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Surgical Stent Fabrication for Unilateral Nasal Obstruction of the Anterior Portion of the Nasal Airway

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Abstract

A description is given of the indication and technical steps for fabricating a unilateral nasal stent to maintain patency of the nasal passage after surgical opening of an obstruction in a pediatric case. The methodology uses a two-step impression of the contralateral unobstructed naris and exterior valve region to generate a two-piece injection mold. The mold is used to fabricate a soft silicone-based anatomical stent. It supports an intranasal skin graft that was placed to reduce the risk of granulation.

Obstructions of the anterior portion of the nasal passage, that is, the region of the naris, vestibule, and external nasal valve, are typically of congenital, traumatic, or iatrogenic etiology.[1,2] The external valve is formed by the lower lateral cartilage, the columella, and the nasal floor. Obstructions located more posterior can have many etiologies, for example, excess bony growth of the nasal process of the maxilla (pyriform aperture stenosis), dermoids, naso-lacrimal duct cysts, gliomas and failure of the naso-buccal membrane to rupture during development (choanal atresia).[3]

A key objective after surgical opening of any nasal obstruction is preventing the newly established airway from closing again due to granulation or shrinkage processes. When the obstruction is deeply seated, for example, in choanal atresia, the stent will typically consist of rigid or inflatable tubing.[4] A vented stent through which the patient can breathe is indicated when the obstruction is bilateral and for patients younger than 9 months. Infants rely heavily on nasal breathing during the first months of their lives, and bilateral obstruction can lead to hypoxia, severe feeding difficulties, and mortality.[5] Once cervical lordosis has developed, the veloglossal and veloepiglottic passage opens and mouth breathing becomes viable.[3,6,7] In older children with established oral breathing ability, or when the obstruction is unilateral, solid stents can be used to maintain patency. In cases where the obstruction is in the anterior portion of the nose (external valve region), only a short stent is needed and it can be custom-made of hard (acrylic resin) or soft (silicone elastomer) materials.

Hard acrylic resin stents have the advantage that they can be precisely shaped, trimmed, and polished to a smooth finish.[8] Soft flexible stents are more difficult to modify after processing; however, when properly designed, they tend to be most comfortable. Furthermore, they can accommodate slight undercuts and reportedly provide a scaffold for mucosal regeneration and minimize scar formation. On the other hand, some authors have argued that soft stents are more susceptible to fungal growth than hard (e.g., acrylic) stents.[9]

This article presents a patient with left nasal deformity and obstruction in the area of the external nasal valve, vestibule, and nostril. The obstruction was surgically opened and a custom stent was placed. The focus of this manuscript is the method of stent fabrication.

Clinical background

A 3-year-old Caucasian male patient underwent surgery for choanal atresia within 3 months of birth. Left nasal aperture stenosis was the diagnosis that prompted a second intervention when he was 1 year of age. A nasal deformity and obstruction in the anterior region remained and required a third surgery at the age of 3 years (Fig 1). The obstruction was opened and a split-thickness skin graft was placed to prevent granulation and recurrent stenosis. An anatomically shaped solid silicone-based stent was placed to support the graft (Fig 2). The approximate special relationship between the impression/future stent and surrounding anatomical landmarks is schematically illustrated

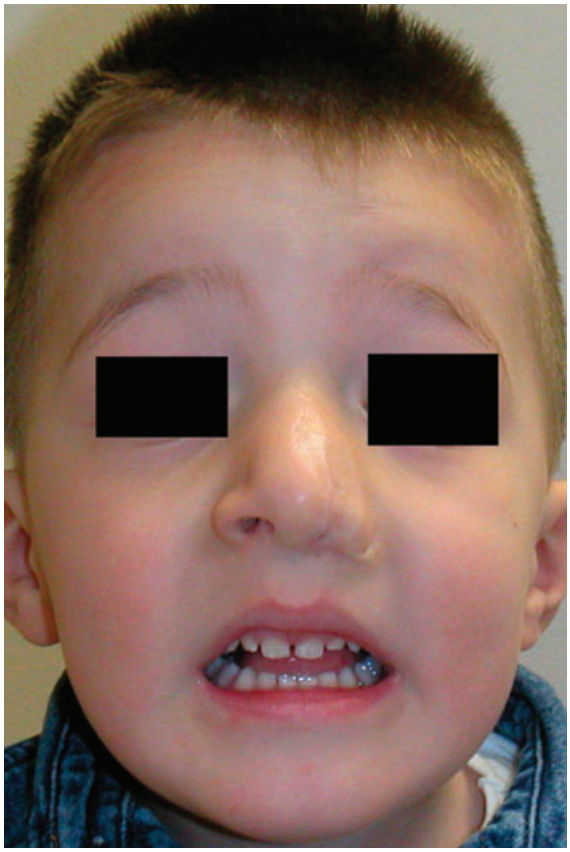

Figure 1 Three-year-old male patient with obstruction of the anterior portion of the left nasal airway; preoperative condition.

in Figure 3. The therapeutic goal was to maintain a patent nasal airway during the healing process while minimizing the risk of pressure necrosis and maximizing comfort for the patient. A stent that is a mirror image of the right (healthy) nasal passage is most likely to lead to an anatomically correct opening. Considering that the right and the left are highly symmetrical, the stent

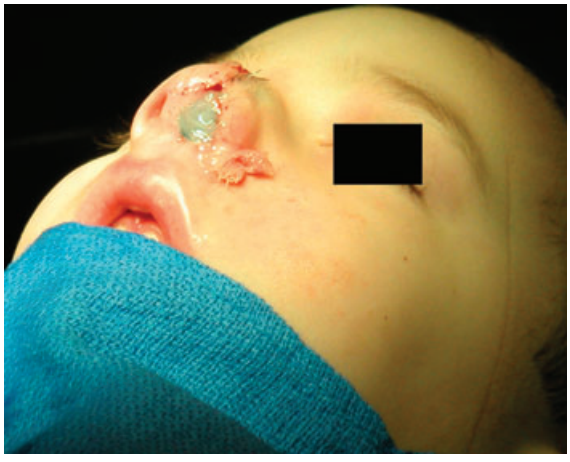

Figure 2 Silicone stent supporting a split-thickness skin graft secured with a suture in left naris.

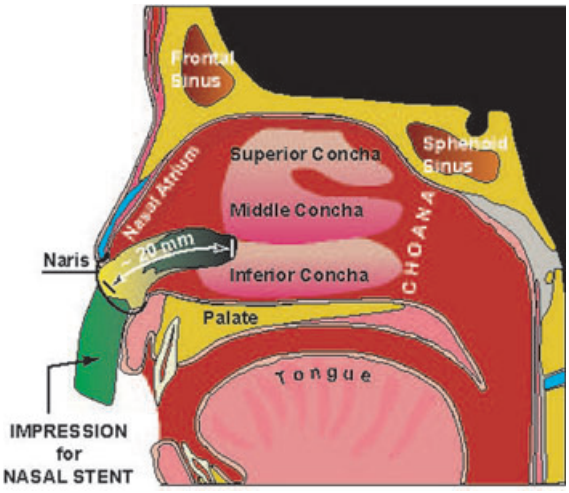

Figure 3 Anatomical diagram of the impression for the nasal stent and surrounding anatomical landmarks. The diagram does not depict the nasal pathology of the patient.

was made based upon an impression without any need for modification (Fig 4) of the normal right external valve. It remained in place for 6 weeks. The opening was patent 6 weeks after stent removal when the patient was last followed up (Fig 5).

Technique

Preparation of impression site

Removal of nasal hair may be necessary in adult patients; however, in small children this is not an issue. The child/adult is asked to thoroughly blow the nose. A moist cotton-tipped applicator is used for further cleaning and for applying a thin layer of petrolatum (Vaseline, Tyco Healthcare Group LP, Mansfield, MA) onto the internal wall of the nose.

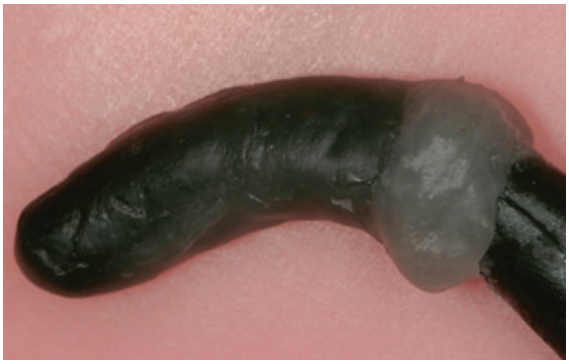

Figure 4 Impression of anterior portion of nasal airway, including nostril; the core and handle of the impression consist of modeling plastic impression compound. The surface (wash) is molded in wax.

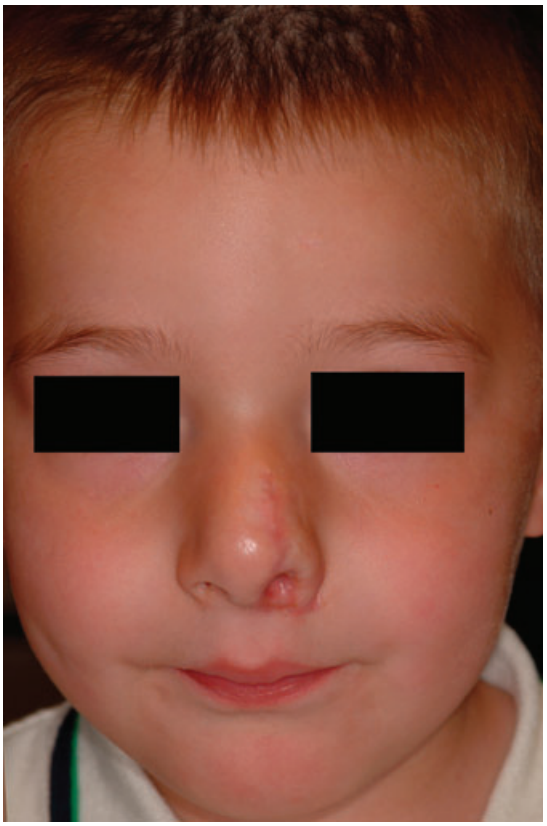

Figure 5 Follow-up 6 weeks after stent removal.

Two-stage impression procedure

One end of a modeling plastic impression compound (Kerr Impression Compound Sticks, Kerr Manufacturing Co., Detroit, MI) is dipped into a water bath for softening. The other (unheated) end serves as a handle. After allowing the compound to cool to a tolerable temperature, it is inserted about 20 mm into the right anterior nasal cavity of the awake and unanaesthetized patient. The advantage of compound over other materials is that it allows incremental refining of the impression and control of viscosity and therefore prevents overextension through aspiration. After initial hardening of the compound in situ, the preliminary impression (which measured about 5 mm at its thinnest cross-section) is removed from the nose and chilled in an ice bath. Up to 1 mm is shaved off the surface to make room for the final impression material, dental impression wax (Kerr Impression Wax, Kerr Manufacturing Co.). The wax will mold at body temperature after reinsertion into the naris. The final wash impression is removed from the patient and chilled in ice water (Fig 4).

For the best possible symmetry, the impression would have to be modified or a wax-up would have to be generated that represents the mirror image of the right nasal passage.[8] Often, as in this case, the impression does not exhibit much lateral curvature or asymmetry and may serve as an adequate representation of the contralateral side.

Final cast fabrication

Lower half of mold

Type IV stone (Denstone, Heraeus Kulzer, South Bend, IN) is poured into a cup. The impression is seated into the stone up to its equator with the end of the handle being in contact with the wall of the container. The handle will generate the sprue portion of the mold through which the silicone material will later be poured. The stone is allowed to set. The impression is left in place while indexing grooves are placed and petrolatum (Vaseline) is applied to the stone surface (Fig 6).

Upper half of mold

Boxing wax (Extra thin boxing wax, Coltene/Whaledent Inc., Mahwah, NJ) is used to create the containment for the upper half of the mold. Type IV stone is poured. The two halves of the mold are separated and the impression is removed. The mold is inspected for surface irregularities and smoothed as

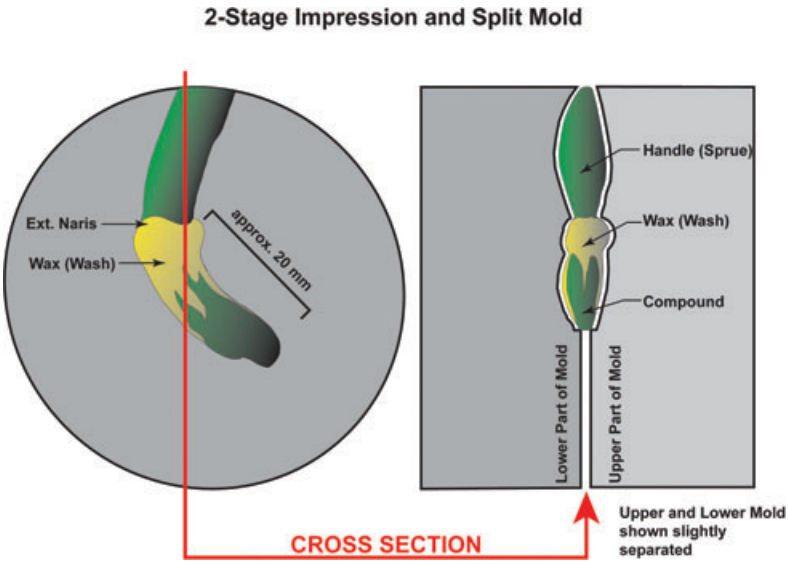

Figure 6 Schematic illustration of final impression.

needed. The stone surface is painted with a separating medium (Separating fluid, Ivoclar Vivadent, Schaan, Liechtenstein). The two halves of the mold are recombined and held together with elastic bands.

Processing of stent

Medical grade Type A silicone material (Silastic, Dow Corning, Midland, MI) is mixed and poured through the sprue opening (formed by the handle of the impression) into the mold. The material is allowed to vulcanize overnight at room temperature. The mold is opened, and the processed stent is removed. Flash is trimmed with a pair of scissors. The finished stent is sterilized in a glutaraldehyde solution (Omnicide, Allegiance Healthcare Corporation, McGaw Park, IL) for 24 hours.

Placement of stent

In the operating room, the stent is placed in situ and secured with a suture (Fig 2). In the described patient, it remained in place for 6 weeks with a further follow-up of the patient at 12 weeks (Fig 5).

Discussion

Custom-made stents are typically not an option to support surgical opening of deep-seated nasal obstructions because the anatomy makes impression making difficult. Therefore, various types of tubing and cannula are used in these cases. Rigid tubing that does not collapse is necessary in small infants, because they are unable to breathe through the mouth and rely entirely on a nasal airway.[8] Custom-made acrylic or silicone stents are indicated when the obstruction is anterior, that is, in the region of the external valve and vestibule. A method for fabricating solid stents for the treatment of unilateral obstructions of the anterior valve is described.

Although some authors argue that surgical opening of a blocked nasal passage is more likely to relapse when a stent is used,[10] most advocate the use of stents for preventing reclosure.[11,12] Unfortunately, solid comparative outcome data of nasal obstruction surgery with different type of stents and without stents are not available.

Summary

A process for fabricating a nasal stent suitable for cases of unilateral obstruction of the anterior portion of the nasal passage has been described. Based upon the high degree of symmetry between the left and right anatomy, the method uses an impression of the healthy side to fabricate the stent for the side that underwent surgical opening.

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