Imaging Airways in Congenital Heart Disease

S. Bruce Greenberg
Professor of Radiology & Pediatrics
Arkansas Children’s Hospital
University of Arkansas for Medical Sciences

Financial disclosure

Toshiba speakers bureau
Consultant for Vital Images

Lecture summary

CTA techniques
- Single phase
- Multiple pulmonary phase

Anomalies
- Isolated
- Multiple
- Post operative

Single phase CTA for cardiopulmonary disease

Technique

- Non-gated acquisition
- Multi-detector CT
  - Helical $\approx 3$ mSV
  - Wide-detector $\approx 1$ mSV

16 detector

Single phase CTA for cardiopulmonary disease

Indications

Anomalous Innominate Artery
Vascular rings
Pulmonary sling
Complex anatomy

Vascular ring

Anomalous innominate artery
Bronchoscopy versus multi-detector computed tomography in the diagnosis of congenital vascular ring
A H Gaafar and K I El-Noueam
CTA detects all vascular rings
Bronchoscopy better for associated airway abnormalities

Bronchoscopy versus multi-detector computed tomography in the diagnosis of congenital vascular ring
A H Gaafar and K I El-Noueam
CTA detects all vascular rings
Bronchoscopy better for associated airway abnormalities

Multi-phase pulmonary CTA for cardiopulmonary disease

- Wide-detector acquisition
- Multiple pulmonary phases
- Single breathe
**Multi phase pulmonary CTA for cardiopulmonary disease**

**Advantages**
- Dynamic airway imaging
- Dynamic pulmonary imaging
- Simultaneous vascular imaging

**Indications**
- Complex physiology
- Post operative imaging

---

**Dynamic pulmonary technique**

- Wide-detector (entire Z-axis)
- Continuous scan mode
- 4 rotations
- 1.4 seconds
- Respiratory rate (ideal 40 / minute)
- Radiation exposure (≈ 1.5 mSV)
  - 80 kVp
  - mAs = [(kg x 2.5) + 5] / 0.36

---

**Scimitar syndrome**

- Hypoplastic right lung with truncated right upper lobe bronchus
- Anomalous venous drainage of right lung to inferior vena cava

---

**Dynamic pulmonary imaging**

---

**Airway volume quantification**

- "Pulmonary ejection fraction" analogous to cardiac ejection fraction
- Right lung ejection fraction 54%, Left lung ejection fraction 66%
Modified BT shunt & left pulmonary artery pseudo-sling

Compression of left bronchus between left pulmonary artery and aorta

Left bronchomalacia & left lung air trapping

Inspiratory
Expiratory

Post Norwood I with Sano shunt

Left bronchus dynamic imaging

Tracheo-esophageal fistula & hypoplastic left heart syndrome

Norwood I with Sano Branch pulmonary artery stenosis

Tracheo-bronchomalacia with left lung air trapping

Left lung air trapping following tracheo-esophageal fistula repair
Vascular stents and the airway
Adverse impact of vascular stent “mass effect” on airways
C Ferandos, H El-Said, R Hamzeh, and J W Moore
Catheterization and Cardiovascular Interventionals
Stent locations associated with airway compression: aortic coarctation, branch pulmonary artery, PDA

PDA stent adjacent to left bronchus

Hypoplastic left heart syndrome post hybrid procedure

Right pulmonary vein thrombosis

Hyperinflation left lung & left bronchomalacia

Single phase CTA limitations?
Bronchoscopy versus multi-detector computed tomography in the diagnosis of congenital vascular ring
A H Gaafar and K I El-Noueam
CTA detects all vascular rings
Bronchoscopy better for associated airway abnormalities
Pre-existing airway problems can complicate CHD

Tracheal compression due to an elongated aortic arch in patients with congenital heart disease: evaluation using multidetector-row CT
N Watanabe, Y Hayabuchi, M Inoue, et al

Hypoplastic left heart syndrome associated with large omphalocele and hypoplastic left bronchus
M Hainstock, D Bardo, M Rice, S Langley
Pediatr Cardiol (2010) 31: 878-880

CTA for Pediatric Cardio-Pulmonary Disease

Single phase imaging
- Adequate for morphology
- Pre-operative imaging

Multiphase airway imaging
- Preferred for dynamic evaluation
  - Airway
  - Lungs
- Post-operative imaging