Electrocardiographic signs of pulmonary hypertension in children who snore

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Abstract

Two children presented with sleep disturbance due to enlarged tonsils and adenoids. One child died during induction of anaesthesia, and postmortem examination showed hypertrophy of the right ventricle and atrium. As a result a prospective survey was carried out of children undergoing tonsillectomy or adenoidectomy, or both. During a nine-month period an electrocardiogram was taken in 92 children. Three electrocardiograms (3.3%) showed evidence of right heart strain. The children with abnormal electrocardiograms had symptoms of sleep disturbance with apnoea, snoring, and daytime somnolence. These symptoms and the electrocardiographic changes were reversed by adenotonsillectomy.

The prevalence of pulmonary hypertension in children with enlarged tonsils and adenoids is still underestimated. When signs and symptoms of sleep disturbance, particularly snoring, are present an electrocardiogram should be obtained and a cardiologist's opinion sought before embarking on routine surgery in view of the potentially fatal consequences.

Introduction

Cor pulmonale due to chronic upper airway obstruction was first described in children by Menashe et al in 1965. Other reports have described a wide range of symptoms with which this syndrome may present: lethargy, enuresis, behaviour disturbance, and poor school performance are common. Disorders of sleep leading to daytime somnolence commonly occur, but snoring is often overlooked as a serious sign.

We describe two children who presented with nasal obstruction, otitis media, and snoring, one of whom died during induction of anaesthesia. After seeing these children we obtained a prospective series of electrocardiograms in children awaiting adenoidectomy and tonsillectomy to determine the incidence of electrocardiographic signs of pulmonary hypertension.

Case reports

CASE 1

A 3-year-old girl was referred to an otolaryngologist because of nasal obstruction, snoring, and general ill health. Physical examination showed large tonsils and adenoids and serous otitis media. Her height and weight were below the third centile for her age. She was admitted for adenoidectomy and aspiration of the middle ear with insertion of grommets but was found to be anaemic (haemoglobin 7.9 g/100 ml, serum iron 2.5 µmol/l (14 µg/100 ml)) and the operation was postponed.

While she was in hospital the nursing and medical staff noticed that she had noisy breathing and disturbed sleep. Episodes of apnoea were terminated with loud snoring after which she woke. This pattern was repeated throughout the night. A chest radiograph showed an enlarged heart (cardiothoracic ratio —0.63). Electrocardiography showed right-axis deviation, right atrial hypertrophy, and right ventricular hypertrophy (fig 1). The iron-deficiency anaemia was corrected and a chest infection treated. After three weeks her condition had apparently improved sufficiently for her to proceed to operation. Shortly after induction of anaesthesia she had a cardiac arrest and resuscitation was unsuccessful. Postmortem examination showed gross hypertrophy and dilatation of the right ventricle and atrium. Section of the lung showed

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FIG 1—Case 1. Electrocardiogram.
medical hypertrophy in the small pulmonary arteries (fig 2). There was no other disease of the heart or lungs to explain the pulmonary hypertension.

**CASE 2**

A 21-year-old boy was examined because of persistent nasal obstruction and snoring while asleep. He was small (10th centile) with serous otitis media and large adenoids. His tonsils were also large but healthy. The middle ear effusion was aspirated and grommets inserted, and adenoidectomy was performed simultaneously. Postoperatively it was noticed that his snoring occurred at the end of prolonged periods of apnoea during sleep. Prolonged periods of upper airway obstruction were relieved only by a large increase in respiratory effort, and restoration of the airway was marked by a loud snore. A cardiologist's advice was sought regarding further investigation. An electrocardiogram showed right-axis deviation, right atrial hypertrophy, and right ventricular hypertrophy. Cardiac catheterisation was performed; pulmonary artery pressure was 45 mm Hg, and other causes of pulmonary hypertension were excluded. At this time he was sleeping for about 18 hours a day. The large tonsils were removed without any complications, and this resulted in a pronounced improvement in his sleeping pattern and general health. Five weeks later electrocardiography showed that the right atrium and right ventricle had returned to normal (P wave in lead II 3.5 to 1.5 mm and S wave in V6 12 mm to 4 mm).

**Prospective electrocardiographic survey**

**METHODS**

The two cases reported above suggested that some children with considerable pulmonary hypertension due to upper airway obstruction may present not with acute respiratory failure or heart failure but with failure to thrive and chronic nasal obstruction leading to snoring and apnoea at night. We therefore carried out a prospective study of children who were to undergo adenoidectomy or tonsillectomy, or both. In nine months 92 children aged between 1 and 13 years underwent 12-lead electrocardiography before their operation. All electrocardiograms were reviewed by a paediatric cardiologist (DP).

**RESULTS**

Three of the 92 electrocardiograms were abnormal and showed signs of right-axis deviation, right ventricular hypertrophy, or right atrial hypertrophy. In each case these changes reverted to within normal limits after adenoidectomy, performed with tonsillectomy in two cases. The three cases are described below.

**Case 3**—A 6-year-old asthmatic boy was assessed because of serious otitis media, persistent nasal obstruction, and a history of daytime drowsiness. After failure of conservative treatment myringotomy, grommet insertion, and adenoidectomy were performed. His tonsils, though large, had not caused any symptoms, but the electrocardiogram showed right atrial and ventricular hypertrophy and they were removed. Figure 3 shows preoperative and postoperative electrocardiograms. The P waves in lead II diminished from 3 to 2 mm and the S wave in lead V6 from 6 to 2 mm. His mother reported that his general alertness and health improved greatly after relief of the upper airway obstruction.

**FIG 2—**Case 1. Photomicrograph of lung tissue ×160 (original magnification).
Discussion

Chronic alveolar hypoventilation due to upper airway obstruction has been documented in many adults since the first report by Burwell et al in 1956. The prevalence of a similar syndrome in children due to hypertrophy of the tonsils and adenoids is probably greatly underestimated if only the extreme forms with congestive failure are considered. The most severe form of this syndrome was first described in 1965. Abnormally high carbon dioxide tension and pulmonary hypertension has been found in children with this severe form, with relief of symptoms and a return to more normal haemodynamics after the tonsils and adenoids have been removed. The range of symptoms in less severe cases, however, is not well documented, and not all children with huge tonsils develop signs of respiratory obstruction. Macartney et al suggested that in some children there may be an increased reactivity of the pulmonary vasculature to hypoxia such as that shown in 20% of normal people at altitude and in some children with small ventricular septal defects.

In children with less severe forms of this syndrome the risk of exacerbating hypoventilation by inducing anaesthesia was predicted by Macartney et al, and Ainger reported two deaths. The results of this study suggest that over 3% of children with chronic otitis media and inflamed adenoids or tonsils may have electrocardiographic signs of early pulmonary hypertension. Specific questioning about sleep pattern should be part of the assessment of any child before the tonsils and adenoids are removed. If there is a history of disturbed sleep, snoring, or daytime drowsiness electrocardiography is indicated; if signs of right heart strain are found particular attention should be paid to the induction of anaesthesia and close monitoring during surgery will be necessary to prevent an otherwise unexpected death.

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References

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ALKANET. Besides the common name, it is called Orchanet, and Spanish Bugloss, and by apothecaries, Enchusa.

Of the many sorts of this herb, there is but one known to grow commonly in this nation; of which one take this description: It hath a great and thick root, of a reddish colour, long, narrow, hairy leaves, green like the leaves of Bugloss, which lie thick upon the ground; the stalks rise up compassed round about, thick with leaves, which are less and narrower than the former; they are tender, and slender, the flowers are hollow, small, and of a reddish colour. It grows in Kent and in many places in the West Country, both in Devonshire and Cornwall. They flower in July and the beginning of August, and the seed is ripe soon after, but the root is in its prime, as carrots and parsnips are, before the herb runs up to stalk.