Recurrent Laryngeal Nerve Injury and Swallowing Dysfunction in Neonatal Aortic Arch Repair

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Background. **We evaluated the incidence, clinical effect, and recovery rate of vocal cord dysfunction (VCD) and swallowing dysfunction in neonates undergoing aortic arch repair.**

Methods. **We retrospectively evaluated 101 neonates who underwent aortic arch reconstruction from 2008 to 2015. Direct flexible laryngoscopy was performed in 89 patients before initiation of postoperative oral feeding after Norwood (n = 63) and non-Norwood (n = 26) arch reconstruction. We defined VCD as immobility of vocal cords or their lack of coaptation and poor mobility.**

Results. **The incidence of VCD after aortic arch repair was 48% (n = 43). There was no significant difference between the VCD and non-VCD groups in postoperative length of stay, extubation failure, cardiopulmonary bypass, cross-clamp, selective cerebral perfusion time, operative death, and The Society of Thoracic Surgeons–European Association for Cardio-Thoracic Surgery (STAT) Congenital Heart Surgery Mortality Categories. Placement of gastrostomy ($p = 0.03$) and documented aspiration ($p = 0.01$) were significantly more common in VCD patients. The incidence of VCD was 41% (n = 26) after Norwood and 65% (n = 17) after non-Norwood repairs ($p = 0.06$). Gastrostomy was required in 44 Norwood patients vs 9 non-Norwood patients ($p = 0.004$). Median length of stay was similar in Norwood patients with or without VCD ($p = .28$) but was significantly longer in non-Norwood patients with VCD vs those without ($p = 0.002$). At follow-up direct flexible laryngoscopy, VCD recovery was 74% (14 of 19) in the Norwood group and 86% (12 of 14) in the non-Norwood group.**

Conclusions. **The incidence of VCD and swallowing dysfunction in neonates undergoing aortic arch reconstruction is high. Patients with VCD have a significantly higher incidence of gastrostomy placement and aspiration. In the Norwood population, length of stay is not associated with presence or absence of VCD. More than 70% of patients in each group who had direct flexible laryngoscopy follow-up recovered vocal cord function.**

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Outcomes after neonatal aortic arch reconstructions have improved greatly over the last 2 decades [1–4]. However, the incidence of postoperative morbidities in this group remains high [5–8]. One of the commonest morbidities in these patients is laryngopharyngeal dysfunction, which manifests clinically as feeding difficulty and impaired ability to protect the airway from aspiration [1, 5, 8–13].

Normal laryngopharyngeal function is a complex mechanism that depends on an intact central nervous system, maturity of the neonate, and intact sensory and motor innervation of local muscles and cartilages [1, 14–17]. Although the left recurrent laryngeal nerve (RLN) is only one element of this physiology, it is a structure that is at uniquely high risk of damage during neonatal aortic arch reconstruction.

The left RLN courses around the distal aortic arch and the patent ductus arteriosus close to the area of dissection needed to reconstruct the distal arch. The RLN supplies motor control to intrinsic laryngeal muscles, and its extralaryngeal branches provide sensory or autonomic fibers to the larynx, trachea, esophagus, and the pharynx [9, 18–20]. Given the function and location of the left RLN, injury to the nerve can be suspected when a patient presents with vocal fold (cord) dysfunction (VCD) or feeding difficulties after aortic arch repair.

The aims of this investigation were to evaluate the incidence and clinical effect of suspected RLN injury in neonates undergoing aortic arch repair by reviewing postoperative evaluations of vocal cord and swallowing function.

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Abbreviations and Acronyms

CPB	=	cardiopulmonary bypass
CPR	=	cardiopulmonary resuscitation
DFL	=	direct flexible laryngoscopy
DHCA	=	deep hypothermic circulatory arrest
IQR	=	interquartile range
LOS	=	length of stay
OPMS	=	oropharyngeal motility study
PEG	=	percutaneous endoscopic gastrostomy
RLN	=	recurrent laryngeal nerve
STAT	=	The Society of Thoracic Surgeons–European Association for Cardio-Thoracic Surgery Congenital Heart Surgery Mortality Categories
UGI	=	upper gastrointestinal
VCD	=	vocal fold (cord) dysfunction

Material and Methods

Study Patients

A retrospective record review was performed of 101 neonates who underwent aortic arch reconstructive operations in the form of Norwood palliations and non-Norwood biventricular repairs at our institution from January 2008 to December 2015. All non-Norwood biventricular aortic arch repairs were performed through a sternotomy on cardiopulmonary bypass (CPB). The study protocol was approved by the Institutional Review Board at Arnold Palmer Hospital for Children.

Since 2008, our institutional strategy has been to evaluate neonates who underwent aortic arch operations with bedside direct flexible laryngoscopy (DFL), bedside clinical examination by a speech therapist, and an oropharyngeal motility study (OPMS) evaluation in the radiology suite. DFL was performed in 89 patients before initiation of postoperative oral feeding after Norwood (n = 63) and non-Norwood (n = 26) aortic arch reconstructive operations (Fig 1). The analysis excluded 12 patients (9 Norwood and 3 non-Norwood) without the initial DFL. There were 2 Norwood operative deaths in the excluded patients, making the overall operative mortality of the initial group of 101 patients 4% (n = 4), and the final cohort, 2.2% (n = 2). Cohort diagnoses are reported in Table 1.

Operative Approach

Among the 63 patients undergoing the Norwood procedure, the operative approach included pulmonary artery homograft reconstruction of the entire aortic arch in all patients. Dissection routinely included ligation and division of the patent ductus arteriosus and mobilization of the proximal descending thoracic aorta well beyond the ductal entrance. Blunt dissection was done immediately adjacent to the vessel adventitia with sparing use of electrocautery. The RLN was visualized and mobilized away from the ductus and aorta with the surrounding connective tissue. Selective cerebral perfusion was used in all patients. Operations included a right ventricle-to-pulmonary artery shunt (Sano) in 14 patients and a modified Blalock-Taussig shunt in 49 patients. Details of intraoperative variables are reported in Table 2.

Among the 23 patients undergoing aortic arch reconstruction for biventricular repair, the operative approach included primary aortic arch reconstruction (pull-up technique) in all patients. Dissection and mobilization of the patent ductus arteriosus and the descending thoracic aorta with visualization and preservation of the RLN were similar to the Norwood palliation. The main difference between the two procedures was that the descending thoracic aorta was pulled up and anastomosed to the midtransverse arch in the non-Norwood arch repair,

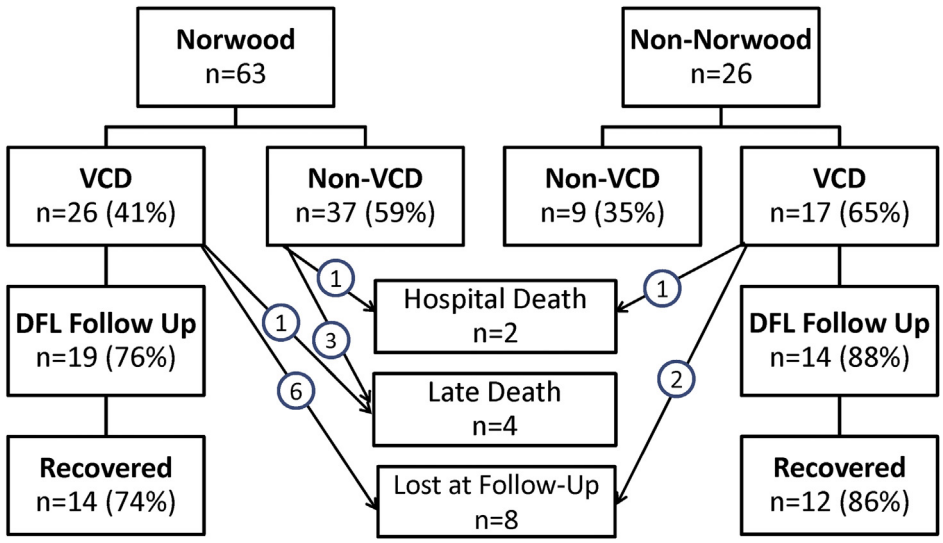

Fig 1. Cohort distribution. (DFL = direct flexible laryngoscopy; VCD = vocal cord dysfunction.)

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