Respiratory complications and Goldenhar syndrome

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Case report

A 29-year-old female was referred to hospital with progressive asthmatic complaints. On presentation, the patient had been experiencing orthopnoea, an audible wheeze during daily activities, and sporadic coughing without sputum production. The patient had a history of recurrent airway infections and a 5-kg weight loss during the previous year, and had stopped smoking several years before. She was known to have oculo-auriculo-vertebral (OAV) syndrome, *i.e.* Goldenhar syndrome, which is a developmental disorder involving mainly first and second branchial arch anomalies.

On physical examination, she was not dyspnoeic at rest, and had a respiratory rate of 14 breaths·min^{-1}, pulse 80 beats·min^{-1}, blood pressure 110/70 mmHg and temperature 37.9°C. The left hemifacial structures and the left hemithorax were underdeveloped. A chest examination revealed a systolic heart murmur grade 2/6 over the apex, and inspiratory and expiratory wheezing over both lungs. There was no oedema or clubbing. Arterial blood gas analysis showed a partial pressure of O_2 of 12.4 kPa and partial pressure of CO_2 of 4.5 kPa. Routine blood analysis and chemistry were normal. Chest radiography was performed (figure 1).

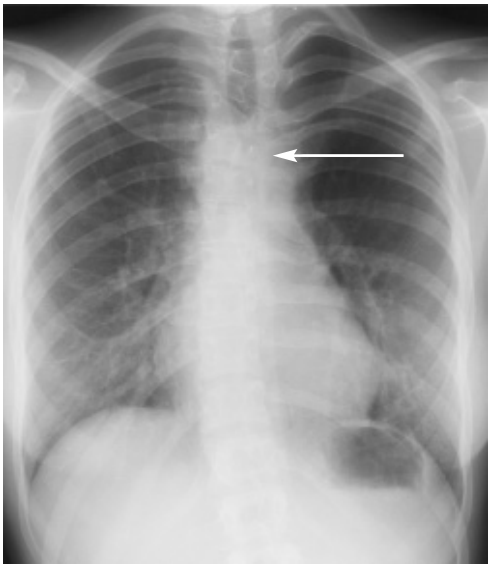

Figure 1
Postero-anterior chest radiograph.

Task 1
Interpret the chest radiograph.

Answer 1

The chest radiograph shows a right-sided aortic arch causing tracheal compression (arrow), a left-sided descending aorta and some rib deformities.

Spirometric values were as follows: forced expiratory volume in one second (FEV_1) 2.09 L (66% predicted); forced vital capacity (FVC) 2.65 L (73% pred); FEV_1/FVC 79%; and peak expiratory flow rate (PEFR) 3.75 $L \cdot s^{-1}$ (53% pred). FEV_1 and PEFR measured in the supine position were 1.53 L (48% pred) and 2.12 $L \cdot s^{-1}$ (30% pred), respectively. PEFR during exercise was 1.95 $L \cdot s^{-1}$ (28% pred). Total lung capacity (TLC) was measured using a body box: 4.16 L (83% pred). Figure 2 shows a flow/volume loop during a maximal inspiratory and expiratory manoeuvre in an upright position.

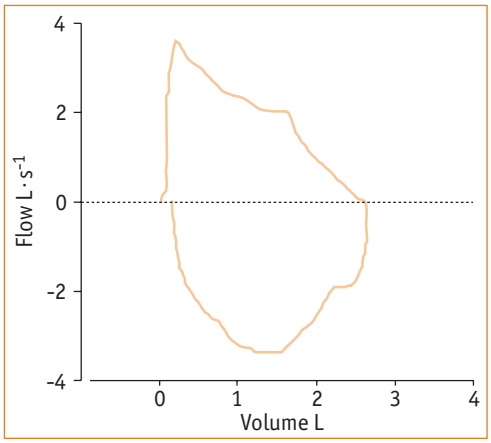

Figure 2
Flow–volume loop during a maximal inspiratory and expiratory manoeuvre.

Task 2

Interpret the flow/volume loop and the spirometry results.

Answer 2

The early expiratory phase of the maximal flow/volume loop shows a relatively horizontal part. Peak flow and FEV_1 are reduced; supine positioning and exercise reduce these values even more. FEV_1/FVC and TLC are normal. These findings suggest an upper intrathoracic airway obstruction, with an increasing obstructive defect in the supine position and upon exercise.

In addition, magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) were performed. The results are shown in figures 3 and 4.

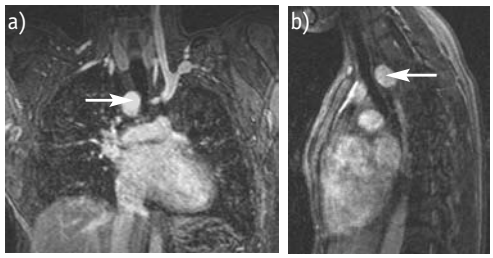

Figure 3
Coronal (a) and sagittal (b) fast low-angle shot (flash) MRI sections at the level of the trachea.

Figure 4
Flash 3D MRA of the intrathoracic blood vessels (anterior view).

Task 3

Interpret the MRI and MRA.

Answer 3

The presence of a right-sided aortic arch is further confirmed by the coronal MRI (figure 3a; arrow indicating tracheal impression by the aorta). An aberrant left brachiocephalic trunk can also be seen. Figure 3b shows the aortic arch posterior to the trachea and oesophagus. MRA shows the aberrant brachiocephalic trunk arising ventrally from the ascending aorta and giving rise to the left subclavian and carotid arteries (figure 4). The right carotid and subclavian arteries have an aberrant ventral origin from the aortic arch.

Bronchoscopy was subsequently performed. There was vocal cord asymmetry, with the left being smaller. A tracheal stenosis was seen 3 cm proximal to the main carina (figure 5). The dorsal wall of the trachea was dyskinetic. The right bronchial system was normal; however, there was an agenesis of the pars superior of the left upper lobe.

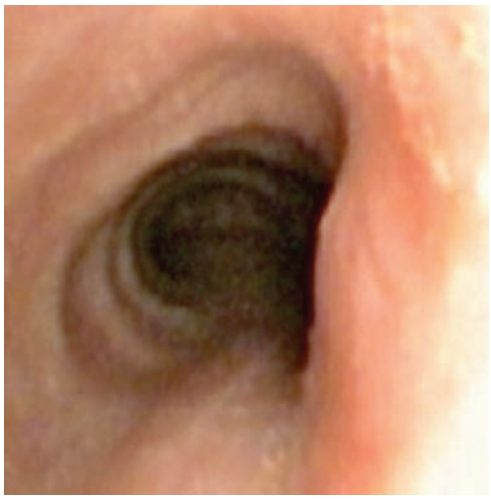

Figure 5
Bronchoscopic view of the distal trachea.

Task 4

Based on the investigations presented to you, suggest a diagnosis.

Answer 4

The diagnosis was tracheal compression due to a vascular ring.

Clinical course

The patient was referred for vascular surgery. Medial sternotomy was performed, and an incomplete vascular ring was identified. The ring was formed by the right-sided aortic arch, the aberrant left brachiocephalic artery and a ductal ligament between the pulmonary artery and the left subclavian artery. A reconstruction of the operative findings is shown in figure 6.

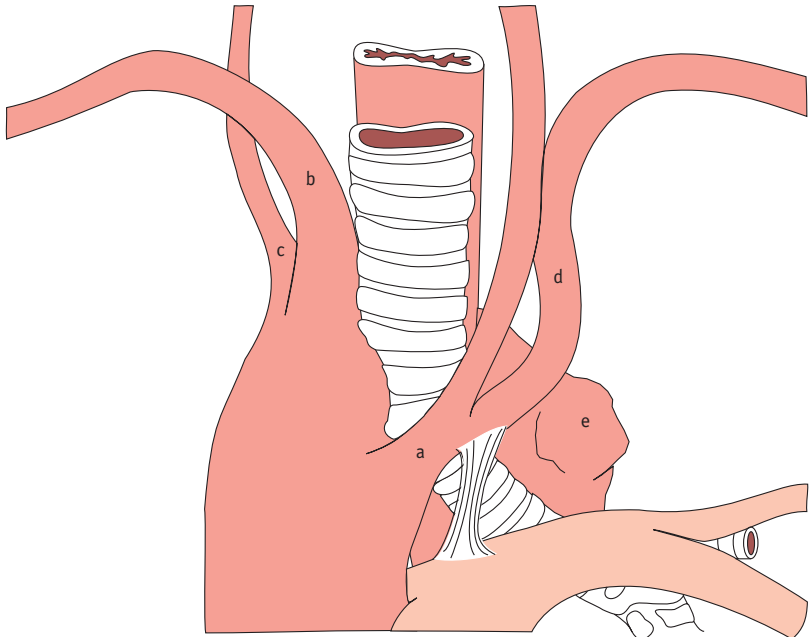

Figure 6
Reconstruction of the operative findings showing the incomplete vascular ring in the anterior view: a) left brachiocephalic trunk, b) right subclavian artery, c) right carotid artery, d) left subclavian artery, and e) aortic diverticulum.

The ductal ligament was cleaved and the left brachiocephalic artery was lengthened using a GORE-TEX vascular prosthesis, which alleviated the aortic impression on the trachea. In addition, the narrow right lateral tracheal wall was widened by tracheopexy.

Initially, the patient experienced an uneventful recovery. However, tracheomalacia at the site of the initial aortic impression continued to cause symptoms. Two years after the initial surgery, resternotomy was performed. A tracheoplasty was carried out, using a patch of autologous pericardium supported by autologous rib cartilage. Symptoms subsequently improved, but recurred 1 month later. Bronchoscopy showed

endotracheal luxation of the autologous rib cartilage graft, and therefore a tracheal stent was placed. Two weeks later, the patient died from massive haemoptysis, presumably caused by aortic erosion. An autopsy was denied.

Discussion

The case presented here shows a patient with Goldenhar syndrome, with not only first and second branchial arch developmental disorders, but also a fourth left branchial arch developmental disorder resulting in a right-sided aortic arch. In the general population, vascular rings are reported with an incidence of <0.2% in children. The mean age at the onset of symptoms ranges from 7 months to 4.5 years. The most common types of vascular rings are the double aortic arch (36%), and the right ascending aorta and left ductus/ligamentum arteriosus (49%). Only a minority of patients with right-sided aorta have symptomatic tracheal compression [1, 2]. The symptoms resulting from a vascular ring are dyspnoea, stridor, wheeze, chest discomfort, chronic cough and recurrent airway infections [3]. Gastrointestinal symptoms, such as emesis and dysphagia, occur in ~40% of cases. Symptoms may occur transiently with exertion, supine positioning and fluid administration, all of which dilate the aorta. Symptoms can also develop later in life due to enlargement of vascular structures with ageing. Documented cases of tracheo-oesophageal compression by a vascular ring in an adult are rare [4, 5].

Noninvasive techniques, such as computed tomographic scanning and MRI, are well suited to demonstrate the anatomical features of a vascular ring and to determine the optimal surgical approach [6, 7]. Bronchoscopy is indicated to rule out other causes of airway obstruction. Echocardiography should be carried out to exclude associated cardiac abnormalities. Spirometric findings may be normal or show flattening of the expiratory part of the flow/volume loop. Surgical division of the ligamentum arteriosum is the treatment of choice in symptomatic patients with a right ascending aorta-left ductus type of vascular ring [2]. At long-term follow-up, 91% of patients are symptom-free after treatment. Residual symptoms can be due to tracheobronchomalacia, but these symptoms usually diminish or disappear with time. If tracheal symptoms persist, tracheal resection or placement of an intraluminal stent should be considered.

The OAV syndrome is a developmental disorder with a heterogeneous phenotype, and its prevalence is one per 19,500 births. Most cases are sporadic, but familial instances have been reported. It combines anomalies (mostly unilateral) of tissues embryologically derived from the first and second branchial arches. The disorder is characterised by microtia, mandibular hypoplasia and hemifacial microsomia. Additionally, there may be ocular and vertebral defects, in which case the disorder is termed Goldenhar syndrome. About 50% of patients have anomalies in addition to the cardinal manifestations described above, which include heart and lung malformations [8]. The respiratory system may be involved with tracheoesophageal fistula with or without oesophageal atresia, unilateral or bilateral pulmonary aplasia or hypoplasia, incomplete lobulation of the lung, sequestration, tracheal and subglottic stenosis, a vertically fused trachea, hemihypertrophy of the epiglottis, and tracheomalacia. Pulmonary lesions are ipsilateral to facial abnormalities and have a 67% coincidence with cardiovascular lesions. Congenital heart defects are common in Goldenhar syndrome and prevalence is reported to range 5–58%. In particular, ventricular septal defect, but also atrial septal defect, tetralogy of Fallot, single ventricle and situs inversus have been reported. Furthermore, a wide variety of vascular defects have been reported, including right ascending aorta, coarctation of the aorta, pulmonary stenosis, transposition of the great vessels, patent ductus arteriosus, a left superior vena cava and totally anomalous pulmonary venous return. Cases of a vascular ring have also been reported previously [9, 10].

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