Neonatal palatal appliance: light-cured resin material and flexible design

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Introduction

In premature neonates, with birth weights between 550 and 1250 g, short-term orotracheal intubation is routine. Despite the use of surfactant and steroids, 20% of these premature neonates develop pulmonary dysplasia, which requires an unpredictable ventilation period with an orotracheal tube.[1, 2] Placement of the orotracheal tube may extend from hours to months,[3] and may result in midface changes.[4] Long-term palate deformation, hypoplastic enamel, and speech incompetency have been documented in 3- to 5- and 7- to 10-year-olds.[5, 6]

In 1984, Erenberg and Nowak described a palatal appliance for use in premature neonates.[7] Their design, which was similar to that described by Sullivan in 1981,[8] has been adopted by a number of major children's hospitals to prevent palatal groove. Medical,[9] dental,[10] and respiratory therapy literature have described its use.[11]

The purpose of this article is to describe a 22-month experience with 76 premature neonates using a new palatal appliance design. This appliance, constructed with visible light-cured urethane, is placed and removed easily. Its chief advantages lie in the properties of visible light-cured urethane, its design (which engages any size orotracheal tube), and its requirement for limited maintenance by the nurse or care provider.

The appliance consists of light-cured pink denture base resin (Triad®, Dentsply Co., York, PA), one 0.032-in. stainless steel ball-clasp wire (3M-Unitek Co., Monrovia, CA), a closed-link synthetic elastic latex polymer chain (3M-Unitek Co.), and a 10-cm piece of dental floss (Johnson and Johnson Co., New Brunswick, NJFig 1 and 2).

After blending the two components of a vinyl impression putty (Express STD®, 3M-Unitek Co.) for 20 sec, the putty is introduced to the palate with a suitable tray and held for 30 sec to produce an accurate impression.

A model is made and is marked in the following areas: along the midsagittal suture to the labial sulcus; at both lateral sulci, 1 mm labial to the crest of the posterior alveolar ridge, on the anterior alveolar crest between the lateral sulcus, and at the hard palate junction with the soft palate (Fig 3, next page). A small sheet of 2-mm thick urethane is placed upon the model and trimmed with a No. 15 scalpel blade to the established lines drawn on the model's alveolar ridge and posterior palate.

The ball-clasp wire is bent at a distance of 4 mm from its ball end, to 30° (bend #1, Fig 4, next page). A 90° bend (bend #2) is made 6 mm from the first. Another 90° bend (bend #3) is made 1 cm from the first. The wire between these 90° bends will be retained in the urethane. At 4 mm from the last bend, the wire is looped upon itself (bend #4), and the excess is cut.

A closed-four-link latex chain is secured to this loop of wire, and a colored piece of dental floss is attached to the wire and latex chain link. The floss is knotted every 2 cm along its length, then the third link of the latex chain is placed on the ball clasp with very slight tension.

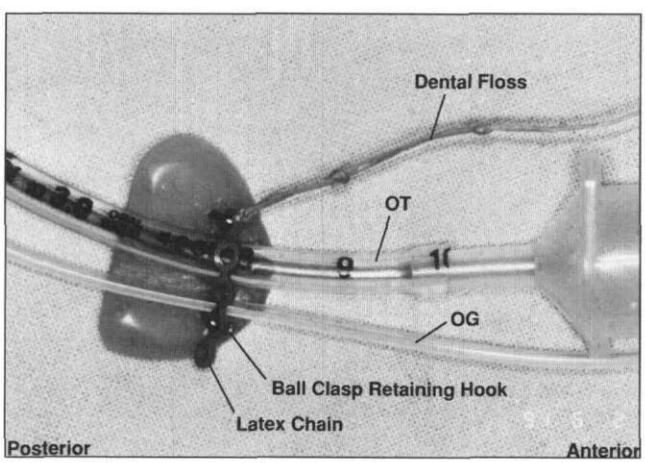

Fig 1. A neonatal palatal appliance holding an orogastric tube (OG) and orotracheal tube (OT).

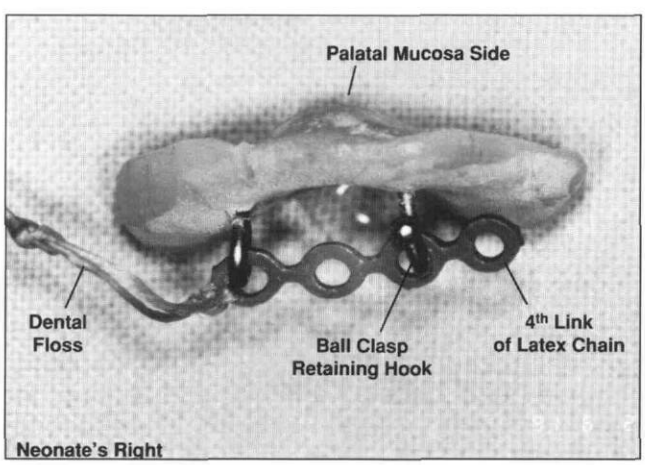

Fig 2. Frontal view of the appliance.

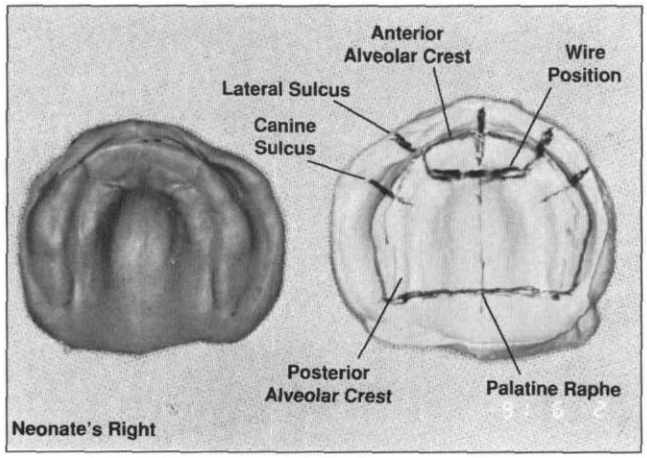

Fig 3. *Impression and model with drawn guide lines for appliance construction.*

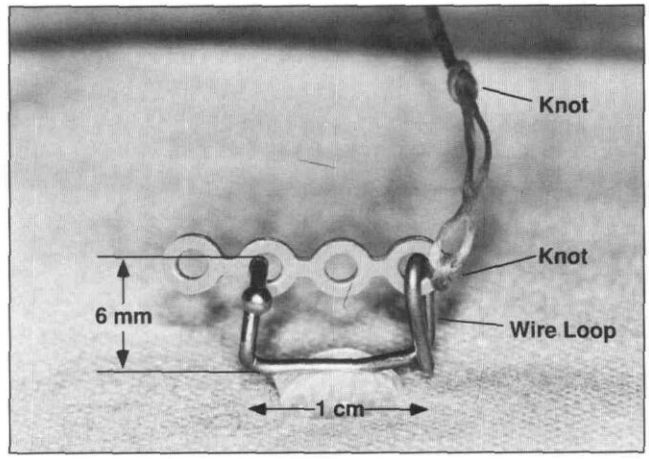

Fig 4. *Bent ball-clasp wire with floss attached.*

The loop or ball-clasp end of the wire is adjusted to create the desired tension on the latex chain. The fourth link remains free for easy access to the chain. This assembly of wire, latex chain, and dental floss is pressed into the urethane sheet material on the palate, according to the lines drawn on the model. Urethane covers the wire. The ball on the wire must clear the urethane by at least 3 mm for easy placement of the latex chain. The urethane material should be about 2 mm thick throughout the appliance base plate.

The appliance is light cured two times for 15 min in a 7 x 5 x 8" portable light-curing oven (Pro-Lite-IIIR®, Pro-Den Systems, Inc., Portland, OR). The initial cure is with the appliance on the model, and the second cure is with the appliance off the model, tissue side up. All surfaces then are smoothed with a suitable acrylic bur. The latex chain is disengaged from the ball wire and the appliance is scrubbed with a bactericidal soap, rinsed, and gas sterilized.

In each case of impression taking and inserting the appliance, oxygen saturation, blood pressure, and heart rate are monitored. An increase in blood pressure indicates tissue impingement by the appliance. Bradycardia indicates the appliance is extended upon the soft palate.

The appliance is inserted with a 3 or 5" curved sterile hemostat which is engaged securely upon the wire anchorage loop — not the latex chain. To aid retention, some nurses and respiratory therapists prefer to apply a methylcellulose denture adhesive (Super-Weinert®, Block Drug Co., Jersey City, NJ) on the palatal mucosal side of the appliance before insertion. The appliance is slipped under the securely taped orotracheal tube (this tape should position the tube at the midline of the maxillary lip). With the hemostat, the latex chain then is moved over the orotracheal and orogastric tubes to engage its third link over the ball-clasp wire. If the appliance rotates during this process, the dental floss should be pulled gently toward the right naris to aid in proper positioning of the appliance. Finally, the hemostat is used to check the fit of the appliance by placing light pressure on the appliance along the palate midpalatine suture. A separate piece of tape is placed on the knotted dental floss directed along the right naris. This avoids posterior slippage of the appliance. The orotracheal tube is oriented to exit directly out of the oral cavity. The tube should have neither a superior direction toward the cranium, nor an inferior direction toward the sternum. Since light-cured urethane is more brittle than acrylic resins,[12] it must not be clamped by a hemostat.

The tape which maintains the orotracheal tube loses its adhesiveness after approximately three days; at that point, the appliance is removed, the tissue condition evaluated, and the appliance reinserted. A second appliance is manufactured for the neonate approximately every 21 to 25 days or when the head circumference increases by 2.5 cm.

Discussion

Premature neonates tolerate the appliance well. Tissue response is excellent with no evidence of tissue ulcerations, inflammation, or candidiasis. Caretaker acceptance for the appliance is high, since there is limited maintenance at each retaping of the orotracheal tube.

Proper initial placement requires using adhesives, although within hours of its placement, the appliance floats away from the palate. The dental floss taped along the right naris determines the appliance's anteroposterior position, and the urethane conformity to the anatomical palate determines the appliance's

transverse position.

The patients' vital signs were monitored before and during the impression-taking process and the appliance insertion. Little variation from the initial data base occurred during the impression or the insertion process. Bradycardia occurred in one neonate when the appliance was overextended upon the soft palate. However, after the appliance was adjusted, bradycardia did not reoccur and the neonate accepted the appliance. Bradycardia episodes also may develop if the appliance is allowed to drift posteriorly into the pharynx. This can occur in the neonate who is more than 32 weeks old and has developed the sucking reflex. This problem is prevented by taping the dental floss placed along the right naris.

Within six months after using the initial appliance in the neonatal intensive care unit, the pediatric dentist's role was limited to impression taking to construct the appliance. All appliance maintenance was performed by respiratory therapists and/or nurses.

By design, the orotracheal tube must resist compression to maintain ventilation. The tube encounters the palate as it exits the trachea. The palate in turn resists pressure exerted by the tube as it exits the oral cavity. Palatal structures are insufficiently calcified in premature neonates to resist iatrogenic, continuous, and prolonged forces. In as few as 12 hr, a palatal groove can form.[5] Palate appliances prevent the maxillary midpalatine suture from developing a groove by dissipating tube flexing forces over the entire palate.

Vinyl polysiloxane has several distinct advantages over the more commonly used thermoplastic compounds; it does not require rapid placement, does not burn lips and mucus membranes, and does not adhere to the orotracheal tube. With one impression, it can produce more than one model accurately detailing the hard palate, the alveolar ridge, and the frontal attachments.[13]

Triad possesses distinct advantages for the palatal coverage portion of the appliance. As a visible light-cured urethane dimethacrylate matrix which has a camphoro-quinone photoinitiator, it also contains a small amount of microfine silica. This was reported by Ogle et al. as being superior to autopolymerized and heat-cured methyl methacrylate resins in dimensional changes and bacterial adherence.[14] Khan et al. reported its superiority in transverse strength and microhardness.[15] No inflammation was reported by Miller for a 12-month period on 26 patients.[16] Visible light-cured urethane completely polymerizes without residual compounds; it is accurate, and easy to manipulate. When polymerized, it is nontoxic and passes the American Dental Association's Biocompatibility Specification No. 41.[13] In summary, this material was chosen for three reasons: it is nonporous, has low bacterial adherence, and has a high degree of polymerization with no free monomer release in the saliva. These properties are particularly amenable for use in the premature neonate with an immature immune system and immature liver function. In addition, it possesses a high degree of stiffness (relative to its thickness) which is necessary to resist distortion from orotracheal tube flexing forces.

The appliance recommended by Erenberg and Nowak for premature neonates must be remade for each change in endotracheal tube size and does not allow the tube to be moved off midline. This design permits placement of the orotracheal and orogastric tubes either on or off the midline, and does not require reconstruction when the orotracheal tube size is increased. In premature neonates, its visible light-cured urethane construction, when compared to methyl methacrylate, has distinct advantages: superior strength, complete polymerization, and low bacterial adherence. The tension created by the latex chain is insufficient to compress the oral tubes, but prevents their slippage despite the presence of oral secretions.

The first three months of appliance use in the neonatal intensive care units demonstrated the nurses' and respiratory therapists' lack of familiarity using the latex chain in a small oral cavity. The floating appliance concept required some attitude adjustment on the part of caretakers who expected the appliance to be fixed in place regardless of movement. In time, the appliance was highly accepted by caretakers despite the required additional responsibility, although it requires little caretaker maintenance.

A floating appliance design must fit accurately with smooth peripheral surfaces having little overlap of the alveolar ridges. This is particularly true in the premature neonate where the palatal epithelium is abraded easily. Appliance extension onto the soft palate also must be avoided, since the vagal response produces bradycardia in the more-than-30-week gestational neonate.

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