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ORIGINAL ARTICLE

Facial skin breakdown in patients with non-invasive ventilation devices: report of two cases and indications for treatment and prevention

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Abstract

Non-invasive ventilation (NIV) provides an effective ventilatory support in patients with respiratory failure without endotracheal intubation. However, there are potential problems with its clinical application and the development of pressure ulcers represents a common complication. Often several intensive care units treat facial skin breakdown related to NIV. In this article, we report our experience in treatment and prevention of these lesions, emphasising the higher risk of certain age groups to develop them, such as preterm infants and elderly patients with comorbidities. We performed daily disinfection of the lesions followed by application of topical cream containing hyaluronic acid (HA) sodium salt. In addition, in order to prevent worsening of injury, we applied a cushion made of gauze pad containing HA sodium salt between the skin and the masks, so as to reduce friction between the NIV devices and the skin. Local medical treatment allowed complete reepithelialisation of the injured skin areas. Systematic monitoring of patients' faces is essential to detect early damages and to intervene with appropriate therapy, especially in preterm infants and elderly. Moreover, refining the devices with the proposed protective cushion can reduce pressure ulcers and increase comfort for the patients.

Introduction

Non-invasive ventilation (NIV) includes all methods of artificial ventilation that do not use an endotracheal tube but nasal or facial masks, mouthpiece or perithoracic devices (1). NIV represents one of the major technical advances in respiratory care over the last decade (2); in fact, in acute or chronic respiratory failure it helps to decrease the effort of breathing and also mortality by 36–75% (3), reducing intubation rates and exposure to the potentially lung-damaging effects of mechanical ventilation.

NIV includes two types of ventilation (4): (i) non-invasive positive pressure ventilation in which ventilation is associated with a positive pressure using nasal, facial or buccal masks; (ii) ventilation with negative pressure, which is not usually used because of its technological complexity. Nasal continuous positive airway pressure (NCPAP) belongs to the first NIV category and it is becoming increasingly popular as a method of respiratory support in the newborn (5,6).

Key Messages

- development of pressure ulcers on the nasal bridge, in the columella region and around the non-invasive ventilation (NIV) mask is a common complication of this method of artificial ventilation, owing to pressure generated on the skin by rigid parts of these devices
- preterm infants and elderly patients with comorbidities represent two age groups of patients with a higher risk for these facial skin injuries because of their poor general health conditions and/or their status of immunosuppression
- in the management of facial skin breakdown related with the use of NIV devices, we performed daily disinfection and application of topical cream containing hyaluronic acid (HA) sodium salt on pressure ulcers; to prevent worsening of injury, we applied a cushion made of

gauze pad containing HA sodium salt between the skin and the mask, thereby reducing friction
- careful and frequent monitoring of patients (with checks every 3–4 hours) is essential to detect early damages and to intervene with appropriate therapy, especially in preterm infants and the elderly, who represent classes of patients with increased risk of development of these common complications
- refining NIV devices with a cushion made of gauze pad containing HA sodium salt can reduce friction between the devices and the skin and increase comfort for patients

The choice of the interface and correct placement of mask are essential steps for realisation of an effective and well-tolerated NIV. Most non-invasive mask ventilation failures are due to technical problems such as air leaks, mask discomfort and skin lesions (7). Among the adverse effects of mask ventilation, skin breakdown, which occurs at the site of mask contact even after only a few hours of ventilation, is a frequent complication, ranging from 2% up to a maximum of 70% (8–21). In most cases, masks were fitted tightly in order to reduce air leaks, which often caused skin lesions, especially where there is very little subcutaneous tissue, such as at the level of nasal bridge or columella (14,22).

The Department of Plastic and Reconstructive and Aesthetic Surgery frequently receives consulting requests from several intensive care units to treat pressure ulcers associated with NIV devices. We report a review of the literature and our experience in treatment and prevention of facial skin breakdown related to the use of several NIV masks. This complication can affect patients of any age group, but we focus on higher risk of certain age groups such as preterm infants and elderly patients with comorbidities because of their poor general health conditions and/or their status of immunosuppression. Therefore, we present two selected clinical cases, first describing a case of nasal injury secondary to nasal continuous positive airway pressure in a preterm infant and then a case of skin necrosis caused by facial mask in an elderly patient.

Methods

Case 1

A 28-week preterm male infant, admitted to the neonatal intensive care unit of our hospital, manifested severe respiratory insufficiency because of his immature lung function. Hence from birth, a NCPAP device (24 hours/day) was initiated. Four weeks later the infant developed nasal ulceration at the level of contact site with nasal prongs; he showed a loss of cutaneous substance of nasal columella with partial exposure of the underlying cartilaginous structures (Figure 1).

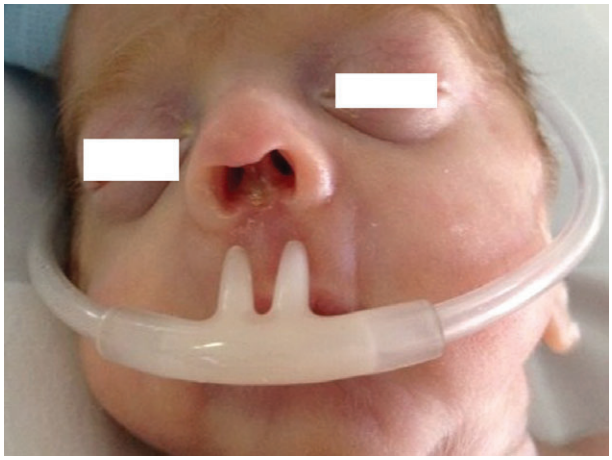

Figure 1 Front view of a 28-week preterm male infant showing nasal injury due to nasal continuous positive airway pressure (NCPAP): loss of cutaneous substance of the columella with partial exposure of the underlying cartilaginous structures at the level of contact site with nasal prongs.

Case 2

A 71-year-old gentleman with multiorgan failure was admitted to the medical sub-intensive care unit for elderly patients of our hospital. The availability of technological equipment in this ward (such as monitors for cardiac and respiratory function, non-invasive mechanical ventilators, peristaltic and volumetric pumps for i.v. therapy and enteral nutrition) allowed non-invasive monitoring of the vital signs of the patient and intensive interventions. Once blood gases deteriorated, to manage the respiratory failure, a facial NIV mask (24 hours/day) was placed. Unfortunately, the prolonged use of this device resulted in increased pressure and consequent trauma at the points of contact between the facial skin and rigid parts of the mask frame. The patient showed four areas of skin necrosis located precisely at the level of nasal bridge, in the nasolabial region bilaterally and in the chin region (Figure 2). The time interval between the initiation of NIV and the onset of injury was 11 days.

In both cases, the use of NIV devices was absolutely necessary; when we moved them away from nares/face of patients, there was a sudden decrease in PO_2. To manage these NIV complications, we performed daily disinfection of the lesions with a highly diluted solution of sodium hypochlorite (0·5% w/v) with topical anti-infective activity (Dakin's solution) followed by accurate cleansing with normal saline in order to avoid hystotoxicity, and application of topical cream containing hyaluronic acid (HA) sodium salt. Moreover, in order to prevent worsening of injury, we applied a cushion made of gauze pad containing HA sodium salt around the nasal cannula for oxygen therapy in case 1, as well as under the frame of facial NIV mask in case 2, thereby reducing friction between the devices and the skin.

All patients were followed up for at least a month after the onset of skin breakdown. The condition of the facial skin was documented systematically by the same plastic and reconstructive surgeon who administered the cushion.

Figure 2 Front view of a 71-year-old gentleman with respiratory failure showing facial skin breakdown related to the use of facial non-invasive ventilation (NIV) mask 24 hours/day. The image shows four areas of skin necrosis located at the points of contact between the facial skin and rigid parts of the mask frame, precisely at the level of nasal bridge, in the nasolabial region bilaterally and in the chin region.

Results

The outcomes of the local medical treatment have been totally satisfactory leading to complete reepithelialisation of the injured skin areas.

Discussion

Until now, most of the results with NIV usage have been beneficial, and it provides a safe and effective ventilatory support in patients with respiratory failure. Nevertheless, there are potential problems with its clinical application that need to be addressed (23–25).

A common complication correlated with the use of NIV is the development of pressure ulcers on the nasal bridge, in the columella region and around the mask (8–21,26–32), as reported in the above two cases.

A pressure ulcer can be defined as an area of local tissue damage caused by pressure, shear or friction (33); in fact, the major underlying mechanism of nasal and/or facial injury related to NIV appears to be pressure generated on the skin by the rigid parts of these devices. Previous literature on pressure sore has shown that despite the ability of the skin to autoregulate its flow, pressure sustained at 35 mmHg or greater for longer than 2-hour duration leads to irreversible ischaemia and subsequent tissue necrosis (24,26,34).

Although the type of damage is the same, the sites of injury differ. In patients with nasal mask or prongs, injuries occur primarily at the base of the nasal septum at the junction between the nasal septum and the philtrum (case 1). This suggests that this is the area where the mask exerts the greatest pressure, as prolonged pressure leads to impairment of tissue perfusion with resultant skin trauma. Instead, in patients with facial mask, lesions are usually multifocal and they are located all around the nose and mouth regions (case 2).

The choice of NIV device should be based on some important parameters: clinical age of patient, severity of respiratory failure, degree of vigilance, morphology of the face, patient compliance and subjective tolerance towards the various available devices. If the patient is able to ventilate for a long time effectively through the nose, then a nasal mask should be prescribed. Otherwise, a face mask should be used in the first instance. In selected cases it is also possible to alternate between several types of masks (4).

However, regardless of the type of chosen mask, the most important practice is to periodically check the facial skin of these patients in order to detect early damages and to intervene with appropriate therapy. Although pressure ulcers due to NIV can occur in a variety of age groups, some groups are at increased risk, such as preterm infants and elderly patients with comorbidities.

In fact, these two categories of patients are usually very debilitated, and have two important conditions that predispose to tissue injury related to NIV devices: prolonged immobility during long hospitalisations and immunosuppression. The prolonged immobility causes a reduction of tissue blood flow and consequently results in alteration of the skin trophism. The condition of immunosuppression, due to immature immune system in preterm infants or its deterioration by several comorbidities such as in elderly patients, hinders the regular mechanism of wound repair. Thus, the combination of these adverse conditions makes preterm infants and the elderly with NIV devices particularly vulnerable to rapid and early mechanisms of damage (35).

Therefore, in the application of NIV, it is important to pay close attention not only to the general health conditions of each patient but also to the trophic status of the skin, especially considering the delicate skin of children and the thin, fragile and inelastic skin of elderly patients (36).

Various attempts have been made to improve the design and performance of NIV devices; some have concentrated on making the materials used soft and malleable, whereas other have changed the shape of the mask to facilitate usage (25). Meduri *et al.* (14) recommend using a patch of wound care dressing on the nasal bridge to reduce skin lesions. Weng (29) found that refining the materials of the masks with polyurethane hydrocolloid dressings that are applied to prevent pressure ulcers can increase tolerance of NIV. Günlemez *et al.* (30) proposed nasal silicon shield application to achieve the same goal.

According to our experience in the management of skin breakdown associated with NIV devices, we suggest an application a protective cushion – made of gauze pad containing HA sodium salt – around the nasal prongs for oxygen therapy and under the frame of facial NIV masks. We found that the use of this protection not only reduced the pressure ulcer rate significantly but also decreased the severity of injuries, reducing friction between the device and the skin as demonstrated

in our clinic. In addition, HA generates a microenvironment stimulating the secretion of growth factors, proliferation and migration of fibroblasts, endothelial cells, keratinocytes and angiogenesis, and it has a positive effect on inflammatory response: the essential conditions for wound healing (37).

In conclusion, we found that refining NIV devices with a protective cushion made of gauze pad containing HA sodium salt can reduce pressure ulcers and increase comfort for patients. It is a safe, simple, reliable, reproducible and versatile method. Thus, we propose it as an alternative approach in the management of facial skin breakdown associated with NIV. In addition, we emphasise the importance of performing systematic monitoring of the facial skin in these patients at the points of contact between the skin and the rigid parts of the mask frame, recommending a close follow-up (checks every 3–4 hours) especially in preterm infants and elderly, who represent classes of patients with increased risk of development of these common complications.

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