The utilization of multidetector computerized tomographic angiography in the evaluation of double aortic arch

Fahad Al Habshan *, Mansour Al Mutairi

King Saud Bin Abdulaziz University for Health Sciences, P.O. Box 22490, Riyadh 11426, Saudi Arabia

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1. Introduction

Vascular ring is one of the serious causes of airway compromise that is usually difficult to diagnose. Multiple conventional imaging modalities, such as chest radiography, barium oesophagography, echocardiography, standard axial computerized tomographic (CT) and conventional angiography are used to diagnose these anomalies and help to plan possible treatment. Barium oesophagography is one of the earliest methods used for the diagnosis of vascular rings, it may indicate compression of the esophagus by an adjacent vessel but this technique does not provide any extra information about the vascular anatomy or the airway compression. Echocardiography has a major limitation in diagnosing vascular rings as the ultrasound does not pass across the bone, air, or scarred tissue. Thus it might raise the index of suspicion but does not provide a definite diagnosis (Parikh et al., 1993; Berdon, 2000). Cardiac catheterization and angiography had been used to diagnose vascular rings but it is an invasive procedure that requires deep sedation or general anesthesia. It also requires the utilization of high volume of contrast material and multiple injections to visualize all the vascular structures. It also does not provide detailed anatomy of the airway. The standard axial CT imaging with contrast helps in obtaining the diagnosis of vascular ring but it does not allow clear definition of the vascular anatomy due to poor enhancement of the vessels. It also does not allow the three-dimensional reconstruction and the multi-planner reformatting of the images (Berdon, 2000).

In contrast to all these modalities, CT angiography using the new generation of the fast multidetector scanners provides the great advantage of performing non-invasive vascular angiography in an ultra short time (Goo et al., 2005). In this paper we discuss a case that illustrates the advantage of this technique.

2. Case

Three year old boy with recurrent wheeze since early infancy and a history of multiple hospital admission was referred for CT angiography to rule out vascular ring. Echocardiography revealed normal intracardiac anatomy. There was difficulty in visualizing the aortic arch due to hyperinflation of the lungs.

The CT study was performed using a 64 slice, light speed General Electric scanner. Axial CT with spiral volume acquisition was obtained with 2.5 mm slice thickness, the tube current was 120 mA and the voltage was 100 kV. Hand injection of
1.5 ml/kg omnipaque contrast medium was used for contrast enhancement. The acquisition was done in the arterial phase using automated contrast tracking. The scan time was around 2 s. No complication observed and the study was adequate for analysis. The images quality was satisfactory for interpretation with optimal enhancement of the great vessels.

3. Findings

The results of the study are shown in Figs. 1 and 2. The study revealed the presence of double aortic arch with a dominant right aortic arch. Each arch gave rise to the ipsilateral common carotid and subclavian artery. The two arches formed a complete vascular ring encircling both the trachea and the esophagus. There was a significant tracheal compression at the site of the vascular ring. The lungs were hyper-inflated.

4. Discussion

CT angiography using the multidetector scanner provides superb results in an ultra short time. The scanning time is usually few seconds for which it is not necessary to deeply sedate the patients undergoing the procedure. It provides spiral volume acquisition which allows the three-dimensional reconstruction and the multi-planner reformatting of the images to scrutinize the images from all different angles. This reconstruction helps greatly in studying the detailed anatomical configuration of the vascular structures and their spatial relationship to the surrounding structures such as the airway and the esophagus. This also helps in defining the details of anatomical abnormalities such as the extent of stenosis or compression of the airway with the distal effect of this abnormality at the parynchemal level.

Fig. 1 shows a classical view for an axial CT image of double aortic arch but it lacks definition and it is difficult to explain when showing the details of the vascular and airway anatomy to the surgeon. Fig. 2 in contrast represents a reconstructed CT angiographic image for our patient with double aortic arch and the high quality image allows quick and easy recognition of the anatomical details. In this image, it is obvious that the right aortic arch is dominant with very clear identification of the branches of each vessel. It also allows the identification of the airway anatomy and the extent of the airway compression. A naso-gastric tube was used to allow the recognition of the esophageal course in relation to the vascular structure. The new generation of workstations and their softwares allow the manipulation and color coding of the images for better demonstration to the audience. These clear images are preferred over the standard axial images by the surgeons as they serve as road maps for them before attempting the surgical repair. However, the utilization of this new imaging modality requires strong background knowledge of the vascular and airway abnormalities. Special skills and training required for the timing and optimization of the vascular contrast enhancement, as well as for reconstruction of the images.

The hazard of radiation exposure should always be remembered when performing procedures that utilize X-ray such as cardiac catheterization and CT angiography. The use of these techniques should be limited to the cases with high index of suspicion (Goo et al., 2005).
References

