



Sleep-related upper airway obstruction in Down's syndrome

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Sleep-related upper airway obstruction (srUAO), sometimes called 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 suggest the possibility of sleep-related UAO, but which may also occur naturally or be associated with other disorders

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 snore and the relationship between snoring and sleep-related UAO in Down's syndrome requires further research.

Upper airway resistance syndrome. There are children who snore and have other symptoms suggestive of UAO but who, on standard sleep studies, do not demonstrate notable hypoxaemic 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.

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.

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 rhinorrhoea
- 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



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.

Physiological effects of sleep-related UAO

- Hypoxaemia
- Sleep disruption
- Hypercapnia
- Nocturnal arousal from sleep

There are significant clinical effects of sleep-related UAO and it can be difficult in individual children to determine the extent to which symptoms of UAO relate to daytime problems in individual children. Cohort studies have identified that learning difficulties, behavioural problems and personality changes can be related to sleep-related UAO. There are also cardiovascular effects and poor growth. Furthermore, the effects of hypoxaemia on the lower airways may produce a rise in airway resistance which may have been labelled as asthma.

Children with UAO differ in many ways from adults. In children it is the younger age group which is most affected (2–3 years) reflecting relatively large lymphoid tissue at this age. In adults it is the older group who are affected

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

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

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

In the UK, paediatric sleep study facilities and procedures are fragmented and variable around the country. There is little consistency in the measurements that are undertaken and it is therefore difficult to compare studies. The simple straightforward measurements used at North Staffordshire Hospital include:

- **Video recordings.** Particularly useful if the child is exposed from neck to waist so that chest wall recession and increased work of breathing can be seen.
- **Pulse oximetry.** Most clinical oximeters provide average measurements. With longer averaging times

within the oximeter, dips in oxygenation are damped out, and falsely low baselines in oxygenation may be measured. Therefore, short averaging times are preferred in sleep studies. It is also important that age-appropriate normative data are used when comparing measures of baseline and dips in oxygenation.

- **Inspiratory resistance.** This can be recognised by examination of the breathing pattern: a shouldering of the inspiratory waveform on respiratory inductance plethysmography (Respirtrace) is found with upper airway obstruction.
- **Carbon dioxide measurements.** These can be performed using both end-tidal and transcutaneous sensors in hospital-based studies.
- **Home video-oximetry.** This is a screening tool that has been found to be very helpful. A video camera and oximeter are set up in a child's home next to their bed. A low level light or infra red light and camera are used and preferably the child is exposed down to the waist. The tapes are reviewed for falls in baseline oxygen saturation, chest wall recession, snoring, sleep position and nocturnal movement.

Other assessments could include:

- **Hypopnoea.** A greater than a 50% reduction in amplitude of either airflow or breathing movements.
- **Paradoxical inward rib cage movement (PIRCM).** This is appropriate for children older than 3–4 years of age; recorded by a band around the chest which measures the increased work of breathing. It may prove to be as useful as oesophageal manometry.
- **Arousals detected on EEG.** Criteria for arousal thresholds and their relevance to daytime symptoms is being investigated in adults but little is known about this in children.
- **Oesophageal pressure measurements (manometry).**

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.

Investigations used in the investigation of sleep-related UAO

Frequent	Additional
• Sleep observation/ sleep study	• Barium/cine swallow
• Fibre-optic endoscopy	• CT/MRI
	• ECG/Echocardiogram
	• Hb measurement

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.

Panel 4: Management options for sleep-related UAO in Down's syndrome

- **Wait and reassess** if necessary.
- **Topical decongestants/steroids** may be useful for intermittent problems.
- **Tonsillo-adenoidectomy.**
- **Nasal CPAP.** Effective and non-invasive. Compliance issues and side effects (pressure sores, nosebleeds, excessive drooling and abdominal distension due to swallowed air) may be problematic.
- **Nasopharyngeal tubes.** Particularly useful in young children and infants. Avoids tracheostomy. Needs to be placed under endoscopy to ensure that the tip is in an appropriate position to overcome tongue base obstruction. Requires periodic review and replacement to account for growth.
- **ENT procedures.** These include:
 - Tonsillectomy
 - Adenoidectomy
 - Uvulopalatopharyngoplasty (mainly adults)
 - Tonsillar pillar plication
 - Midface advancement
 - Tongue hyoid suspension
 - Anterior tongue reduction
 - Laryngotracheostomy
 - Mandibular splint
 - Tracheostomy (usually an emergency or last resort procedure).

The most suitable treatment option depends upon the particular patient. Advice from an expert in paediatric ENT surgery should be sought for all ENT procedures.

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.

Panel 5: Particular surgical issues for children with Down's syndrome

- Hospital admission recommended for all surgery, including tonsillo-adenoidectomy and endoscopy.
- Pre-med sedation for tonsillo-adenoidectomy or endoscopy should be avoided as it may aggravate UAO.
- Admittance to PICU or high dependency unit recommended as there is a high incidence of post-surgery airway problems.

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

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