Individualized Nasal Mask Fabrication for Positive Pressure Ventilation Using Dental Methods

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Purpose: The aim of this study was to develop a simple technique to manufacture individualized ventilatory nasal masks for pediatric patients using materials and procedures commonly applied in dentistry. ***Materials and Methods:*** Three cases of pediatric patients who met with severe difficulties in their adaptation to commercially available nasal masks are described: one premature infant, one child diagnosed with achondroplasia, and one child with congenital central hypoventilation syndrome. ***Results:*** In each case, a light nasal mask was designed with two independent parts that become perfectly adapted to the patient's nose: one soft for the skin contact, and another rigid for dimensional stability. In all patients, adequate levels of ventilation were reached. ***Conclusion:*** This easy, inexpensive nasal mask fabrication technique can be used in a great number of patients, increasing the efficacy of individualized masks. *Int J Prosthodont 2004;17:247–250.*

Noninvasive positive pressure ventilation (NPPV) systems using facial interfaces became common in the 1980s because of an increasing necessity for long-term mechanical ventilation and home care.[1,2] According to the manufacturing method, there are two types of nasal masks: commercially available and individually fabricated. Commercially available masks are cheaper, but they show air leakage problems, may cause skin irritation, and are not as well tolerated.[3,4] Individually fabricated masks are better adapted to the facial anatomy of the patient, but they are expensive and usually must be manufactured by an expert.[5]

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Different studies have shown that NPPV therapy can be successfully used in children,[6,7] but the commercially available masks are occasionally difficult to adjust in the youngest patients. On the other hand, the use of positive pressure ventilation via the nose presents a series of side-effects such as nasal dryness and congestion, oral and eye irritation, and abrasion of the bridge of the nose.[3,8] In spite of its disadvantages, NPPV is a useful treatment for several medical conditions such as obstructive sleep apnea,[9] chronic respiratory insufficiency,[10] and neuromuscular diseases.[11]

The present article presents a technique to fabricate individualized ventilatory nasal masks using materials and procedures commonly applied in dentistry for pediatric patients who could not be successfully treated with commercially available nasal masks.

Case Presentations

Patient 1

An 8-month-old male premature infant with pulmonary immaturity admitted in the authors' Pediatric Intensive Care Unit was unsuccessfully treated using NPPV to

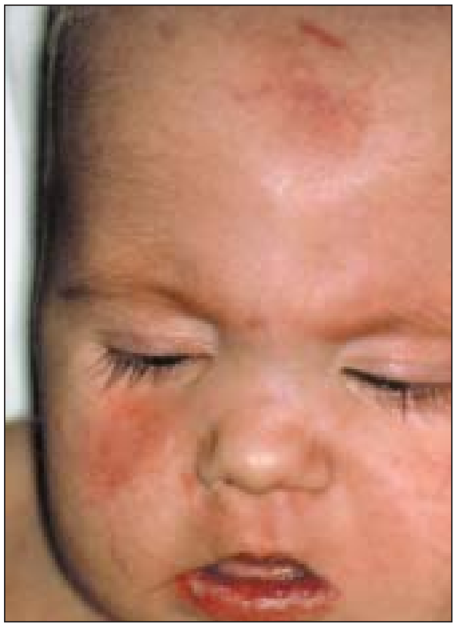


Fig 1 Skin lesions caused by excessive pressure contact of standard nasal mask (patient 1).

achieve adequate oxygen saturation levels. Air leakage could not be stopped because of the patient's reduced craniofacial development. Moreover, tightness of the nasal mask strips caused several skin lesions in the supporting areas (Fig 1). Therefore, the possibility of manufacturing an individualized nasal mask was considered. Otherwise, a tracheotomy would have had to be performed in the following hours.

Patient 2

Patient 2 was a 7-year-old boy with achondroplasia treated with NPPV. His small nasal bridge made the adjustment of any type of commercial mask very difficult, causing air leakage and making the mask highly unstable, especially during sleep. This situation caused very frequent hospital admissions for oxygen saturation control and eventually for ventilation.

Patient 3

The third patient was a 5-year-old girl with congenital central hypoventilation syndrome under palliative treatment with home NPPV. She needed regular controls because of difficulty adapting to a standard mask. She had poor quality of life during the day because of the size and complexity of the interface.

Nasal Interface Fabrication

First, an impression of the nose and nearby areas is taken using fast-setting irreversible hydrocolloid (Fig 2a); later, the impression is poured in dental stone. The nasal mask is outlined on the cast following the most adequate design to the facial anatomy of each patient (Fig 2b). Afterward, a 2-mm-thick thermo-conformable soft silicone plate (Drufosoft, Dreve-Dentamid) is adapted to the plaster model using a heat-vacuum machine (Erkopress, Erkodent Erichkopp); then, the plate is cut following the marked line (Fig 2c). On the model and with the soft mask placed on top, a new 2-mm thermo-conformable vinyl splint (Drufolon-E, Dreve-Dentamid) cut 2 mm from the inside of the soft plate limit is made. Then, with both masks placed over the plaster model, the holes for the nostrils are made. Afterward, the tubes to connect the nasal mask and the portable home ventilator machine are selected. These tubes become luted to the vinyl splint with autopolymerizable acrylic resin (Dentalplast Kfo, Bredent) in the position that best allows the passage of air into the nostrils. Finally, the number and position of the necessary strips to fix the nasal mask are selected. The fastening handles are made with orthodontic wire and fastened to the rigid splint using autopolymerizable acrylic resin (Fig 2d). The average time necessary to complete the whole process is 2 hours.

The result is a light nasal mask (range 5 to 10 g) with two independent parts perfectly adapted to the patient's nose; the thermo-adaptable plate is soft for the skin contact, also providing an optimal peripheral airtight seal. The vinyl splint is rigid to give dimensional and positional stability to the nasal mask and join it more easily to the ventilation device (Fig 3).

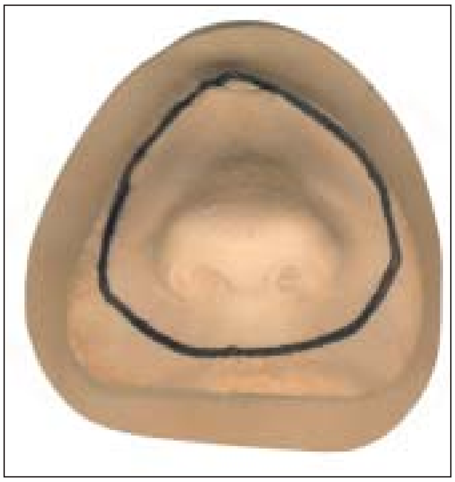
Discussion

Standard masks are the most commonly used interfaces for NPPV, but a number of variables govern the choice of the nasal interface for NPPV, including patient pathology, duration of ventilation, level of the user's physical dependency, etc.[5,12,13] In the present study, the necessity of manufacturing individualized nasal masks was mainly determined by patient age and physical characteristics that made adaptation to standardized masks impossible. The use of dental prosthetic procedures to manufacture ventilatory interfaces has been described by other authors, particularly with oral splints[12,14–16] because of similarities in the requirements and manufacturing process.

The nasal mask was fabricated by applying two different materials to increase cushioning effect and elastic recovery, as has been suggested for maxillofacial prostheses.[17] The criteria for nasal masks proposed by

Fig 2a *(left)* Nasal mask construction: impression of nose.

Fig 2b *(below)* Nasal mask design outlined on cast.



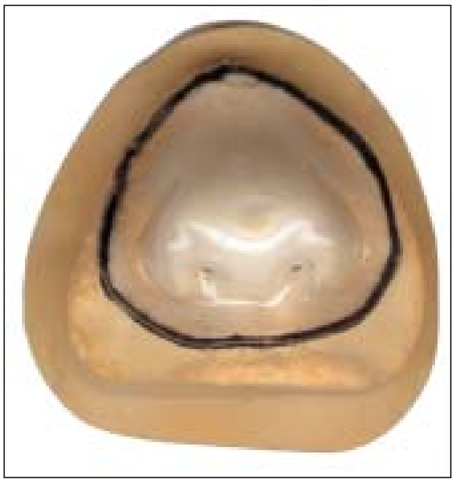


Fig 2c Soft silicone adapted to plaster model.

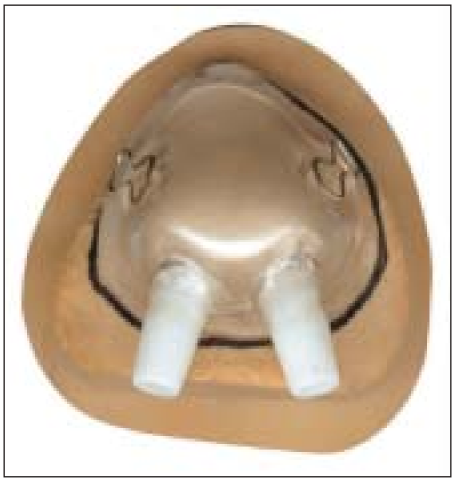


Fig 2d Individualized nasal mask.

Cornette and Mougel,[13] such as perfect adaptation to the patient's anatomy, optimal efficacy and comfort, minimal pressure on skin, lightness, nontraumatic nature, and durability, are fulfilled by this nasal mask. In addition, it presents other advantages: It allows the air directly into the nose and, having two independent parts, the soft mask can be easily removed to be carefully washed to avoid skin irritation and improve its durability.[5]

The manufacturing time is shorter than that reported by other authors[15] but longer than the 20- to 30-minute time required for the Lyon mask.[18] Nevertheless, the time spent manufacturing the mask compensates for its durability and the scarce adjustments needed. In adults, the amount of time spent in the manufacturing

Fig 3 Nasal mask after 1 year of follow-up (patient 1).

of copies would be increasingly reduced by keeping the plaster models. Nevertheless, they cannot be used in severe episodes of gained/lost weight or alterations of facial morphology.[12] They should not be kept for a long time in children because of the morphologic changes inherent to growth.

Sophisticated systems for producing facial prostheses using laser surface scanning/digitizing and computer-aided design/manufacturing (CAD/CAM) technologies have been recently introduced.[19] Although these techniques are expensive and usually show limited ability to scan complex curvatures (eg, nostrils), these new manufacturing approaches will probably be useful in the future for automated nasal mask fabrication.

The basic components of the present system cost little and are commercially available, and experience in their manufacture is quickly acquired. The interface is well-tolerated and adaptable, and it increases the advantages of several other individualized masks, making it recommendable for a significant number of patients. In the three cases described, adequate levels of ventilation were reached with the proposed mask in agreement with other authors[12,20]; however, we consider that any new mask design must be tested by a pneumologist to evaluate its ventilatory efficacy.

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