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The Importance of Appropriate PAP Silicone Mask Selection in Sleep Apnea Management

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Abstract: *Positive airway pressure (PAP) is the standard treatment for patients with moderate to severe obstructive sleep apnea, especially when a correctable anatomic obstacle is not identified. The PAP efficiency strongly depends on the appropriate use during sleep. Despite the recent advancements in PAP interface designs, overall adherence to therapy remains low. The main sources of discomfort consist of air leakage and mask overtightening leading to skin problems. However, these disadvantages have been partially reduced by new interfaces like nasal pillows that have the capacity to reduce the contact of the silicone cushion with the skin, reducing the chances of skin irritation. At the same time, assuring a better seal prevents air leakage and is particularly useful in patients with internal valve insufficiency. We present a case of a 57-year-old patient with severe sleep apnea syndrome whose efficient treatment was delayed by an inadequate PAP mask prescription at diagnosis. Due to low treatment compliance secondary to the perceived adverse effects of the oronasal mask, the patient decided to discontinue treatment for two years with subsequent aggravation of sleep apnea symptoms. The patient's sensitivity to the silicone mask cushion and treatment ineffectiveness due to internal valve collapse were the main causes of treatment failure. After changing of PAP interface, the patient achieved long-term compliance. Our case report reflects the importance of choosing the most suitable PAP interface in accordance with the patient's particularities. In the absence of this approach, appropriate treatment might be delayed with detrimental consequences, especially in severe cases. Considering PAP adherence following therapy initiation usually predicts long-term compliance, finding the best mask design from the beginning can predict therapeutic success.*

Keywords: *OSA, PAP interface, nasal mask, oronasal mask, nasal pillow*

Introduction

Patients with obstructive sleep apnea are treated with positive airway pressure (PAP), considered the gold standard, especially in moderate and severe cases. The three main types of PAP devices consist of continuous PAP (CPAP), auto-adjusting (APAP), and bilevel PAP (BiPAP). The PAP machine is connected by tubing made of plastic to a mask adapted to patients' needs. The anatomy of a typical mask consists of a mask frame (that holds the PAP mask together), headgear, and mask cushion. The last one comes in contact with the face, having an important role in mask sealing and comfort, and usually is made of silicone.

The pressure can be delivered through two main types of masks: nasal masks (covering only the nose) and full-face masks (placed over the nose and the mouth). The first type is subdivided into nasal and nasal pillows [1]. The oronasal mask secures the nose and mouth, extending from the lower lip to the nasal bridge, resulting in pressure applied on the face and more contact with the silicone cushion. This can lead to skin irritation, especially in sensitive people prone to skin problems [2-3]. At the same time, the mask position highly depends on facial particularities, predisposing to air leakage.

The nasal mask has a triangle shape and is placed directly above the upper lip and below the eye angle. This type of mask permits a natural way of pressure delivery, resembling normal breathing. Thus,

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in the case of a nasal mask, the pressure is applied less directly compared to nasal pillows, representing two cushions inserted at the nostril's outer surface. The last mentioned have a minimalistic design, offering the highest comfort for the patient [4]. They also have the capacity to dilate the internal valve due to cushions that sit inside the nostrils. Through this mechanism, their usage extends to patients with internal valve deficiency, in whom the PAP efficiency is reduced by nasal resistance [5]. Thus, the air turbulence and subsequent retropalatal collapse, characteristic in these patients, are reduced.

One of the reasons for interrupting CPAP therapy is related to mask intolerance. Therefore, finding the optimal mask that satisfies the patient need and is adapted to the patient's particularities is one of the most important steps for achieving treatment success.

Considering that adherence at therapy implementation usually predicts long-term patients' compliance to PAP, finding the best mask design from the beginning can predict therapeutic success. Our case report is representative and supports the available specialized literature data. We advocate for a mask prescription guide to support physicians in therapeutic decisions. At the same time, we consider that a short therapeutic trial with different mask types for each patient might be necessary before prescribing a CPAP interface. Despite the time and financial resource drain in the short term, it can significantly reduce long-term healthcare expenses by increasing therapeutic compliance. Thus, preventable chronic pathologies associated with inadequate sleep apnea treatment, which usually represent a great burden on the health system, can be reduced.

2. Materials and methods

A 57-year-old patient (BMI 39 kg/m^2) received a diagnosis of severe obstructive sleep apnea (AHI= 91.3) following an at-home polysomnographic study exploration. The device identified a preponderance of apneas over hypopneas (562 vs 40) with predominantly obstructive events (n=562, 92%). He complained of severe daytime sleepiness (Epworth Sleep Scale Score=20) and a secondary reduced quality of life. The patient's personal medical history also includes hypertension, type 2 diabetes, and Parkinson's disease, controlled by medication. Confronting a severe patient, a prompt therapeutic decision was necessary.

From available therapeutic methods (Figure 1), a full-face mask (Figure 1A) was chosen as the first-line treatment in this case.

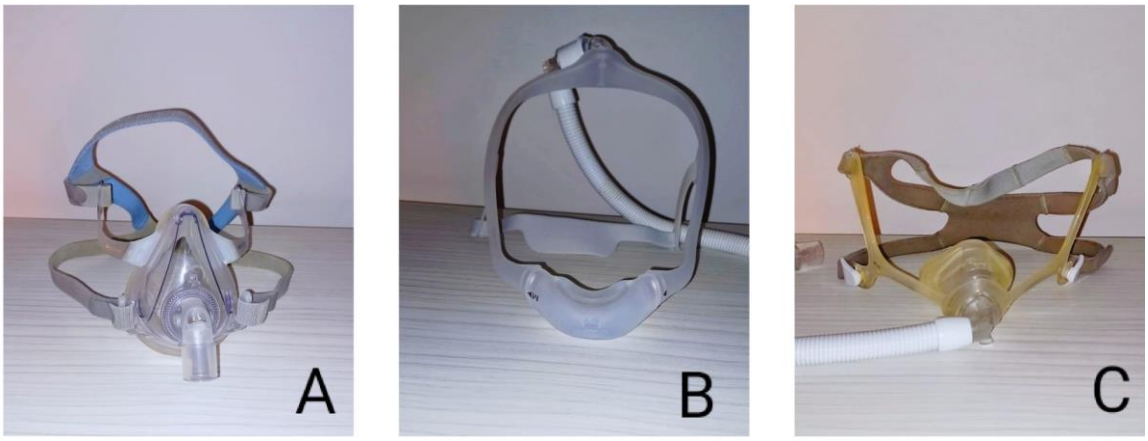

Figure 1. Different PAP interfaces **(A)** full-face/oronasal mask, **(B)** pillow mask **(C)** nasal mask

The patient found the oronasal mask uncomfortable and stopped the treatment despite disturbing daytime symptoms (Figure 2). The main complaints concerned the unbearable air leakage that resulted in eyes irritation and too high perceived pressure. At the same time, the patient had a skin sensitivity to mask's material, developing a skin irritation, difficult to treat.

Figure 2. Patient with oronasal mask

Figure 3. Patient with nasal mask

Faced with increasingly pronounced daytime sleepiness, the patient decided to try the PAP treatment again two years later. A nasal mask was the second treatment option for the patient, considering that it is usually one of the most preferred and most prescribed interfaces, showing good results in most cases.

Even though the patient reported an overall reduction in side effects compared to the oronasal mask with improved comfort, the patient's compliance was also low. He perceived nasal bridge discomfort and pain. The mask leakage, although reduced compared with full-face mask, increased the perceived discomfort. From anamnestic data, nasal vasoconstrictor spray dependence with consequently intermittent nasal obstruction during the night was pointed out. Also, the patient didn't feel improvement in day-time somnolence.

Following further investigations, internal nasal valve incompetence was displayed during an extended clinical examination (Figure 4). Probably this was one of the reasons for the prescribed masks' failure.

Figure 4. External valve incompetence

In view of previous low adherence to full-face mask and nasal mask, and upper lateral cartilages collapse during inspiration (Figure 4), a nasal pillow mask was considered to be the right option for the patient (Figure 5).

Figure 4. Patient with pillow mask

The patient tolerated APAP well and perceived an improvement in the quality of sleep with the pillow mask compared to the oronasal mask and nasal mask. The patient reported a sensation of dryness within the nasal passages with slight nostrils pain, which has been reduced by PAP humidifier.

He continued APAP treatment at home using a nasal pillow mask (Figure 4).

Regarding the APAP masks, the nasal mask's manufacturer was Philips Respironics, whereas the full mask and nasal pillow mask were furnished by ResMed. The composition remained uniform across all these masks: their cushions and frame material featured high-quality silicone, while the headgear was made from nylon/polyurethane. The tubing, serving as an important component of the PAP system, is composed of thermoplastic polyester elastomer.

3. Results and discussions

According to relevant literature on the subject, there are no specific guidelines to assist physicians in selecting the most suitable mask for sleep apnea patients. Therefore, the choice of CPAP delivery interface is mainly decided by the clinician's personal experience and the patient's preference [6].

A closer follow-up and change of PAP interface when needed is a possible strategy to avoid treatment discontinuation.

Studies suggest that early PAP experience is associated with long-term PAP adherence [7]. A period of just 3 days following PAP initiation is needed to predict long-term compliance.

An extensive literature meta-analysis was published in 2018, comparing the nasal and oronasal PAP interface in terms of treatment adherence, pressure level needed for favorable results, and residual AHI. [8]. The main finding was that oronasal mask usage was associated with significantly higher pressure, simultaneously with high AHI residual events and low compliance. They express concern relating to the widespread usage of full-faced masks for sleep apnea treatment in clinical practice. These remarks are also reflected in our case report. An oronasal mask represented the first treatment option chosen for our patient, with negative effects on compliance and subsequent treatment discontinuation. Also, in accordance with the literature data, our patient optimal pressure level decreased while using the nasal mask compared with the oronasal one.

The reasons behind the differences in the efficiency of oronasal and nasal interfaces have been extensively examined over recent years.

In order to prove the previous hypothesis regarding the physiological mechanism behind different PAP interface dissimilarities, Ebben M et al. showed anatomic evidence of higher nasal mask efficiency using cine magnetic resonance imaging. They proved that the oronasal mask was associated with a reduction in anteroposterior diameter at the retropalatal level, making a nasal mask more effective in upper airway opening [9]. Similarly, Andrade R. et al. managed to demonstrate the physiological local changes following different CPAP route delivery using a customized oronasal mask with separated oral and nasal compartments connected to a multidirectional valve. Drug-induced sleep endoscopy with low doses of midazolam highlighted a progressive upper airway obstruction at the level of the retroglossal area when the pressure was administered through oronasal and oral masks, compared with more stable breathing during the nasal route [10]. The differences between the two aforementioned studies regarding the level of obstruction consist in the circumstances in which the patients were evaluated. In the first study, the patients were awake during MRI examination, allowing compensatory muscle activation in the jaw, minimizing the effect of the oronasal mask on mandibular posterior displacement and retroglossal space reduction.

The role of posterior mandibular displacement in poorer obstructive episodes correction during oronasal usage was investigated by Kaminska M et al. [11]. Through mandibular stabilization, using a mandibular advancement device (MAD) accompanying the oronasal mask, effective pressure for correcting obstructive events was reduced, resulting in good therapeutic outcomes. Authors suggest that a combination treatment of oronasal mask with MAD might be a proper solution, especially in patients who don't tolerate nasal masks. In agreement with Kaminska's findings, a case series published in the Journal of clinical sleep medicine demonstrated that oronasal masks required very high CPAP pressure

and resulted in incomplete control of upper airway obstruction. Changing to a nasal mask allowed adequate control of obstructive events with significantly lower effective pressures. The authors speculated that increased CPAP mask strep tension applied to prevent mask leaks in the case of oronasal mask aggravates mandibular posterior displacement [6].

Even if the majority of studies advocate for nasal mask usage rather than oronasal one [12], there are conflicting opinions regarding nasal mask type [7-14]. Nasal pillows have been designed to overcome the perceived adverse effects of nasal masks. Ryan S and al. concluded that despite improved satisfaction and increased comfort obtained by nasal pillow use, this therapy doesn't result in improved PAP compliance [13]. They suggest that patients should be evaluated on an individual basis for the most suitable device. However, a study published in 2017 by Lanza A et al. shows a similar rate of PAP adherence and equal efficiency when comparing the two interface types. Yet, they noted that nostrils pain was a specific nasal pillow side effect [15]. This symptom was also the main complaint of our patient, but a humidifier resolved it. In our case, the nasal discomfort was probably higher due to nasal dryness and obstruction. Despite this adverse effect, overall satisfaction with nasal pillows is usually high. Zonato A. sustained even that nasal pillows can be a proper initial option on titration nights in sleep laboratories [7].

The role of the nasal valve in sleep apnea syndrome has been investigated in several studies. It is associated with poorer nocturnal respiratory patterns and can determine an increase in OSA severity. Thus, some authors suggest that improving nasal valve function may be clinically relevant in selected patients [5]. Schönhofer B. et al. proved that a nasal dilator can reduce nasal resistance and increase airflow. The authors obtained a reduction in CPAP level, which determined improved compliance to therapy [16]. Nasal pillows might reduce airflow turbulence by similar mechanisms encountered in nasal dilators, being fitted in nostrils and resolving internal nasal valve incompetence. This effect was highlighted in our case report, considering the increased compliance of the patient following treatment implementation.

Conclusions

The type of PAP delivery interface is likely to influence the patient's acceptance of therapy and long-term compliance. Considering the increasingly acknowledged adverse health effects of untreated sleep apnea, improvements in CPAP adherence are essential, especially in severe cases. Finding the most suitable PAP mask from the beginning might prevent treatment initiation delays and result in overall therapeutic success.

We support a more individualized approach when prescribing a silicone PAP mask, as some adverse reactions, like skin sensitivity to silicone, might reduce compliance to therapy. Also, the patients who didn't respond well to oronasal/nasal masks should be investigated for dynamic nasal valve collapse. Considering our experience, nasal pillows might be the right therapeutic solution for these particular situations by reducing airflow turbulence and improving sleep apnea treatment outcomes.

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