REVIEW

Medical Therapy for Obstructive Sleep Apnoea

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ABSTRACT

Obstructive Sleep Apnoea (OSA) is increasingly recognised as a condition that not only causes excessive daytime sleepiness, but is also an important cardiovascular risk factor. Treatment of OSA should include conservative measures such as weight loss and positional therapy, the nuances of which are discussed in this article. However this in itself is not sufficient treatment for most patients. The first line of treatment for OSA that is recommended across the entire spectrum of disease is continuous positive airway pressure (CPAP) therapy. Indications for initiating CPAP are discussed, as well as possible alternatives to CPAP such as surgery or dental devices. In initiating CPAP treatment, machine-patient interface needs to be carefully considered, as there is a wide range of masks available. Factors to be considered in the choice of CPAP machine and mode are discussed. Finally, patient-specific factors such as patient acceptance of treatment, common problems encountered in CPAP follow-up and the importance of patient education are addressed.

Keywords: Conservative measures, Continuous positive airway pressure, Obstructive sleep apnoea

INTRODUCTION

Obstructive Sleep Apnoea (OSA) is a condition in which there is repeated obstruction of the upper airway during sleep. This is usually caused by a combination of a more flaccid upper motor airway tone during sleep, a congenitally narrower upper airway (especially in the region of the posterior pharynx), and increased soft tissue in the retropharyngeal space. OSA tends to worsen as one ages or puts on weight. Obstructive sleep apnoea syndrome (OSAS) occurs when obstructive sleep apnoea is associated with significant daytime sleepiness. This condition has become much more widely appreciated over the last five to 10 years, and we are seeing an increasing awareness among medical practitioners and the general public about this condition. This is a promising start, for it is only with a proper index of suspicion that we will be able to correctly identify patients who should undergo testing to diagnose sleep apnoea, and start them on appropriate treatment. However, locally, considerable barriers remain in terms of accessibility and affordability of care.

HOW IMPORTANT IS THIS PROBLEM IN SINGAPORE?

Unfortunately, there is a paucity of local data on the local epidemiology and treatment of OSA. One local study showed that Malays and Indians have markedly higher prevalence of snoring and sleep breathing-related disorders, which are only partly explained by known factors of sex, age and body habitus[1]. Another local study drawing on a population of patients seen at a tertiary centre found that 24% of a sample of young adults from 30 to 60 years were reported to be snorers by their bed-partners, and of these 72% were found on polysomnographic studies to have significant sleep apnoea[2]. We can also extrapolate some data from regional studies. Studies in Hong Kong show an estimated prevalence of two to four per cent for OSAS[3,4] if we were to extrapolate this to our local population we would be looking at an estimated 80,000 to 160,000 patients with OSAS, or possibly more, since local studies on ethnicity indicate a higher rate of OSAS among non-Chinese ethnic groups[5]. Extrapolation from these results suggests

that the overall incidence of OSAS in our population could reach as high as 15% [2]. In another local study of obese patients undergoing assessment for bariatric surgery, nearly half (49% of 176 patients) were found to have an apnoea-hypopnea index (AHI) of >15events/hour [6]. Elsewhere in the region, the reported incidence of OSAS ranges from 4.5% among Korean Men[7] to 7.5% among Indian men [8].
Amongst our youngsters, the future looks ominous. In 1996, 13.8% of boys and 12.2% of girls among the primary six cohort were classified as overweight; by 2008 the numbers were reported as 17.7% of boys and 12.86% of girls, respectively [9]. Since childhood obesity is a very strong predictor of adult obesity, we should anticipate an increase in adult obesity, which is likely to lead to an increase in the incidence of OSA as well. Indeed among obese Singapore schoolchildren with an ideal body weight >180% predicted, the incidence of OSAS was found to be 13.3%.[10] The current incidence of obesity (BMI >30) in our adult population was estimated in the 2004 National Health Survey to be around 6.8%, a figure virtually unchanged from the last survey in 1998 despite the on-going National Healthy Lifestyle programme since 1992 [11].

IMPLICATIONS OF OSAS

OSAS carries a significant morbidity, affecting the patient's daily life as well as increasing the risk of multiple cardio-respiratory disorders. Obstructive sleep apnoea is recognised as an independent risk factor for hypertension, stroke, depression and type II diabetes, coronary heart disease, arrhythmia, heart failure and stroke[12,13]. Patients with OSAS have also been shown to have an increased risk of serious road traffic accidents[14]; they have poorer quality of life[15], and the sleep and quality of life of their bed partners are also affected[16].

TREATMENT OF OSA

The principles of treatment of OSAS are not substantially different in Asia or in Singapore from those applicable in Western countries; however our healthcare model provides unique challenges in that most patients have to pay for diagnostic tests, continuous positive airway pressure (CPAP) machines and oral appliances out of pocket, so financial considerations are an important part of the decision algorithm in the management of our patients. Treatment options include conservative measures, continuous positive airway pressure (CPAP), oral appliances and surgery.

Conservative Measures

Conservative measures including weight loss measures for overweight patients should be emphasised to all patients; positional therapy may be useful in patients within a small proportion of patients who have predominantly positional OSA.

Weight Loss: Effectiveness in Treatment of OSA

In the sleep heart health study, a weight loss of 10% translated into a 26% decrease in AHI; conversely a weight gain of 10% led to an increase in AHI of 32%[17]. A study from Sweden was able to show impressive results with a nine-week inpatient programme where patients with severe OSA were placed on a liquid, very low energy diet which resulted in a successful weight loss of 20kg or more in patients in the intervention group; these patients had a mean drop in AHI of 25 events/hour and 67% of the intervention group had an AHI <15 at the end of the nine weeks[18]. Even more impressively, at follow-up one year later, patients were found to have maintained this improvement (the patients had sustained follow-up through the year to help them maintain their weight loss)[19].

However, as we all know, in everyday clinical practice, it is not easy to motivate people to lose weight. In a series of 216 overweight patients (mean BMI 32.8) on a weight-reduction programme involving a low-calorie diet, exercise programme and regular visits to an outpatient clinic for compliance reinforcement, weight reduction sufficient to cure the OSA was achieved in only 24 (11%) patients. The mean BMI in "cured" patients decreased to 27 and AHI decreased from a mean of 44 to just 3. Weight loss was maintained successfully in only 13 patients on reassessment after 94 months; six of 13 patients (46%) who maintained weight loss and 11 of 13 patients (85%) who regained the lost weight reported a recurrence of OSAS symptoms with a corresponding increase in their AHI back to >40. Overall, only a rather depressing 3% of patients had long-term relief of OSA with conservative weight-loss measures alone[20]. The fact that some patients had recurrent symptoms despite maintaining weight loss highlights that although weight is certainly an important risk factor for OSA, it is not the only reason why patients develop OSA. Closer to home, a study from Hong Kong showed that eight of 91 patients (8.7%) with OSA who were referred to a weight loss programme were able to lose sufficient weight to achieve an AHI <5; in

this study, patients were randomised between weight loss measures alone, versus CPAP or an oral appliance; it is worth noting that significant weight loss was achieved only among patients randomised to the CPAP arm[21].

Weight Loss – Pharmacological Aids to Weight Loss

There is relatively little direct data on how pharmacological weight loss strategies impact OSA. Sibutramine is a serotonin/norepinephrine uptake inhibitor which had been found to be an effective adjunct to weight loss programmes (mean weight loss – 3.72kg across 4 RCTs); a report of 87 obese male patients with symptomatic OSA and well controlled hypertension found that it was effective with a mean weight loss of 8.3kg (about 10% weight), a corresponding decrease in AHI by a mean of 16.3 and a mean drop in Epworth score of 4.5, with no change in systolic or diastolic blood pressure[22]. However, Sibutramine was withdrawn in Singapore and most major markets last year after a large-scale study found an increased risk of non-fatal myocardial infarction and non-fatal stroke in patients with high cardiovascular risk who used the drug on a long-term basis [23]. The only other remaining FDA-approved drug for weight loss is Orlistat; there is currently no direct data on the effect of Orlistat on OSA.

Weight Loss – Surgical Approach to Weight Loss

Bariatric surgery – either by open laparotomy or by laparoscopic gastric banding procedures – is an option available in Singapore for a subset of patients with morbid obesity. Locally, one centre offering laparoscopic banding reported a good success rate (median 53% reduction in excess weight among 256 patients with a median initial BMI of 41; obstructive sleep apnoea was not studied in this cohort but 84% had improvement or resolution of hypertension or diabetes)[24]. Grunstein et al reported that patients who went for bariatric surgery had a drop in BMI by 9.7 +/-5 kg/m2 from a baseline of 42.2+/- 4.4 at 2 years post-surgery versus controls with a similar BMI and no drop in weight over the same time; persistence of snoring among patients who had surgery was 21.6 % versus 71.3% in controls; persistence of apnoea was similarly 27.9 versus 71.3% in controls[25]. A meta-analysis of 12 studies representing 342 patients by Greenburg et al concluded that while bariatric surgery consistently seems to significantly decrease AHI, the residual AHI was still consistent with moderately severe OSA[26]. Another study also found that OSA can recur after several years in these patients, even in patients who did not regain weight[26]. The 30-day mortality for bariatric surgery has been reported to be as high as two per cent at one year[28], highlighting that careful consideration has to be made of the risk-benefit ratio for every patient.

Positional Therapy

The severity of OSA has been shown to vary with posture in a significant subset of patients with OSA. Conventionally, positional sleep apnoea is defined as a supine AHI that is at least twice that of the lateral AHI. In a review of 326 polysomnograms, positional sleep apnoea (using the above criteria with the additional caveat that the non-supine AHI must be <5) was seen in 49 of 99 patients (49.5%) with mild sleep apnoea (AHI 5 to 15/h), 14 of 72 patients (19.4%) with moderate sleep apnoea (AHI 15 to 30/h), and 5 of 77 patients (6.5%) with severe sleep apnoea (AHI > 30/h)[29]. The incidence seems to be inversely proportional to the severity of sleep apnoea and obesity, and is more common in younger patients[30,31]. From this, we can infer that positional therapy – that is getting the patient to sleep in a posture in which the sleep apnoea is ameliorated – may have a role to play in the treatment of patients with mild apnoea with a predominance in a particular posture, although patients with more severe sleep apnoea are much less likely to have a normal AHI in any sleep posture.

Various methods have been tried to achieve positional therapy. One well-described method of doing so involves the tennis-ball method, whereby the patient is asked to sew a pocket containing a tennis ball to the back of their pyjamas. This causes discomfort in the supine position, inducing the patient to turn to his side. In a six-month follow-up of 50 patients who were thus advised, 38% reported that they were still compliant to the tennis ball at six months and a further 24% said they were no longer using the tennis ball method but were able to avoid the supine sleeping posture by other means. These patients had a significant improvement in sleep quality, decrease in snoring and daytime sleepiness compared to patients who were not able to avoid the supine posture; patients who were not using the tennis ball method were generally younger and were unable to comply because of discomfort[32]. Another small, randomised single-blind trial of 13 patients with mild-moderate sleep apnoea (mean

AHI 17) found that CPAP was superior to positional therapy using the tennis-ball method in decreasing AHI and improving minimum oxygen saturation, but there was no difference in Epworth, maintenance of wakefulness sleep latency or mood and quality-of-life measurements[33]. Studies involving other positional devices such as special pillows are few and involve very small patient numbers. They tend to report modest efficacy in lowering AHI and in a significant proportion of patients who do not tolerate the devices[34,35].

Pharmacological Treatment Of OSA

In some patients who are adequately treated with CPAP, residual excessive daytime sleepiness persists. In such cases, Modafinil, a wake-promoting analeptic agent, has been shown to be effective in decreasing excessive daytime sleepiness. In a randomised, double blind trial, Modafinil was shown to significantly improve sleep latency on maintenance of wakefulness test (15 min vs. 5.3 min for controls) and decrease Epworth score (-4.5 vs. placebo group) without affecting nighttime sleep or CPAP usage.[36] More recently, similar results have also been reported for the newer drug Amordafinil[37].However, caution should be exercised in the usage of such agents and it is imperative to ensure that the residual sleepiness is not due to non-compliance with CPAP or inadequate CPAP pressures (e.g. if patients put on weight, a previously therapeutic CPAP level may become inadequate to abolish apnoea/hypopnoeas, leading to increased daytime sleepiness). Modafinil is also a relatively expensive drug.

Currently there is no drug therapy that has been shown satisfactorily to abolish both the AHI and the daytime sleepiness in OSA. Drugs that have been tried and found wanting for the treatment of OSA include the following[38]:

- REM sleep suppressants – based on the observation that OSA tends to worsen considerably during REM sleep, with events occurring exclusively in REM sleep in some patients. Drugs in this category that have been tried include selective serotonin reuptake inhibitors, e.g. Fluoxetine, Protryptyline and Clonidine.

- Serotonergic Agents – activation of certain serotonergic receptors can lead to excitation of upper airway dilator motor neurons, however, the pathways are complex. Agents which may act in this instance include Mirtazepine, Fluoxetine and Paroxetine.

- Ventilatory stimulants, e.g. Methyxanthine derivatives, opioid antagonists,Doxepram and nicotine.

The only instances in which pharmacological therapy has been shown to be effective in the treatment of OSA is in OSA related to hypothyroidism and to acromegaly. In a study of newly diagnosed hypothyroid patients, 15 of 50 patients (30%) were found to have AHI >5. Twelve of these were studied again after achieving biochemical euthyroidism with Thyroxine replacement; 10 of 12 patients were found to have normalised their AHI[39]. Subclinical hypothyroidism is present in up to 11% of patients with OSA, but it does not seem to significantly impact the severity of OSA[40]; Levothyroxine replacement in these patients has not been found to reverse sleep-disordered breathing[41]. In acromegalic patients, up to 50% were found to have sleep-disordered breathing with an AHI >20; after six month's therapy with Ocreotide, there was a mean decrease in AHI of 28% +/- 10% together with a decrease in tongue volume on MRI[42].

Other Alternative or Conservative Measures

Supplemental nocturnal oxygen has been reported to improve the symptoms of OSA and reduce night-time hypoxemia. However, in randomised trials of CPAP versus nocturnal oxygen, it was shown that while CPAP treats sleep disruptions, arousals and abolishes apnoeas and hypopneas, supplemental oxygen was able only to improve desaturations during sleep with no effect on other sleep parameters or blood pressure [43,44]. The American Academy of Sleep Medicine does not recommend oxygen supplementation as the primary treatment of OSA [45].

One other class of treatment that needs to be considered is the treatment of chronic rhinitis. Per se, treatment of rhinitis with Oxymetazoline or with intranasal corticosteroids has not been found to be an effective treatment for OSAS (although there are only two very small studies addressing this issue directly)[46,47]. However, nasal resistance is one of the factors that influences patient acceptance of CPAP therapy, and treatment with topical nasal sprays has been shown to be one of a number of

concurrent measures that improved compliance among patients [48].

TREATMENT OF OSA: CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP)

Since this was first described by Colin Sullivan in 1983[49], CPAP has been the mainstay of non-surgical treatment for OSAS. The principle behind treatment lies in the creation of a pneumatic splint by applying an intraluminal pressure strong enough to prevent expiratory collapse and hence airway obstruction when the patient is asleep. There has been a staggering amount of literature produced regarding various aspects of the use of positive pressure treatment for obstructive sleep apnoea, and it is not possible to provide an in-depth coverage of it all in this short article. We will focus here on practical aspects of CPAP treatment for the managing physician, as well as new developments that impact clinical practice.

When is CPAP Indicated?

CPAP is generally considered the treatment of choice for patients who have moderate-severe OSA (AHI >15/h)[50]. CPAP is undoubtedly effective in decreasing the AHI; multiple studies have consistently shown that the AHI can be readily lowered to below 10/h in a patient who has been properly titrated[50-52]. CPAP has been shown to be effective in treating excessive daytime sleepiness both subjectively and objectively. Other benefits of CPAP therapy include improved quality of life [53], reduced nocturnal and daytime blood pressure [54], reduced cardiovascular events and improvement in inflammatory mediators[55]. CPAP has even been shown to improve quality of life measures in patients' bed partners[16]. Thus, CPAP is indicated for patients who have a raised AHI and who have daytime sleepiness; it should also be offered to patients who have complications associated with OSA, namely hypertension, ischaemic heart disease and other components of the metabolic syndrome[50].

Treatment of patients with a mildly raised AHI between five to 15 is controversial; at least two randomised controlled trials have shown that although patients do have improvements in self-reported sleepiness and snoring, there is minimal blood pressure decrease with CPAP and no change in multiple sleep latency tests or Epworth sleepiness scores. Improvements in quality of life and psychometric and mood tests were no better in CPAP patients than in the placebo groups in these trials[56,57]. Patients with a lower AHI also show worse compliance compared with other patients with more severe and symptomatic OSA[58]. Treatment for patients with AHI between five to 15 is therefore mainly indicated for those who are symptomatic from OSA (excessive daytime sleepiness, insomnia, impaired cognition or mood disorders) or have significant co-morbid conditions such as hypertension, ischaemic heart disease or a previous cerebrovascular event[50].

Management of Patient on Continuous Positive Airway Pressure (CPAP)

There are three factors to consider in the initiation and follow-up of a patient on CPAP: the machine-patient interface (mask), choice of CPAP machine and mode, and patient factors affecting compliance.

Machine-Patient Interface

For many patients, the major hurdle to CPAP acceptance and compliance is the patient-machine interface. The repertoire of interfaces has expanded from a simple nasal mask to full face masks, nasal pillows and intraoral devices, and even cloth masks (Fig.1). Most masks have a rim to fit to the patient's face comfortably and maintain a good seal to prevent air leak. This may be a soft compliant silicon that bulges out on inspiration, or a gelatinous material. There should be a small orifice to allow exhaled carbon dioxide to be washed out. A Cochrane review of the available data comparing various interfaces found that there was insufficient data to recommend any one particular interface over the others[59]; choice between interfaces is driven by patient choice, availability and cost. In certain instances, one particular interface may be preferred, for example, an oronasal mask may be better for a mouth breather than a nasal mask alone, or a nasal mask could be recommended together with a chin strap to prevent leaks; claustrophobic patients or patients who have skin allergy to a close-fitting nasal or facial mask may prefer nasal prongs or pillow interfaces that fit over the patients' head instead. Certain strapless oral interfaces or nasal pillows may be suitable for patients who have nasal congestion or persistent air leaks with nasal masks[60,61]. Interfaces such as nasal pillows/prongs tend to dilate the external nares and reduce nasal resistance, and may be useful in patients with nasal congestion[55].

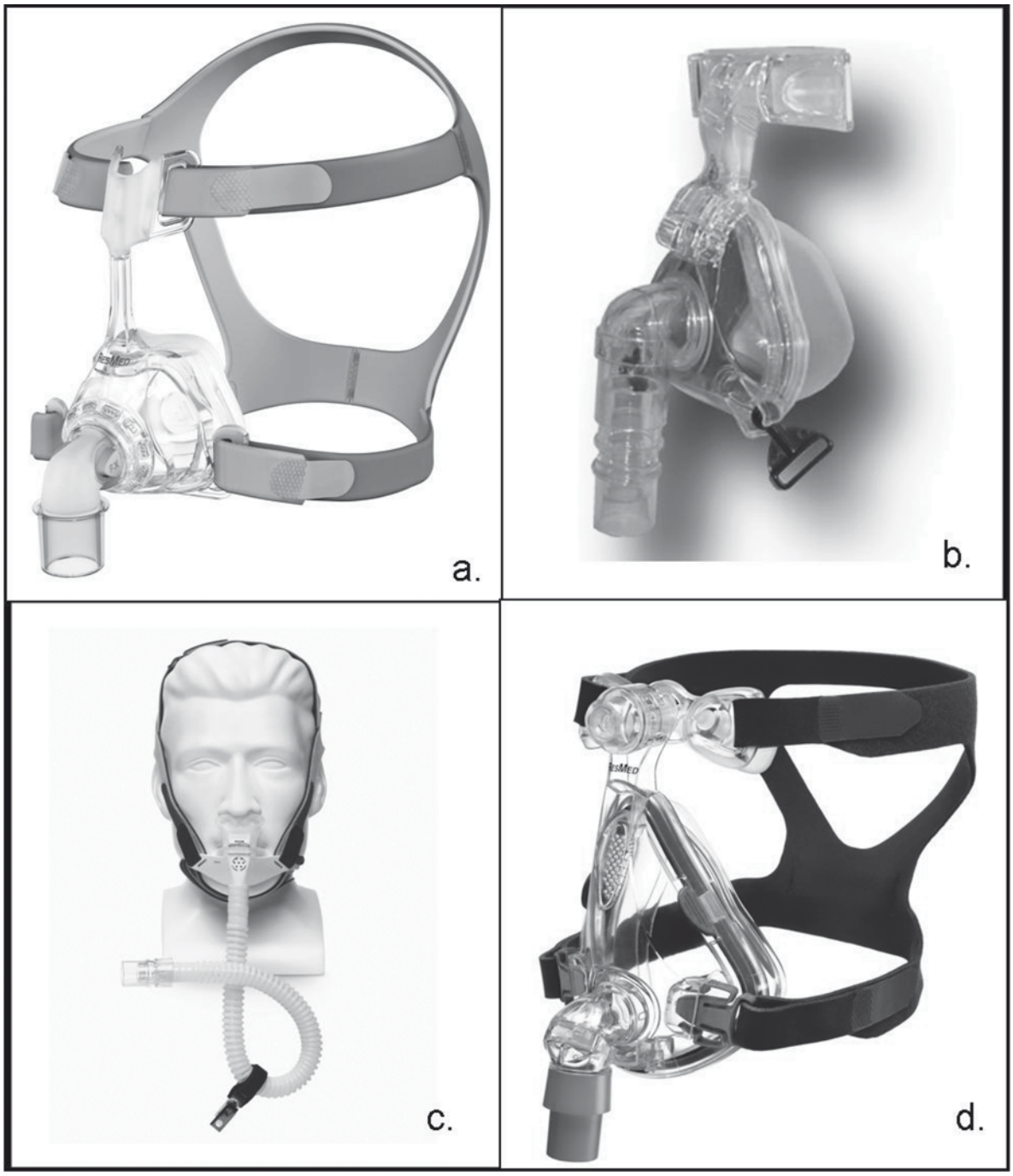

Fig 1 Various mask types: a. Nasal mask with silicon cushion, b. Nasal mask with gel cushion, c. Nasal pillows with chin stap, d. Full face mask.
a.d courtesy of Resmed; b,c courtesy of Philips Respironics

Careful fitting of the mask is a very important part of acclimatising the patient to the CPAP machine. A poorly fitted mask will allow air leaks which may render CPAP treatment ineffective; the gush of air can cause conjunctivitis, patient discomfort and noise which may keep the patient awake. Conversely, a mask that is too tight is uncomfortable, and may lead to skin breakdown and claustrophobia. An appropriately fitted mask should allow two fingers to be easily slipped under the straps on either side.

Choice of CPAP Machine and Mode

The next important part of the equation that must receive careful attention is that of the positive pressure machine itself. The terminology that is used to describe the way in which pressure is delivered by machines from different companies is littered with an array of acronyms which can be bewildering for the uninitiated; similar devices can have different acronyms depending on the manufacturer.

Most familiar, and commonly used, is fixed Continuous Positive Airway Pressure or CPAP, where the machine delivers a pre-set pressure that is constant and unchanged between inspiration and expiration. The pressure that is needed for treatment of the OSA is ideally determined by an attended positive airway pressure titration during an overnight study[62]. Various tweaks to this have been developed by different companies. One of these is expiratory pressure relief, which attempts to improve patient comfort by allowing a small drop in pressure during early expiration; this is known variously as C-flex (Respironics; Murrysville, PA) or expiratory pressure release (EPR) (ResMed Corporation, Poway, CA).

Auto-titrating PAP (APAP) devices vary the pressures delivered according to the degree of obstruction sensed by the machines. There is a two-fold intended benefit provided by these devices: firstly, they can titrate the amount of pressure delivered according to the severity of the sleep apnoea, which varies in a patient depending on sleeping posture and sleep stages. Secondly, an auto-titrating device can select the necessary level of PAP pressure without the need for an attended titration study. There have been an increasing number of studies which support the use of APAP devices [63]. However, a recent randomised, cross-over study from Hong Kong found no difference between an auto-titrating positive pressure device and fixed-pressure CPAP in terms of improvement in symptoms and quality-of-life scores in patients with severe OSA [64]. The problem with APAP is that there are quite a few different devices in the market which all run on their own proprietary algorithm, either using airflow limitation, vibrations (snoring), airway impedance, or airflow magnitude to measure obstruction and hence the level of positive airway pressure needed. In bench top testing, the responses of different auto-titrating positive pressure devices to apnoeas, hypopneas, flow limitation and snoring have been shown to be considerably different[65]. Patient acceptance between devices may also vary[66]. As such, data from one study using one type of device may not necessarily be generalisable to other APAP devices. The American Academy of Sleep Medicine has issued a position statement on the use of APAP devices; generally, they may be used to treat patients or as a means to determine an appropriate fixed pressure only if the patient does not have significant cardiopulmonary co-morbidities (such as congestive heart failure, chronic obstructive pulmonary disease, obesity-hypoventilation, or central sleep apnoea). Patients on APAP should also be monitored carefully to determine treatment efficacy with a view to re-evaluation and/or a titration study should symptoms persist [63].

Other more advanced modalities for positive pressure treatment of OSA include bi-level positive airway pressure, or BiPAP, and adaptive servoventilation (ASV). BiPAP refers to positive pressure ventilation where the machine delivers an increased pressure over and above the baseline during inspiration. This differential in pressure between inspiration and expiration helps the patients to improve ventilation. BiPAP is indicated in patients who are hypoventilators (Obesity-hypoventilation syndrome), and may also be useful in patients who are unable to maintain airway patency even with very high levels of CPAP, or who have difficulty exhaling against high levels of positive pressure[50]. In ASV, a baseline level of respiratory airway pressure is chosen to keep the airway open, and subsequently the machine adapts the IPAP-EPAP difference to maintain a relatively stable tidal volume, that is, IPAP increases if the machine senses a decreasing breath-to-breath tidal volume, and decreases once it senses the tidal volume increasing. This algorithm was originally designed to treat Cheynne-Stokes form of central apnoeas[67], and has also been marketed

more recently as being ideal for complex sleep apnoea (patients with central sleep apnoea that appears or persists after treatment for obstructive sleep apnoea)[68].

Patient Acceptance and Adherence

The last, but certainly not least, part of the equation to consider is that of the patient, and his acceptance and adherence to CPAP. Internationally, five to 50% of OSAS patients recommended for CPAP either reject this treatment option or discontinue within the first week, and 12% to 25% of remaining patients can be expected to have discontinued CPAP by 3 years[69]. A study of 112 patients from a university centre in Hong Kong found that 75% and 72% of patients were using CPAP objectively for > or = 4 h/d and at least 70% of the nights per week at one month and three months, respectively [70].

The only independent predictor of compliance to CPAP in this population was a high AHI, however in other studies, compliance correlated with severity of symptoms and OSA[58], age (younger patients, women and African-Americans appear to be at risk of non-compliance) and presence of a bed partner [71]. One study showed that patients who had difficulty with CPAP during the initial titration had markedly worse compliance hereafter (2.5h mean usage per night vs. 5h)[71], suggesting that a screening question on the morning after the titration study would be useful for identifying patients at risk of default.

To keep these low uptake and long-term compliance rates in perspective though, one must remember that treatment for any chronic disease will have the same compliance issues; it has been estimated that between 20% to 50% patients are non-compliant to chronic medical therapy [72].

Usual methods taken to try and increase compliance include mask optimisation, heated humidification, topical nasal therapy, and sleep apnoea education; taken together, these were shown in one study to enable 24% of one cohort of previously non-compliant patients to achieve a minimum usage of 4h/night[48]. Some studies show that heated humidification on its own may improve compliance, especially in patients with nasal congestion or dryness [73,74], although in other studies the results are more equivocal[75].

A systematic approach to CPAP treatment including education, objective adherence monitoring, early intervention for side-effects and telephone and clinic support is essential to optimise CPAP adherence[55]. In an Australian study, two one-hour group cognitive behaviour sessions were shown in a randomised trial to significantly improve CPAP uptake (only four patients in the intervention group did not take up CPAP after the titration study, vs. 15 patients in the usual care group), and compliance (intervention group had 2.9h more usage per night at 28 days)[76]. Similarly, an orientation session by the sleep technologist to introduce patients to the CPAP and masks halved the number of patients rejecting CPAP (from 88/699 to 44/782, $P < 0.001$)[77] in a Brazilian study. However, a similar study from a Chinese University involving educational brochures, CPAP education by nurses, and more intensive follow-up, did not manage to show an improvement in compliance [78].

Other options that have shown effectiveness in various studies include switching to adjustable bi-level ventilation[48], auto-PAP[79] or addition of C-flex[80]. One additional point to note is that patient compliance should be assessed objectively as many patients overestimate their CPAP usage. In one study, reported mean CPAP usage time was 6.1h versus an actual measurement of 4.9h. Over-reporting was worse among non-compliant patients [81].

Table 1 shows some of the common problems encountered in initiating and maintaining patients on CPAP, as well as some suggested methods for dealing with these problems.

ALTERNATIVES TO CPAP

No discussion of CPAP would be complete without a brief consideration of the alternatives which are available to patients. The other options available include surgery, dental appliances and conservative measures, which have been discussed in detail above. From the earlier discussion, it will be apparent that conservative measures such as weight loss and positional therapy are not necessarily efficacious in relieving the apnoeas/hypopnoea nor easily implemented, and the limitations of relying on these alone to treat OSAS will be self-evident.

Surgery for OSA

Surgery is an option that may appeal to some patients, as it offers a relatively long-term solution to the problem. However, the overall success rate

Table 1. Common Problems Encountered during CPAP Treatment and Some Suggested Solutions.

Problems Encountered during CPAP	Possible Solutions
Dry throat	Treat rhinitis with nasal steroids and antihistamines; Add humidifier
Facial pressure sores	Loosen straps (allow 2 fingers to slip under strap when fitted); May need to re-fit or change mask
Facial eczema	Loosen straps (allow 2 fingers to slip under strap when fitted); May need to re-fit or change mask
Abdominal bloating	Consider reducing CPAP pressure; Prokinetic agents (eg domperidone)
Backache	Analgesia; Consider reducing CPAP pressures
Patient woken up by alarms	Check for excessive leaks; Switch from Auto mode to a fixed pressure
Patient unable to fall asleep with CPAP	Set longer ramp time; Acclimatise with afternoon naps wearing CPAP
Patient complains of air hunger (not enough air) when initiating CPAP	Shorten/switch off ramp
Patient unable to tolerate pressures	Initiate treatment with a lower pressure first; Daytime acclimatisation; Switch from fixed to auto mode of CPAP Change to BiPAP, try adding expiratory pressure relief

for surgical procedures was calculated in a recent meta-analysis to be only 66% with an overall complication rate of 14.6%;[82] careful matching of patients to the appropriate procedure is crucial but unfortunately, current literature does not fully elucidate the patient populations which may benefit most from surgery. It is worth noting as well that the definition of "success" in many of these studies is a reduction of AHI by 50% or more, or a reduction of AHI to less than 20 – that is, many of these patients would have a residual AHI which may not be sufficient to completely abolish symptoms.

Dental Devices for OSA

Dental appliances are another alternative to CPAP in selected patients. The American Academy of

Sleep Medicine recommends oral appliances for patients with moderate-to-severe OSAS who refuse CPAP therapy, and as first-line (along with CPAP) therapy in patients with mild-to-moderate OSAS[83]. Compared to CPAP, oral appliances are less efficacious in reducing AHI, but have better patient acceptance. Overall, treatment failure occurs in up to 35% to 40 % of patients, that is, up to 50% of patients can expect to have successful abolishment of apnoeas/hypopneas (to AHI <5), or at a partial response reducing their AHI to less than half in 25%[84]. Among Asian patients, a randomised controlled trial from Hong Kong comparing CPAP to oral appliances to conservative measures found that CPAP was found to have the best improvement in terms of physiological, symptomatic and quality of life measures. Both CPAP and oral appliances were effective in decreasing diastolic blood pressure. However, the superiority of CPAP compared to oral appliances in improving health-related quality of life scores was negated when an additional domain including the impact of treatment side-effects was added, indicating that the beneficial effect of CPAP on quality of life measures was reduced by problems with treatment side-effects [21].

CONCLUSION

Despite its undoubted efficacy in the treatment of OSA, CPAP remains an imperfect modality of treatment. Patient acceptability and compliance are a challenge; while effective, CPAP works only when the patient is using the machine. Cost of treatment is another issue, especially locally where CPAP machines are not usually covered by insurance payments and are not medisave-deductible. However, with improvements in positive pressure interfaces and technology enabling better synchrony between patient and machine, we should see increased patient comfort and acceptance. Crucially, the cost of CPAP treatment has also come down over the years and it should continue to become more affordable, hopefully allowing more of our patients to be adequately treated.

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