 minutes while 5 patients received all doses in an antegrade fashion.

Preoperative demographics and postoperative outcomes were compared between the two groups at our institution.

Categorical variables were analyzed using Fisher's exact test while continuous variables were analyzed using two sample independent t-testing. A p-value <0.5 was set as the standard for assessment of statistical significance.

## RESULTS

Variable	Antegrade (n = 5)	Retrograde (n = 43)	P value
Age (days)	63.2 +/- 107.5	16.6 +/- 44.6	NS
Gender (M/F)	M = 3, F = 2	M = 21, F = 22	
Admission Wt (kg)	3.6 +/- 1.9	3.5 +/- 1.0	NS
CPB Time (min)	95.6 +/- 36.5	146.7 +/- 44.3	<.05
ACC Time (min)	74.4 +/- 24.4	101.3 +/- 29.6	NS
Volume of Cardioplegia (mL/kg)	25.6 +/- 14.5	23.5 +/- 13.4	NS
Ventricular Septal Defect (Y/N)	Y = 2 N = 3	Y = 20 N = 23	NS

Table 1: Patients from the Retrograde group had longer CPB times; Otherwise there were no statistically significant differences in preoperative demographics or intraoperative characteristics; CPB = Cardiopulmonary bypass, ACC = Aortic Cross Clamp, NS = Not significant, N = number

	Antegrade (n = 5)	Retrograde (n = 43)	P value
Postoperative ventilation (days)	10.2 +/- 10.1	6.7 +/- 8.6	NS
Postoperative arrhythmias (Y/N)	Y = 0, N = 5	Y = 12, N = 31	NS
Survival at discharge (Y/N)	Y = 5 N = 0	Y = 43 N = 0	NS
Postoperative length of stay (days)	24.8 +/- 11.8	18.3 +/- 15.3	NS

Table 2: All patients from both groups survived to discharge or transfer; Patients from the retrograde group displayed a trend towards an increased incidence in postoperative arrhythmias; NS = Not significant; N = Number

## RESULTS

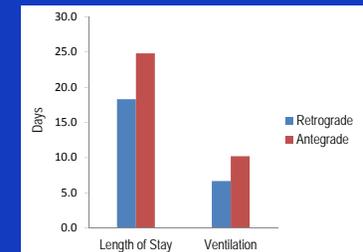


Figure 3: Patients from the retrograde group displayed a trend towards a shorter hospital length of stay and postoperative ventilation days.

## DISCUSSION

Patients receiving retrograde cardioplegia displayed a 100% survival-to-discharge/transfer rate and a trend toward shorter durations of postoperative ventilation and hospital length of stay.

The retrograde cardioplegia group also displayed a trend towards an increased incidence of postoperative arrhythmias, conflicting with a previous study. This is presumably due to the proximity of the coronary sinus to the AV Node and potential for irritation.

## LIMITATIONS AND FUTURE DIRECTIONS

### Limitations

Retrospective chart review  
 Small sample size of patients receiving antegrade cardioplegia.

### Future Directions

Prospective study with larger antegrade sample size  
 Incidence of postoperative arrhythmias with retrograde cardioplegia  
 Long-term outcomes of retrograde cardioplegia

## CONCLUSIONS

As evidenced by a zero mortality rate and a trend towards improved postoperative outcomes, retrograde cardioplegia remains a safe and efficacious means of myocardial protection during neonatal arterial switch operations.