

SLEEPINESS AND SLEEP APNEA IN AVIATION – MEDICAL APPROACH

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Abstract: *Everyone knows the cognitive and performance related effects of fatigue: lack of concentration, forgetfulness, inability to determine priorities or make decisions. Flight crew members are well aware that efficiency of performance under these conditions - sleepiness and sleep apnea - is significantly decreased and presents high threat to flight safety. The determination of “fitness to fly” for aviators with sleep disorders can be very difficult because we could not obtain coherent information about fatigue from current aeromedical guidelines. Majority of air organisations do not provide any helpful somnological assistance. Evaluation of medical requirements for pilots needs partnership. This paper presents the first step of the author's efforts to promote the implementation of a fatigue risk management system (FRMS) in Romania – a treatment algorithm in sleep apnea .*

Key Words: *Fatigue, Sleepiness, Sleep apnea*

1. INTRODUCTION

If the diagnosis of a sleep related breathing disorder in aviators has been done step by step, in case of necessity a treatment has to follow.

This has to be done by a stepwise proceeding as well, dependent on the graduation of the disorder and the collateral diseases.

Step one contains the general recommendations, step two pharmacologic approaches and step three mechanical methods.

2. GENERAL RECOMMENDATIONS

Anytime helpful and in less severe cases salutary is the sanitation of obstructed upper airways by otorhinolaryngologic treatment, e.g. surgical therapy of a ronchopathy or a relevant septum deviation, of adenoids or enlarged tonsils, sometimes a cautious resection of pharyngeal tissue.

Also the stabilization of a lax epiglottis can be reasonable. An otorhinolaryngologic examination in every patient with nighttime breathing problems is mandatory. Naturally concomitant pulmonary and cardiovascular diseases have to be treated consequently.

In moderate cases this can lead to disappearance of the sleep related breathing disorder yet.

For example a sufficient pharmacological therapy of heart failure can heal Cheyne-Stokes ventilation, and as a mild obstructive sleep apnea can be generated by the hydropic congestion of neck tissue in heart failure, it may disappear if the latter is treated successfully.

An important general recommendation is the loss of weight. There is a strong correlation between body weight and severity of sleep apnea.

However, an adequate weight reduction sometimes is able to heal the patient from his breathing disorder, but in each case it is helpful to optimize the other therapies, which normally only operate symptomatically.

Every kilogram counts, as fat depots in the neck region being relevant for the obstruction of extrathoracic airways are reduced in the early phase of fasting. Men should be requested to reduce their neck circumference under 43 cm, marking the border of pathologic snoring. We all know the difficulties of the most people in reducing their weight, but we should not stop to mention it.

Procedures of sleep hygiene are meaningful in every sleeping disorder. This contains some simple but important actions like abandonment of late and opulent meals or late elevated consumption of alcoholics.

Hypnotics of the benzodiazepine group should be avoided with respect to their relaxation effect to the muscles.

Self-evident the sleeping room should be well aired and not too much heated.

On the other hand a too cold bedroom is adverse, too, ideal are 18-22° Celsius. Sport of course is a good and healthful activity, but in the last two hours before going to bed it can destroy the sleep quality.

And the quality of the mattress also plays an important role for the quality of sleeping. All mattresses have a life expectancy of 8-10 years, after that they have to be changed.

The only exception is the water mattress, showing the necessity of change by a puddle. A big problem for aviators patients with sleep related breathing disorders is shift working.

If even healthy shift workers having reached the fourth decade of life have difficulties with the timely resynchronization of day-and-night rhythm, then those with sleep disorders of any kind and any age are absolutely unable for this and risk a severe impairment of their vigilance and health. Hence patients with sleep disorders should resign from shift work as fast as possible.

This applies for sleep related breathing disorders as well. As banal the rules of sleep hygiene may be, as important it is to discuss them with the patients.

These rules not only are valid for sleep related breathing disorders, but generally for all sleep disorders, and should be respected by all humans on behalf of a good, healthy sleep.

3. MEDICATION

There have been many attempts to treat sleep related breathing disorders by a pharmacological approach, but most have failed. Successful is only the treatment of mild postmenopausal obstructive forms in women with estrogen-gestagen combinations, which enhance the muscle tone and thus help to keep open the airways.

But this therapy only works in less severe cases and includes the necessity of a careful observation of the patient due to an incidence increase of hormone dependent gynecologic tumors.

This is the reason for refusal of this approach by many experts. In the textbooks of sleep medicine the application of retarded theophylline is often recommended in patients with snoring or mild sleep apnea.

The mechanism of working in nighttime airway obstructions is not known at last, postulated is an effect of toning up of muscles.

Using theophylline the AHI can be reduced by app. 25 %, which reduces its inset on mild forms of sleep related breathing disorders.

It is known that the effect disappears after 1-2 years of usage. The major effect of theophylline is probably reduced to its central stimulating effect. Therefore the reduction of snoring is bought by a reduction of sleep quality, and the passing effect is a consequence of adaption, like one can adapt to coffee consumption in the evening.

Today it no longer has any relevance in the modern treatment of sleep related breathing disorders. In about 10 % of the patients the daytime sleepiness persists despite an optimal treatment of the breathing disorder.

The causes are not yet well analysed today, it depends most likely on a central nervous damage, which is the consequence of longtime nighttime oxygen desaturations, and which does not allow the patient to reach his premorbid vigilance level despite an optimal therapy.

In these cases the option of treatment with vigilance augmenting substances is given.

Having had only the amphetamines quite recently, which include the risk of addiction and relevant side effects, now we can use modafinile, a substance stimulating selectively the central vigilance centers without any intolerable side effects.

With a dosage of 100-400 mg daily it is licensed for the therapy of persisting sleepiness despite optimal treatment in sleep apnea patients, beside this in the treatment of narcolepsy and shift workers syndrome.

4. MECHANICAL THERAPY

The device based treatment can be divided on the one hand in oral appliances with the target of dilatation of the upper airways, which naturally only can be used in obstructive forms of breathing disorders, and on the other hand in the mechanical breathing support treatment, which represents the therapeutic gold standard.

4.1. Oral appliances

Already 1934 Pierre Robin tried to treat the disease named to him with an intraoral monobloc appliance.

The real history of oral devices started in 1982 with the tongue retainer built by Cartwright. The operating principle of every oral appliance is the opening of air space in the oropharynx, the ways used to reach this target are different.

There have been many experiments with tongue retainers, pelottes and tongue protrusors.

All these did not prove themselves. The breakthrough was done in 1984 by the neurologist Meyer-Ewert, who with the assistance of a dentist constructed a device, which according to the example of the Esmarch-

Heidelberg maneuver well known from the emergency medicine (to open the airways of an unconscious person) protracts the lower jaw and by this opens the pharyngeal airways.

This idea was modified and improved in the following years and decades.

The recent used appliances firstly were constructed in 1996 by the German orthodontist Hinz, who himself was suffering from a sleep apnea. In the meantime the devices were improved continuously.

Today there are two devices which have showed their efficiency in studies: The IST device by Hinz - (fig 1) and the Thornton Adjustable Positioner (TAP) – fig 2.

The principle of operating is the protrusion of the lower jaw for app. 60-70 % of the possible protrusion, and a dental opening of app. 5 mm, leading to an opening of the posterior airway space.



Fig. 1: IST[®]-plus by Hinz. The splints are connected by attachments allowing to open and move the mouth.



Fig. 2: Thornton Adjustable Positioner (TAP[®]). The mandibular protrusion is achieved by hooking the upper jaw's splint in the lower jaw's splint.

Oral devices are able to stop snoring, but they reduce the AHI only by app. 50 %, so that they are not therapy of choice for severe cases.

But in pure snorers they work well, and for sleep apnea patients with an AHI up to 25/hour they can be a good and more comfortable alternative to nCPAP application. The range of response is only app. 70 %, because the obstruction of upper airways can be on different levels which cannot be antagonized by mandibular protraction, and there are no good predictors of response.

Today it can be tested with inexpensive thermolabile boil-and-bite devices, which predict quite well the effect of oral devices. But, the thermolabile appliances may not be used for any length of time being able to bring the teeth to move. As mentioned above, the application of oral appliances should be constrained to pure snorers and less severe cases of obstructive sleep apnea. Only in rare cases of severe sleep apnea a treatment attempt is justified, if a patient at least cannot accept nCPAP therapy, or in addition to nCPAP, if this alone is not able to break the airways obstruction. Before application a thorough dental examination is necessary. To estimate the anatomy of the facial cranium and tissue, a lateral cephalometry has to be done, the appraisal of the jaw links minimum needs an orthopantomogram.

Precondition for treatment with an oral appliance is a nearly intact denture, not less than four pillars (or implants) in each jaw are needed.

General contraindications are body weight more than 150 % of normal, epilepsy and too small stoma (e.g. in scleroderma). Severe diseases of the jaw links, denture in need of rehabilitation, profound periodontitis or toothless jaws are additional contraindications.

Side effects are rare and mostly transient, like increased salivation and morning lockjaw.

Real severe side effects like change of teeth location or gingival problems are described but very seldom.

Naturally the effect of oral devices has to be controlled by polygraphy or polysomnography, also in the long run, except in social indication of habitual snorers, where the appliances are well effective and a good chance to recover the bedroom's peace.

4.2. Mechanical breathing support devices

In 1981 the Australian Colin E. Sullivan firstly presented nCPAP therapy for treatment of obstructive sleep apnea. nCPAP is denoting "nasal Continuous Positive Airways Pressure" and thus means overpressure air insufflation to the upper airways using a nasal mask.

Until today this still is the gold standard treatment of obstructive sleep related breathing disorders. Having been as big as a refrigerator and producing noise like a strong vacuum cleaner in the early eighties, today the machines have the size of a lady's handbag and are hardly to hear.



Fig. 3: Patient with nCPAP device.

The principle of nCPAP therapy is not ventilation, but pneumatic splinting of the extrathoracic airways, thus effectively being the same mode of action as tracheal intubation.

In obstructive forms of sleep related breathing disorders it works well due to undisturbed breathing action.

In central breathing injuries nCPAP is less helpful, here a real ventilation therapy is indicated, so called NIPPV (Non Invasive Positive Pressure Ventilation). This technique, similar to the ventilation methods being used in intensive care units, today can be applied at home via nasal masks.

Effectiveness of nCPAP is well documented scientifically. It not only suppresses nighttime breathing disturbances, but restores quality of sleep, so that the patient's daytime condition recovers. The usually applied mask pressures range between 4 and 14 mbar, in case of a higher need of pressure or in patients with severe pulmonary or cardiac diseases a BiLevel device should be used. This machine is able to detect in- and expiration of the patient using a pneumotachygraph, and lowers the mask pressure in the expiration phase. On the one hand this enhances the comfort of the appliance, because the patient has not to expire against a high mask pressure, on the other hand it unburdens the heart and bronchial system.

Contraindications against nCPAP and nBiLevel are tumors of the nasopharyngeal space, a not surgical reconstructed lax epiglottis and deficient cooperation of the patient, as the devices are too expensive for collecting dust unused.

Side effects do happen, mostly nasopharyngeal mucosa problems by the insufflation of cold and dry air, which can be treated with a heated humidifier.

Other complications are very rare. The required mask pressure has to be evaluated and fixed in the sleep laboratory using polysomnography.

Its level depends of a lot of factors like body weight, sleep phases and body position.

In patients with varying need of mask pressure during the night today it is possible to use an automatically, self-titrating nCPAP appliance.

5. CONCLUSIONS

In summary, oral devices are, in the case of accurate, censorious application, a fine and in addition inexpensive treatment option for less severe cases of obstructive sleep related breathing disorders, in which nCPAP devices are not yet clearly indicated.

Usage and quality of adjustment have to be controlled periodically, generally yearly with ambulatory cardiorespiratory polygraphy, in case of abnormalities via cardiorespiratory polysomnography in the sleep laboratory.

Evaluation of medical requirements for pilots needs partnership.

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