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Evaluation of the Upper Airway in Patients with Snoring and OSA

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1. Introduction

Snoring and obstructive sleep apnoea (OSA) both exhibit multilevel upper airway obstruction. The Importance of evaluating the dynamics of the obstructing upper airway cannot be emphasised enough. Accurate assessment and evaluation of the upper airway could potentially lead to improved surgical and non-surgical treatment outcomes. Most of these patients would have undergone an ambulatory sleep study or a polysomnography prior to deciding what treatment modality is going to be offered to them. Treatment options available include nasal continuous positive airway pressure (nCPAP), mandibular advancement splints (MAS) or surgery. In terms of selecting a treatment option, in cases where the sleep study has confirmed moderate or severe OSA, nCPAP would be favoured. In the remainder and the nCPAP failed patients, further evaluation of the upper airway is useful and necessary. This chapter will not address sleep studies but will discuss various methods of assessing the upper airway and will include clinical evaluation of the upper airway during wakefulness and sleep.

2. Clinical examination

This can be quite easily conducted in out patient setting and addresses the patency of the nasal passage as well as the assessment of different segments of the pharynx. Anterior rhinoscopy using a simple nasal speculum allows visualisation of the anterior aspect of the nasal cavity and helps in identifying problems of caudal dislocation of the septum and if the nasal valve area is compromised. However, a rigid endoscope is more useful in a more comprehensive evaluation of the nasal passage and will identify problems such as deviated nasal septum, nasal polyps (fig. 1) and rhinosinusitis. The identification of these pathological features is important as they may be a cause of failed compliance and efficacy in the nCPAP patients.

Simple oropharyngeal cavity examination provides the clinician with useful information and of note would be the size and grading of palatine tonsils, the length of the soft palate and uvula and more subtle features such as redundant pharyngeal folds. Friedman tongue position[1] and Mallampati[2] grading are also utilised by many clinicians in order to select patients who may be suitable for palatal surgery. For example in patients with Friedman tongue position 3 or 4 (figs. 2 & 3) palatal surgery is unlikely to be successful. In contrast Friedman tongue position 1(fig. 4) would yield better results following palatal surgery. One

must however take in to account that as this assessment is done during wakefulness it may not truly reflect what happens to the upper airway during sleep as there must undoubtedly be some variation in the muscle tone in the state of wakefulness and different stages of sleep.

Fig. 1. Nasal Polyps

Fig. 2. Friedman tongue position 3

Fig. 3. Friedman tongue position 4

Fig. 4. Friedman tongue position 1

Probably the most useful equipment in assessing the upper airway is the flexible fibreoptic nasopharyngoscope which is widely available and allows brilliant visualisation of all aspects of the naso, oro and hypopharynx. Local anaesthesia in the form of a nasal spray can be used in allowing an easier and tolerable insertion of the scope and the different segments of the pharynx are carefully assessed. The patient could be asked to simulate a snoring sound to try and ascertain the level responsible for causing the turbulent airflow resulting in the snoring sound. Herzog[3] has reported a study based on simulating snoring sound in order to establish a model of grading upper airway obstruction. However, not all patients can simulate snoring and some may do this with mouth open or closed and these patients are usually sitting up whilst during sleep patients may be supine, prone or in lateral

positions. In any case the fact that the muscle tone variation in sleep and wakefulness must also be borne in mind. Another commonly used technique during the flexible endoscopic assessment is the Mullers[4] manoeuvre. This essentially is a reversed Valsalva procedure which some patients do find difficult to perform. Furthermore, there is subjective variation in the assessment of the degree of collapse noted in different segments of the pharynx and thus the reliability of this technique may be questioned.

3. Imaging

Xrays of the maxilla and mandible in the form of cephalometry[5] may provide useful data of various parameters and dimensions controlling the upper airway. This can be particularly useful when the patient is being considered for invasive surgery such as maxillo-mandibular advancement or indeed when considering patients for MAS, though for the latter it is presently used for research purposes only. The limitation of this evaluation technique is that it provides a two dimensional image and that so during wakefulness. It also exposes the patient to considerable amount of radiation.

In contrast, computed tomography (CT) scanning and magnetic resonance imaging (MRI) provide more sophisticated imaging and allows objective cross sectional area and volumetric analysis. [6, 7] They are both more expensive than the cephalometry and the CT scans would also involve radiation. The MRI is quite noisy but is excellent at delineating soft tissue margins as well as fat deposition in the parapharyngeal space. For research reasons cine CT and dynamic MRI studies have been conducted to evaluate the upper airway but it is not considered to be practical or cost effective for routine use.

4. Acoustic analysis

This form of evaluation is safe in that there is no radiation involved and it is relatively cheap. It can be performed easily during sleep and at patient's home and simultaneously with polysomnography. Multiple night recordings can be carried out and based on sound frequency spectrum, acoustic analysis can potentially discern simple snoring from OSA.[8] Attempts have been made to correlate snoring sound frequency with different levels of obstruction and comparisons of this technique have been made to others such as drug induced sedation endoscopy.[9]

The sensitivity and specificity of this technique has often been questioned and although it can provide useful screening process, its role in helping with selecting treatment modalities is somewhat limited.[10] The other problems in studies with acoustic analysis are that of variation of software and the choice of central or fundamental frequency in determining the site of obstruction.

5. Pressure transducers

Numerous devices have been described which can measure pressure changes in different segments of the upper airway during an obstructive episode. Different numbers of transducers can be used to measure pressures at different levels of upper aerodigestive tract ranging from the nasopharynx to the oesophagus. The transducers are attached to a catheter which is introduced though the nose in a similar fashion to a nasogastric tube. This device can be left *in-situ* during sleep thus allowing an overnight recording.

One of the more recent devices illustrated in figures 5 and 6 and known as Apnea-Graph AG200 (MRA, Medical UK) seems quite promising in that it is capable of combining polysomnography data with pressure recording thus providing the clinician with information regarding the severity of OSA as well as giving some idea regarding the anatomical obstructive segment in the individual patient. Essentially, it relies on measuring pressure and airflow simultaneously at different levels in the pharynx. It stores and analyses the cardio-respiratory data of a patient with simultaneous recording of two different sites in the upper airway using a micro-pressure and temperature transducer catheter. Tvinnereim[11] *et* al published an encouraging study illustrating the importance of using this pressure catheter evaluation before embarking on surgical treatment. Singh[12] *et* al also demonstrated some usefulness of this technique, though they had some reservations about the ability of this device to accurately detect hypopharyngeal obstruction. They compared the Apnea-Graph to polysomnography. In addition they assessed correlation in some of these patients pharyngeal obstruction data to that seen whilst performing drug induced sleep endoscopy (DISE) and concluded the latter to be superior as it allowed visualisation of the upper airway and was also more useful in indentifying lateral wall collapse. They also commented that in their group of patients, some found it difficult to tolerate the catheter for the whole night and stressed that as the catheter moves during respiration the transducers would also move thus the accuracy of the levels identified could be questioned. Another point to note is that this device has fixed transducers on a catheter and has a fixed reference transducer and does not take in to account that all patients are morphologically different and therefore the positioning will not be identical in all patients.

Fig. 5. The Apnea-Graph device with its components: a pulsoximeter and the fine bore nasal catheter with four transducers

Fig. 6. Silver 'reference' marker indicating the correct position of the Apnea-Graph catheter

6. Sleep nasendoscopy

Sleep nasendoscopy (SNE) which is also known as drug induced sedation endoscopy (DISE) was pioneered at our institute.[13] The beauty of this technique lies in the fact that it allows a three dimensional visualisation of the upper airway during sleep albeit drug induced. This assessment is carried out in an operating theatre setting with the help of an anaesthetist who provides sedation to the patient and closely monitors the patients cardiovascular and respiratory parameters. The sedative agents commonly used are midazolam or propofol, however in some units both the drugs are used.

Drug induced sleep is different from natural physiological sleep but one could argue that the drug used for sedation has the same effect on the different segments of the pharynx thus it would allow us to compare the proportionate obstruction caused at each anatomical level in a similar manner that may exist in natural sleep.

An audit of 2,485 procedures performed over a period of 10 years at our institute has demonstrated that SNE correlates well with apnoea-hypopnoea index and mean oxygen desaturation.[14] We have also demonstrated the usefulness of SNE in predicting treatment success in snorers using MAS.[15,16] Similarly, SNE has allowed site specific target selection in surgical patients and improved surgical outcomes in our group of patients undergoing laser assisted palatoplasty with or without tonsillectomy has been reported.[17-19]

Sleep nasendoscopy assessment of snoring is useful as it provides evaluation of the upper airway in the dynamic mode during sleep. However, numerous controversies and debates have arisen and attempts have been made to address some of these by various authors.

For instance, criticisms made by Marais[20], whilst comparing snorers and non-snorers, it was claimed that snoring was produced during SNE in a large number of the non-snorers and was not produced in many of the snorers. This was challenged by Berry *et* al[21], demonstrating in their study using target controlled infusion of propofol during SNE that all their snorers and non-snorers responded as expected.

Similarly, questions and concerns that arose about test-retest reliability and of inter-rater reliability of SNE have been elegantly addressed by studies conducted by Rodriguez-Bruno *et* al[22] and Kezirian *et* al[23] respectively.

Bispectral index monitoring (BIS) has provided an adjunct to the assessment of sleep nasendoscopy in determining the level of sedation required for snoring assessment.[24] BIS (figs. 7 & 8) monitor is a neurophysiological monitoring device which continually analyses a patient's electroencephalogram during sedation and general anaesthesia to assess the level of consciousness and depth of anaesthesia.

Fig. 7. Four sensor BIS electrode attached on patient's forehead

Fig. 8. BIS Monitor reading during Sleep Nasendoscopy

The issue of assessing the patient at the correct moment has not previously been addressed and this indeed is an important point as one has to bear in mind the pharmacology and the pharmacokinetics of the different drugs used during sedation. If the patient is assessed too

early, the muscle relaxation effect of the drug may be over emphasised and if the patient is assessed too late then important anatomical aspect of the obstructive episodes may be missed. Thus the depth of sedation during which the assessment is conducted should be as close to the levels of depth of natural sleep. Evaluation only occurs as a snap shot of a patients whole sleep cycle. However, combining it with BIS values of patients undergoing natural sleep allows a more accurate assessment of sleep disordered breathing.
Finally, a couple of studies have compared awake assessment with SNE in the same group of patients and advocate that SNE is superior; further highlighting the point that there is muscle tone variation in control of upper airway during wakefulness and that during obstructive episodes in sleep. It appeared that hypopharyngeal or laryngeal obstruction could be missed in up to a third of the patients if the assessment was carried out in the awake state only.[25, 26]

7. Summary

In order to attain a successful outcome in treating patients with obstructive upper airway in snorers and OSA it is crucial to evaluate the upper airway dynamics very carefully. Apart from its usefulness in research, imaging has a relatively minor role to play in evaluation except in maxillo-mandibular advancement surgery.
Site specific treatment in these patients is required and therefore techniques that offer localisation of these anatomical obstructive segments would prove useful. In the author's opinion the two techniques that appear to do so are sleep nasendoscopy and the Apnea-Graph. This view has also been supported by a recent evidence based review article on assessment of obstruction level and selection of patients for obstructive sleep apnoea surgery.[27]
Sleep nasendoscopy appears somewhat superior as it allows visualisation of the upper airway whereas the Apnea-Graph merely looks at the pressure values and relies on correct positioning of the transducers. Out-patient clinical examination of the nose and the oropharynx is of paramount importance as it will help identifying potential nCPAP patients who may fail this form of therapy if there is an obvious anatomical problem.

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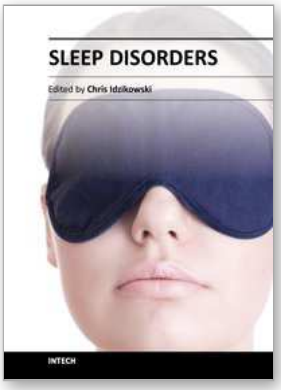

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For progress to be maintained in a clinical field like sleep medicine, unimpeded, unrestricted access to data and the advances in clinical practice should be available. The reason why this book is exciting is that it breaks down the barriers to dissemination of information, providing scientists, physicians, researchers and interested individuals with a valuable insight into the latest diverse developments within the study of sleep disorders. This book is a collection of chapters, which can be viewed as independent units dealing with different aspects and issues connected to sleep disorders, having in common that they reflect leading edge ideas, reflections and observations. The authors take into account the medical and social aspects of sleep-related disorders, concentrating on different focus groups, from adults to pregnant women, adolescents, children and professional workers.

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