Sleep-related upper airway obstruction (srUAO), or obstructive sleep apnoea, is only one of a broader range of respiratory control disorders associated with sleep, known collectively as sleep disordered breathing (SDB). These disorders are not related only to the upper airway; there are complex relationships between the upper and lower airway and it is important to be aware that lower airway problems may also cause problems that are aggravated by sleep.

General features of sleep-related UAO

Clinical Presentation

Panel 1 lists clinical features which may be associated with sleep-related UAO, but which may also occur naturally or be associated with other disorders.

Snoring

Snoring is one feature which manifests during the early stages of sleep disordered breathing and is therefore an important symptom to consider. However, many children without Down’s syndrome either snore or have other symptoms suggestive of UAO but who, on standard sleep studies, do not demonstrate notable hypoaxemic episodes or increased upper airway resistance. On oesophageal manometry these children may show large negative pleural pressures, reflecting the increased work of breathing. This condition is called upper airway resistance syndrome. Opinion is divided as to the clinical relevance of this syndrome.

It is important to recognise that the spectrum of sleep disordered breathing is not static – for instance children can develop into snorers abruptly, perhaps as a result of upper airway resistance syndrome due to a respiratory infection, and then spontaneously revert to a normal breathing pattern during sleep.

Panel 1: Clinical features which may be associated with sleep-related UAO

Frequent:
- Snoring. A UK study (Ali et al 1993) suggests around 12% of all children in the UK below the age of 6 are habitual snorers whereas only 1–2% have sleep-related UAO. Snoring may also be related to atopy (asthma, rhinitis).
- Sleep disturbance. Very common in childhood. Underlying UAO must be distinguished from nocturnal cough, pruritus, polyuria, parasomnias or psychological and drug-related factors.
- Mouth breathing and halitosis.
- Restless sleep.
- Chronic rhinorrhea.
- Subcostal and sternal recession.
- Odd sleep positions, such as hanging over the bed or sleeping upright with the head extended to optimise the upper airway.

Less frequent:
- Swallowing difficulties.
- Recurrent upper respiratory tract infections.
- Nausea and vomiting.
- Daytime sleepiness.
- Persistent or secondary enuresis.
- Nocturnal sweating.
- Cyanosis.
- Apnoea.

Associated only with severe problems:
- Pulmonary hypertension.
- Heart failure.

Sleep-related UAO may be difficult to diagnose due to its insidious onset. A child may appear completely normal in a clinic setting and although parents may be aware that snoring and restlessness have increased over a period of time, they may not realise that this is abnormal. Restless sleep is experienced by many children both with and without Down’s syndrome and with and without sleep-related UAO.
Therefore, historical accounts and observations of symptoms and their progression over time are important.

**Pathophysiology**
The pathophysiology of sleep-related UAO is not straightforward. Factors that lead to the development of upper airway problems include anatomical factors, such as changes in cranio-facial structure, obesity and lymphoid hyperplasia (particularly between 2 and 6 years of age), and central effects such as abnormalities in pharyngeal tone. In addition, there are undoubtedly genetic factors; sleep-related UAO often runs within families.

**Prevalence**
In the absence of widely accepted diagnostic criteria for this disorder, prevalence estimates vary from study to study. A UK study by Ali et al. (1993) used as diagnostic criteria a combination of clinical features, need for adenotonsillectomy, and certain desaturation criteria and found that around 2% of all children under 5 years of age may have significant sleep-related UAO. Where desaturation figures alone are taken into account, the prevalence appears much higher (Owen et al. 1995).

**Adverse effects**
Most adverse effects are mediated through hypoxaemia. Dips in oxygen saturation due to episodic obstruction are observed rather than an overall drop in baseline oxygen saturation. In children with Down’s syndrome, baseline lowering is also seen and this may reflect lower airway problems or an inter-relationship of the two. A further primary physiological consequence is hypercapnia. Disruption of sleep architecture and nocturnal arousals from sleep are secondary physiological effects which themselves have clinical consequences.

**Clinical effects of sleep-related UAO**
- Neurocognitive (learning difficulties, behavioural disturbances, personality changes)
- Cardiovascular effects, pulmonary hypertension
- Poor growth
- Lower airway effects: cyanotic-apnoeic episodes, bronchoreactivity labelled as asthma

(30–60 years). Adults are generally obese whereas children frequently exhibit growth failure. Children desaturate more easily than adults but arouse less and tend to preserve better sleep architecture. Adults are more likely than children to have episodes of complete obstruction. Children are more likely to show daytime behavioural problems whereas adults may have daytime hypersomnolence. Adults are at risk of pulmonary hypertension and cardiac arrhythmias.

**Sleep-related UAO in Down’s syndrome**
There is a much higher prevalence of sleep-related UAO in children with Down’s syndrome than in other children. Estimates vary from 30–60% according to the diagnostic criteria used. Therefore, all children with Down’s syndrome would benefit from regular respiratory review and general clinical assessments should always include specific enquiries for symptoms of sleep-related breathing disorders.

Some factors which predispose to sleep-related UAO in Down’s syndrome are shown in Panel 2.

Panel 2: Factors predisposing to sleep-related UAO in Down’s syndrome
- Maxillary/mandibular hypoplasia
- Macroglossia
- Small upper airway
- Increased secretions
- Increased lower respiratory tract anomalies
- Obesity
- Hypotonia
- Lymphoid hyperplasia

**Physiological effects of sleep-related UAO**
- Hypoxaemia
- Hypercapnia
- Sleep disruption
- Nocturnal arousal from sleep

**Features of sleep-related UAO in Down’s syndrome**
Not only do children with Down’s syndrome have a different pathophysiology from adults, they also differ in some respects from other children with sleep-related UAO. The recognised childhood tendency to desaturate more than adults (see previously) is further exacerbated in those with Down’s syndrome for reasons such as airway(s) and lung hypoplasia, and abnormalities in alveolar structure. In other children, desaturations and arousals occur mainly in REM sleep but in Down’s syndrome they may occur through the whole of sleep and therefore children with Down’s syndrome have more disturbance of their sleep architecture.
A UK study by Stebbens et al (1991) of 32 preschool children with Down’s syndrome used a questionnaire for six signs and symptoms, overnight tape recordings and an overall clinical assessment. The questionnaire findings suggested that in a population group of children with Down’s syndrome, one third would have at least three symptoms suggesting sleep-related problems. The most frequent clinically significant problems were snoring and chest wall recession. Other sleep-related problems included restlessness, mouth breathing and excessive sweating, although these were not significantly increased.

The overnight recordings showed that 41% of the children with Down’s syndrome had a pattern of an increased inspiratory resistance on the respiratory waveform compared to 3% of controls. Two-thirds of the children with Down’s syndrome had oxygen saturation levels below that of the lowest found in controls, possibly reflecting exacerbation of UAO by lung hypoplasia. Unsurprisingly, they also had an increased number of dips in oxygen saturation during sleep. These occurred particularly during non-regular breathing.

Investigation of sleep-related UAO

The key investigation of sleep-related UAO is the sleep observation or sleep study, but additional investigations may be helpful.

Sleep studies. The methodology used in sleep studies is very variable and includes studies of daytime naps, night studies and the traditional full polysomnogram. This method has been adapted from investigations in adults and it has been questioned whether all the measures used (shown in Panel 3) are relevant for children. Additional measurements could include oesophageal manometry, but this procedure may be too invasive in children.

Panel 3: Measures used in full polysomnogram

- Respiratory movements
- Airflow
- ECG
- EEG, EOG, EMG
- Oxygenation
- Carbon dioxide
- Movement
- Video recordings

In addition to sleep studies, there are a number of other investigations that may be required.

Fibreoptic endoscopy is very useful to help identify the site of obstruction. This is best performed under a light general anaesthetic to give a much better picture of the dynamics of the airway rather than under a deep anaesthetic with a rigid scope. There may be multiple sites or there may be one main site which, when dealt with, predominantly overcomes the obstruction. In Down’s syndrome, obstruction is often tongue-based, where the tongue approximates to the pharynx during sleep. This appears to be the most predominant problem and the most difficult to treat.

Barium/cine swallow. Noisy breathing may be due to upper airway problems or there may be an additional lower airway component. A barium/cine swallow looking for a vascular ring as a cause of large airway obstruction can be useful in establishing the source of the noise.
MRI or CT imaging can be useful if the anatomy is complicated or endoscopy proves difficult.

ECG and echocardiogram are useful in assessing possible cardiac effects of a sleep-related breathing disorder.

Haemoglobin measurement should be carried out if any procedure is to be performed or if severe hypoxaemia is suspected.

For this reason, after investigation and diagnosis, consideration should be given to a period of observation (3–6 months) and reassessment before pursuing treatment options (Panel 4).

There are also particular surgical issues for children with Down’s syndrome as shown in Panel 5.

Management
There is no one ideal treatment for sleep-related UAO in children with Down’s syndrome. Treatments are not always effective and have associated morbidity and mortality risks. Spontaneous resolution may occur over time but less frequently than for other children.

Conclusion
The high prevalence of sleep-related UAO in people with Down’s syndrome, and its associated significant morbidity, suggests that those with the syndrome would benefit from regular respiratory review. Any clinical assessment should always include specific enquiry for symptoms of sleep-related breathing disorders.

Further reading

A complete transcript of this presentation, together with references, is available at www.dsmig.org.uk.