CASE REPORT

Ocular disorders in non-invasive ventilation and CPAP therapy—A case report

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Background: The benefits of non-invasive ventilation (NIV) in the treatment of several chronic and acute disorders are well documented. However, the side effects associated with this type of treatment must always be taken into account. Patients often fail to mention ocular symptoms.

Clinical case: A male, 80 years old, autonomous in activities of daily living, with a personal history of chronic obstructive pulmonary disease (COPD) and chronic hypercapnic respiratory failure was admitted to the emergency room due to dyspnea and a depressed level of consciousness. The patient deteriorated to severe respiratory acidosis and was started on NIV. On the third day of admission there was note of significant ocular irritation in addition to a dermal lesion on the bridge of the nose. Ophthalmology reported a corneal ulcer and bilateral conjunctivitis and prescribed topical antibiotic and steroids, with improvement of the symptoms.

Discussion: Ocular disorders in relation with NIV are more common than documented in clinical practice. It's essential that every professional that deals with this type of therapy is sensitive to the recognition and early diagnosis of this secondary effect, motivating timely evaluation. This case exemplifies the rapid onset of this type of complication, especially if the staff is poorly trained in NIV application and in patients with a decreased level of consciousness. Centers need to develop protocols to evaluate patients under NIV for ocular symptoms, with the goal of early therapeutic intervention. The creation and divulgation of these procedures will drastically improve the quality of care to acute and chronic patients in need of NIV.

Key Words: *noninvasive ventilation; dry eye syndromes; case report*

INTRODUCTION

The benefits of non-invasive ventilation (NIV) in the treatment of obstructive sleep apnea (OSA), exacerbations of chronic obstructive pulmonary disease (COPD), congestive heart failure induced pulmonary edema, and acute and chronic hypoxic and hypercapnic respiratory failure have been documented [1]. However, the side effects associated with this type of treatment must be considered and addressed, since they can largely contribute to low patient compliance [2].

The most common mask-related complications reported when a patient is receiving NIV or CPAP therapy are exhalation discomfort, claustrophobia, aerophagia, facial erythema, leaks, skin rashes, pressure sores, dry nose, dry mouth, and dry eyes, with or without conjunctivitis; however, patients often fail to mention ocular symptoms [1]. We describe an interesting clinical case of a patient under NIV in which the existence of serious ocular complications was observed.

CLINICAL CASE

We report a case of a male, 80 years old, autonomous in activities of daily living, with a personal history of COPD and chronic hypercapnic respiratory failure, as well as stage 3B pulmonary adenocarcinoma, currently in treatment with chemotherapy.

He was admitted to the emergency room because of dyspnea and a depressed level of consciousness. The family reported progressive worsening of his pattern of dyspnea and marked asthenia in the last few days. They denied fever, hemoptysis, weight loss, or other constitutional symptoms. On objective examination, the patient was confused and presented with the following: a Glasgow Coma Scale of 13, a temperature of 37 °C, blood pressure was 150/60 mmHg, a heart rate of 85 beats per minute (bpm), was tachypneic, and had respiratory rate of 32 bpm; auscultation revealed bilateral reduction of breath sounds. Arterial blood gas analysis showed pH 7.35, PaO_2 53 mmHg, $PaCO_2$ 56 mmHg, and HCO_3 27 mEq/L. Blood work showed 12 g of hemoglobin with 12×10^9/L leukocytes and a normal renal function. electrocardiogram presented sinus rhythm, 105 bpm, without repolarization abnormalities. Chest radiography revealed bilateral infiltrates. The patient deteriorated to severe respiratory acidosis and was started on NIV with Philips BiPAP vision, IPAP 15 EPAP 6, supplemental oxygen 0.5 L per minute, oronasal interface. He was then admitted to an Internal Medicine ward under NIV. In this setting, NIV is applied by the internal medicine staff, with monitoring by nurses every 4 h and by a physician every 12 h. On the third day of admission, the patient transferred to the care of the non-invasive mechanical ventilation unit, who noted significant ocular irritation in addition to a dermal lesion on the bridge of the nose. The family informed the NIV unit personnel that the mask was causing discomfort. The skin breakdown and the patient's complaint of discomfort made it clear that there was intolerance and poor

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FIGURE 1

First day of observation by the NIV team and by Ophthalmology, with exuberant conjunctivitis and eye irritation.

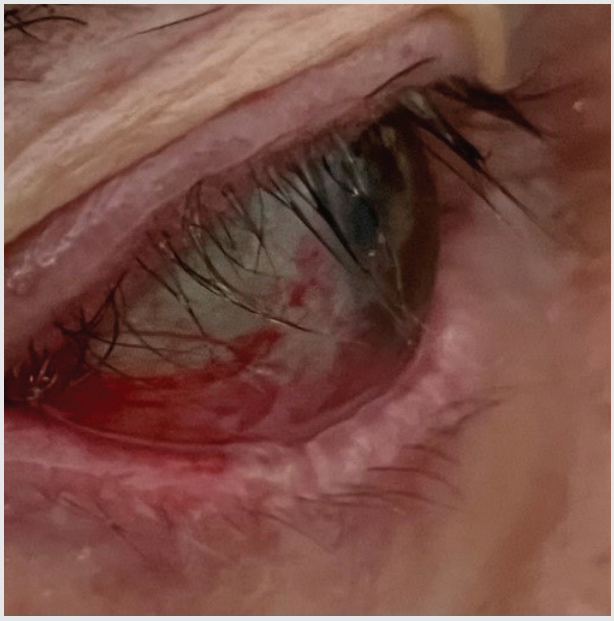
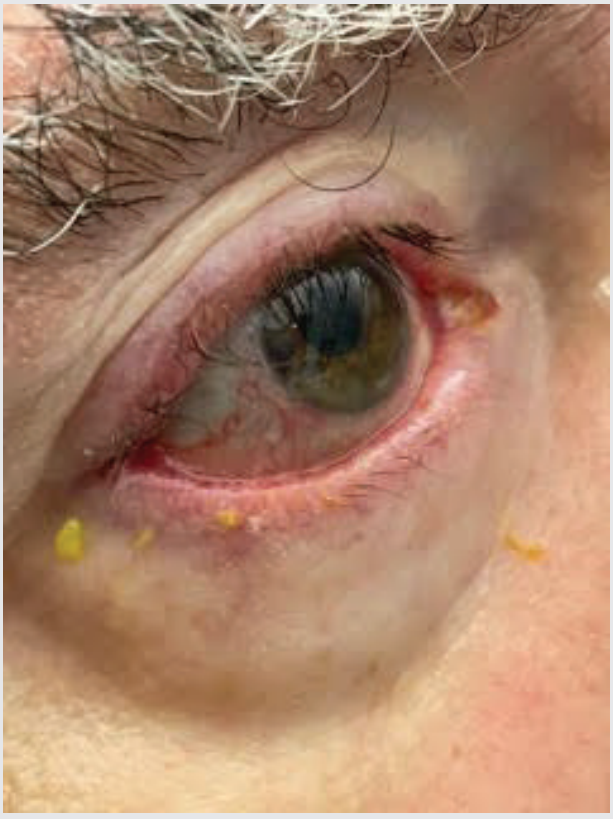


FIGURE 2

Favorable outcome of the patient's ocular symptoms after 4 days of topical treatment and appropriate interface adjustment.



positioning of the interface throughout the last several days. The physicians belonging to the NIV unit observed peri-mask leaks on patient examination, ranging from 30 to 35 L/min. After repositioning the maximal leakage value observed was 10 to 20 L/min. On that afternoon the patient was evaluated by Ophthalmology who reported a corneal ulcer (Figure 1) and bilateral conjunctivitis and prescribed topical antibiotic and steroids. The Ophthalmologist agreed that the peri-mask leaks were probably responsible for the eye injury. The patient was under NIV for a total of 5 days, with a progressive decrease in IPAP and EPAP. The improvement of ocular symptoms was gradual, after pressure adjustment and a well-fitting interface as well as adequate topical ophthalmic treatment. After suspension of NIV the ocular symptoms disappeared (Figure 2). He was weaned to low flow oxygen, with nasal prongs at 2 L/min, after the resolution of the respiratory acidemia, which he maintained for 2 days. He remained apyretic and hemodynamically stable and was able to spend periods of time sitting on the couch. He was evaluated by oncology and the next chemotherapy session was scheduled. The patient was then discharged from the hospital. Written informed consent for publication of their details was obtained from the patient.

DISCUSSION

Dry eye disease (DED) is defined as "a multifactorial disease of the ocular surface characterized by a loss of homeostasis of the tearfilm, and accompanied by ocular symptoms, in which tearfilm instability and hyper-osmolarity, ocular surface inflammation and damage, and neuro-sensory abnormalities play etiological roles" [3]. DED is also known as dry eye syndrome, keratoconjunctivitis sicca, and dysfunctional tear syndrome [4]. The prevalence of DED varies worldwide between 5% and 34%; this is the most commonly occurring ocular surface disorder throughout the world [5]. It has become increasingly more prevalent in recent years for a plethora of reasons such as wearing contact lenses, rising usage of smartphones and computers, and normal aging. Additionally, environmental factors including cigarette smoke, dust, and exposure to dry air have been shown to worsen DED [2].

The ocular surface is continuously lubricated and moisturized by tear secretion, maintaining comfort, as well as conjunctival and corneal health and function. Damage to the ocular surface with alteration of its anatomy increases the likelihood of developing DED [6]. Stress to the ocular surface is postulated as the pathogenetic triggering mechanism, leading to the release of proinflammatory chemokines, matrix metalloproteinases, and cytokines that activate CD4 T cells. The CD4 cells invade the ocular surface and the lacrimal gland, leading to apoptosis, creating a vicious cycle of ocular surface damage and inflammation [2]. Cool, dry air blowing into the eye damages the ocular surface by the mechanism previously described; an example of this is treatment with NIV or CPAP, in both a chronic or acute setting.

The cause for eye irritation and conjunctivitis in NIV users is usually small air leaks near the eyes. Assessing for these leaks by placing the back of the hand over the area, and asking the patient about eye irritation routinely throughout the treatment and every time the mask is fitted can help in the prevention of this difficulty. Artificial tears can be applied if the eyes are affected [6].

NIV is an important tool in acute settings. In a prospective, cross-sectional study, Smith et al. [7] observed 50 consecutive patients admitted to wards other than the intensive care unit (ICU) in a tertiary hospital and treated with NIV for hypercapnic respiratory failure. The 14-item Condensed Memorial Symptom Assessment Scale was used to evaluate physical and psychological symptoms 36 h after beginning NIV. The prevalence of dry eye symptoms was found to be 44%. Of the 44% of patients experiencing symptomatic dry eyes, 19% experienced bothersome dry eye related symptoms, 13% rated the dry eyes as somewhat bothersome and 12% rated it as very bothersome. In this study it was not

considered if there were pre-existing dry eye conditions prior to admission. Still, the high prevalence of ocular symptoms in this context is noteworthy.

In 2019 Yesilbalkan and Ozbudak [8] aimed to determine the complications seen in patients undergoing NIV in an acute setting, including all patients who underwent NIV in the ICU of a university hospital for pulmonary diseases, with a total of 40 participants. The patients were followed up for 7 days, and a novel NIV related complications questionnaire was used to document side effects related to the ventilation therapy. The occurrence rate of dry eyes on the first day was 65%, on the fourth day 70% and on the seventh day 67.5%. Patients experienced eye dryness throughout the duration of the treatment but there was no significant increase in the severity of this symptom, with the progression of days. This study advocates that ocular dryness is a potential side effect of NIV in an acute setting, but the duration of treatment is unlikely to increase the severity of these symptoms. Thus, preventative measures and proper eye care management can help reduce the incidence of this side effect.

Kousha et al. [9] designed a two-phase prospective cohort single-centre study between November 2014 and August 2015 in an ICU in a large district general hospital [9]. The first phase of the study was primarily observational: ophthalmic assessments were performed, which included a full eye examination of the external eye, eyelids, eyelid position, and ocular surface using a portable slit lamp. In the first phase, the researchers collected the risk factors for exposure keropathy (EK) as well as its initial prevalence in the 257 patients included. The overall rate of EK was found to be 21%, with a prevalence of EK of 54.3% in mechanically ventilated patients, versus 5.1% in patients receiving NIV or no ventilatory support ($p < 0.001$). In the second phase of the study, they introduced an eye care protocol, using Lacri-Lube® lubricant eye ointment, based on the eye assessments performed at a minimum of every 8 h. After institution of the protocol the rate of EK was significantly reduced from 21% to only 2.6% (3 cases) of patients ($p < 0.001$). The use of mechanical ventilation and incomplete eye closure were the major risk factors found to increase the incidence of EK; adequate eye care protocols could significantly reduce this side effect.

A rare ophthalmological complication associated with CPAP therapy is CPAP-associated retrograde air escape via the nasolacrimal system (CRANS), which happens more frequently in patients with anatomical alterations of the lacrimal pathway, due to trauma or past surgical interventions [10]. Symptoms of eye dryness or irritation, epiphora and even eyelid flutter are amongst the most reported [11]. Treatment usually involves replacing CPAP with other therapy; if the patient has had a Jones tube placed, physical occlusion of the tube may be attempted, more recently, the use of a full-face mask has been described [11].

CONCLUSION

DED emerging from ocular surface injury in OSA is a common problem and should not be underestimated. Chronic DED has the potential to permanently damage the ocular surface, causing discomfort and visual loss. Ocular surface damage has a significant impact on quality of life and restricts daily activities, productivity, and patient well-being.

Ocular disorders in relation with NIV are more common than documented in clinical practice. It's essential that every professional that deals with this type of therapy is sensitive to the recognition and early diagnosis of this secondary effect, motivating timely evaluation by an Ophthalmologist. This case exemplifies the rapid onset of this type of complication, especially if the staff is poorly trained in NIV application and in patients with a decreased level of consciousness. The staff outside the intensive care setting, in conventional medicine wards, has a lower level of knowledge and training in NIV application, which translates into less and poorer patient monitoring, as well as greater difficulty in identifying and correcting possible associated complications. This case happened during the COVID-19 pandemic, when there were fewer beds available in intensive care and greater hospital and staff burden, resulting in a greater tendency for application of NIV outside specialized environments. Although in the hospital in question there is a protocol for the application of NIV outside the ICU, specific training of staff is still necessary.

The chosen interface is an important consideration, and the correct size and adjustment of the mask can be decisive factors. Adjusting the mask straps correctly (particularly when oronasal masks are used) or changing the interface to a different/better fitting one may prevent eye irritation. Another option, when feasible, is to reduce the inspiratory pressure or tidal volume, depending on the ventilatory mode.

Another aspect is the lack of protocols for ocular symptoms or complications in this setting. Centers need to develop protocols to evaluate patients under NIV for ocular symptoms, with the goal of early therapeutic intervention. The creation and divulgation of these procedures will drastically improve the quality of care to acute and chronic patients in need of NIV.

DISCLOSURES

Contributors

All authors contributed to the conception or design of the work, the acquisition, analysis, or interpretation of the data. All authors were involved in drafting and commenting on the paper and have approved the final version.

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Competing interests

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no financial relationships with any organizations that might have an interest in the submitted work in the previous 3 years; no other relationships or activities that could appear to have influenced the submitted work.

Ethical approval

Ethical Requirement of Research Ethics Board approval for this project was formally waived by the institution.

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