

Original Articles

The Role of MRI/MRA in Investigating Tracheal Compression by Anomalous Innominate Artery in Infants

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Key words Neonatal stridor; Anomalous innominate artery; MRI; MRA

Introduction

Endoscopic examination of the airway, either with flexible or rigid instrument, is the gold standard in paediatric airway assessment. Recently magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) are increasingly used in paediatric airway evaluation. This case report presents a patient in whom imaging the airway with MRI and MRA both confirm the endoscopic diagnosis of distal tracheal compression by an anomalous innominate artery (AIA), and supply essential information on extratracheal pathology and spatial relationship. The use of various investigation modalities in AIA is also discussed.

Case Report

A 5-month-old male infant presented to us with a history of noisy breathing soon after birth. He was a full-term infant born in Canada with good Apgar scores and no history of perinatal problem or endotracheal intubation. On examination, stridor was evident, was mainly

inspiratory and became biphasic when the child was agitated. Tracheal tug and subcostal insucking were obvious, especially when the child was crying.

Anteroposterior chest radiograph (CXR) was normal. Echocardiography and Doppler flow studies did not show features of intrathoracic vascular ring. Endoscopic assessment of the airway under general anaesthesia was then performed. Rigid ventilating bronchoscopy revealed distal tracheal obstruction by an extrinsic pulsatile lesion arising from the right anterior direction at about 1.5 cm above the carina, suggestive of compression by AIA. The lumen of the airway was reduced by an estimated 80% on inspection. Flexible endoscopy of the upper airway did not show other obstructive lesions from the nasal cavities to the glottic area.

With this differential diagnosis in mind, MRI of the trachea was performed and this demonstrated the pathological anatomy with tracheal compression by a vessel in front causing significant reduction in lumen (Figure 1). Interestingly, the brachiocephalic vein crossed the midline over the trachea at the same site and might have contributed to the airway obstruction. In addition, contrast enhanced MR angiogram (MRA) was performed (Figure 2). The latter was able to generate 3-dimensional images of the intrathoracic vessels and their relationship to the midline. In this patient, MRA demonstrated both the anomalous origin of innominate artery to the left of midline and the absence of other vascular pathology such as ring or sling. The combined MRI & MRA finding therefore confirmed the diagnosis of AIA. Conventional angiography was not performed.

The child had been tolerating his feeds quite well and the parents denied any history of cyanotic episodes or apnoeic spells. We elected to manage the condition conservatively and the child achieved satisfactory gain in weight and height. Stridor and subcostal insucking gradually decreased. On last follow-up at the age of 3, all the respiratory symptoms had subsided.

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Figure 1 MRI T1 weighted sagittal view of trachea. Solid arrow = AIA. Appeared as black dot as this is a non-contrast scan. Open arrow = brachiocephalic vein.

Discussion

The causes of neonatal airway obstruction are many and distinctly different from adults. Developmental anomalies of great vessels in the thorax with formation of vascular rings and slings around the trachea and oesophagus are an important and often surgically correctable cause. Among this group of patients, AIA is believed to be one of the most common causes accounting for more than 50% of cases.^{1,2}

Conventionally, investigation for patients with suspected AIA involved a combination of CXR, barium swallow, endoscopy and arteriography, with endoscopy being an almost indispensable element.

Lateral CXR with demonstration of anterior tracheal wall compression may be seen in 1/3 of patients with AIA.³ However, Mustard⁴ reported that this finding could also be present in 30% of randomly selected lateral CXR films. The use of lateral CXR as a primary diagnostic tool is therefore limited. Barium swallow aims at providing indirect evidence by ruling out other vascular pathologies such as double aortic arch or pulmonary sling, which may give rise to similar symptoms in infants.

Endoscopic examination of an airway compressed by AIA often reveals specific findings, including (i) airway compression at 1-2 cm above the carina, (ii) pulsatile nature of the extrinsic compression, (iii) compression from the

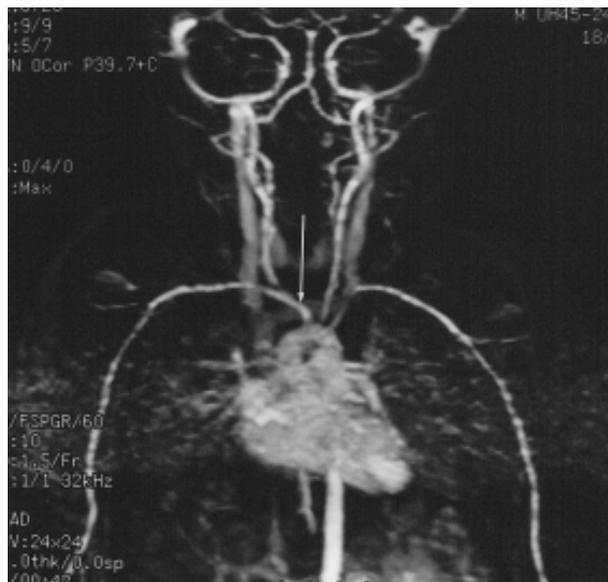


Figure 2 Contrast enhanced MRA. Long arrow aligned along midline and pointed to AIA

right-anterior direction and (iv) diminishing right temporal and radial pulse when the rigid endoscope is applied against the site of compression.

The role of arteriography lies in depicting the pathologic vascular anatomy. Although arteriogram can usually show the anomalous origin of the innominate artery to the left of the trachea, it cannot demonstrate the actual tracheal compression. In fact, innominate artery takeoff to the left of the trachea occurs even in normal situation, and this finding does not imply airway compression. In addition, the invasiveness of the procedure is a disadvantage and the exposure to irradiation may be substantial. Historically, the combined endoscopic and arteriography findings confirm the diagnosis of AIA.

As illustrated in this patient, MRI and MRA have the virtue of providing all the essential diagnostic information conventionally obtained from CXR, endoscopy and arteriogram in one single investigation and in a relatively non-invasive manner. In addition the spatial relationship between the various structures was well depicted by the MRA, as was the actual act of compression. Such 3-dimensional images cannot be obtained with plain MRI alone. The use of MRI/MRA for airway compression have therefore greatly increased recently.^{5,6} Besides vascular pathologies, other lesions like mediastinal mass or lymphadenopathy leading to extrinsic airway compression are also well demonstrated by MRI.

Although MRI can provide good images of the trachea and its surrounding structures, it cannot replace endoscopic assessment. Endoscopy has the advantage of examining the whole airway for synchronous pathology which is not uncommon in kids with airway problem, and some of

which are not well demonstrated by MRI e.g. laryngomalacia. Endoscopy should still be the first line investigation for kids presenting with stridor. MRI and MRA can however, largely eliminated the need for arteriography and barium swallow when the endoscopic finding suggests the diagnosis of AIA.

Despite the advantages of using MRI/MRA in the diagnosis of AIA, this modality of investigation is costly and may not be available in every setting. It is interesting to note that in attempts to contain cost, some report suggested confining investigation for kids with suspected vascular anomalies to plain radiographs and barium studies alone.⁷

In this patient, the extent of airway obstruction was significant on assessment with rigid endoscopy and MRI with 80% reduction of lumen. Despite the severity of obstruction, this patient did well with conservative treatment. This is in accordance with observation by Ardito that the severity of symptom bears no relationship to the extent of obstruction.³ Therefore, the decision for surgical intervention in neonatal airway obstruction by AIA should not be based only on endoscopic or MRI findings. The absolute indication for surgery in AIA is still the presence of reflex apnoea, while relative indications include

recurrent or chronic respiratory distress, sputum retention, atelectasis and recurrent chest infection.

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