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Space Maintenance in the Primary and Mixed Dentitions

Giovana Anovazzi Medeiros DDS, MSc, PhD
University of Michigan School of Dentistry, anovazzi@umich.edu

Chia-En Tsai DDS
University of Michigan School of Dentistry, chiaents@umich.edu

James R. Boynton DDS, MS
The University of Michigan School of Dentistry, jboynton@umich.edu

Space Maintenance in the Primary and Mixed Dentitions

By Giovana Anovazzi Medeiros, DDS, MSc, PhD, Chia-En Tsai, DDS, and James R. Boynton, DDS, MS

Abstract

Primary teeth serve many critical functions in the growing child: they allow for proper chewing function for appropriate diet and nutrition, help in speech production and development, promote self-esteem, and importantly, preserve space for eruption of the succedaneous permanent dentition. Premature loss of a primary molar can cause a loss of arch perimeter and negatively impact the normal eruption path of premolars.

Space maintenance is an approach to minimize or prevent untoward consequences after the unavoidable loss of a primary molar. Several types of space maintainers can be used to preserve arch length, including fixed unilateral space maintainers, such as the band and loop, crown and loop, or distal shoe; and fixed bilateral appliances, such as the transpalatal arch, Nance appliance, and lower lingual holding arch.

This guide to space maintenance describes the background, considerations for use, indications for different appliances, and describes steps involved in chairside and laboratory fabrication of common space maintainer appliances.

Dental caries is the most common chronic childhood disease — by 5 years of age, 40% to 60% of children have experienced caries.[1] If decay is left untreated, the child can face many adverse outcomes, such as pain, infection, poor nutrition, sleep difficulties, missed school days, poor self-esteem, and missing teeth.[2] There are several reasons that primary teeth may be extracted, such as caries, orthodontic concerns, trauma, periodontal disease, and over-retention.[3] A retrospective investigation found the principal reason for primary tooth extraction in children ages 3 to 13 was dental caries.[4]

The premature loss of a primary tooth may lead to a loss of arch length, which can produce or increase the severity of malocclusion, including crowding, rotations, ectopic eruption, crossbite, excessive overjet/overbite, and unfavorable molar relationships.[5] When arch integrity is disrupted by early loss of primary teeth, opposing teeth can supraerupt, more distal teeth can drift and tip mesially, and more-forward teeth can drift and tip distally, potentially causing loss of arch length and circumference, blocked or deflected eruption of permanent teeth, poor esthetics, food impaction areas, increased caries and periodontal disease, traumatic interference and untoward jaw relationships, and other negative aspects (Figure 1).[6] Whenever possible, attempts should be made to restore the decayed primary tooth to prevent these negative sequelae.

When early primary tooth loss is unavoidable, corrective measures such as passive space maintenance may be needed to optimize the normal process of occlusal development.[6] There are certain diagnostic criteria that must be considered before determining the need for placement of a space maintainer after premature loss of a primary molar, including the child's oral hygiene, presence or absence of the succedaneous tooth, the amount of bone covering of the permanent tooth, the patient's ability to cooperate, the patient's health status, the patient's age at tooth loss, the spacing in primary dentition, the molar intercuspal relationship, and root development in the succedaneous tooth.[7,8]

The goal of space maintenance is to prevent loss of arch length, width, and perimeter by maintaining the relative position of the existing dentition, although there are a lack of randomized controlled trials that evaluate efficacy of the approach.[5]

The use of space maintainers should be considered to reduce the prevalence and severity of malocclusion following premature loss of primary teeth. When primary incisors are lost prematurely, there is little evidence to support that space maintenance is necessary — there may be a redistribution of space in the anterior, but no net space loss.[9] It is prudent to consider space maintenance in the event of premature loss of a primary molar. Generally, more space is lost from early loss of a primary second molar than a first primary molar; more space is lost when the second primary molar is extracted before eruption of the first permanent molar; and any appliance should be placed within the first few months following tooth loss.[10]

Space maintenance after premature loss of first primary molars: If a primary molar is lost before eruption of the first permanent molar, a space maintainer is generally desirable to stabilize position of the second primary molar and canine, especially during the ages of 5 to 7 years during eruption of the first permanent molar. If the first primary molar is lost after first permanent molars have erupted into occlusion and the second primary molar is in position, minimal space loss is expected.[6]

Space maintenance after premature loss of second primary molars: If a primary second molar is lost before the eruption of the first permanent molar, as much as 8 mm of space loss may occur as the permanent molar erupts into the space, and space maintenance should be considered. If the primary second molar is lost after eruption of the first permanent molar, quadrant space loss of 2-3 mm may be expected, and space maintenance should be considered.[6] Space maintainers can be designed as fixed unilateral, fixed bilateral, or removable.[11]

Fixed unilateral appliances

Unilateral appliances are used to maintain space for a single missing tooth. Unilateral space maintainers comprise of a rigid component spanning the edentulous space and utilize the teeth adjacent to the space as abutments. As long as a fixed unilateral space maintainer is retained and intact, the position of the teeth is stabilized. Therefore, the efficacy of these space maintainers is directly related to their longevity. Multiple fixed unilateral space maintainers can be used on the same patient where tooth loss occurs in different quadrants; however, their use should be limited to single span edentulous areas, as the risk of breakage and failures greatly increases where two adjacent teeth have been lost. Fixed unilateral appliances include the band and loop, crown and loop, and the distal shoe.

Band and loop (lab fabricated or chairside): Band and loop space maintainers can be used in both permanent and primary dentitions when there is loss of a single molar tooth and are frequently used to maintain space for unilateral loss of the primary first molar before or after eruption of the permanent first molar.[9] The band and loop can also be used to provide space maintenance for premature loss of a primary second molar, but requires the permanent first molar to be erupted sufficiently for full seating of the band. The appliance consists of a band that is cemented to the primary or permanent molar. A 0.036-inch round wire is used to make a loop that extends to contact the distal surface of adjacent tooth.[12] It is simple to fabricate (lab-fabricated or chairside) and well-tolerated by patients. The protocol for a lab-fabricated band and loop consists of one appointment for impression with the band seated on the molar, laboratory time for appliance fabrication, and a second appointment to cement the appliance. Alternatively, the prefabricated (chairside) band and

(Continued on Page 48)

Figure 1 — Panoramic radiograph of an 11-year-old patient shows mesial drift of #3 and distal movement of the anterior segment with midline shift. #A was extracted at age 7 without space maintainence.

loop may be used, which can be delivered in the same appointment.

Distal shoe (lab fabricated or chairside): This appliance is used when the second primary molar is lost prematurely and the first permanent molar is unerupted. The distal shoe provides an eruption guide for the first permanent molars, preventing mesial drift during eruption.[9] The first primary molar is banded for attachment of a 0.036- or 0.040-inch round wire that has an intra-alveolar metal blade extension lying just mesial to the unerupted first permanent molar. A periapical radiograph is obtained after try-in before cementation to evaluate the position of the distal shoe blade in relation to the first permanent molar.[12] Delivering the appliance at the time of the extractions can avoid an additional appointment and surgical incision. A model and a periapical radiograph may be sent to the laboratory for distal shoe fabrication before the extraction appointment, or a prefabricated (chairside) distal shoe can be delivered immediately following extraction. Distal shoe space maintainers are challenging to place, require careful management, close follow-up, and swift removal after initial eruption of the first permanent molar; aggressive attempts to maintain the second primary molar (e.g. pulpectomy) before the eruption of the first permanent molar should be strongly considered.[13]

Crown and loop: The crown and loop appliance is an option when the tooth distal to the space is severely damaged, has extensive decay, or has had pulp therapy. The crown and loop involves fitting a stainless steel crown on the abutment tooth and soldering a wire loop directly to the facial and lingual surfaces of the stainless steel crown. The loop should be fabricated wide enough so that the permanent succedaneous tooth can erupt into the space. A helpful characteristic of the crown and loop maintainer is that, if necessary, the loop can be cut off and the crown can continue to provide the necessary restorative needs of the abutment tooth.[9,12] As cementation of a metal band directly onto a stainless steel crown is feasible and reliable, the crown and loop approach may be substituted by placement of a band and loop over a stainless steel crown-restored abutment.

Fixed bilateral appliances

Bilateral appliances are indicated to maintain space when teeth are lost in both quadrants of the same arch or multiple teeth have been lost within a quadrant. Examples of fixed bilateral space maintainers include the Nance appliance and the transpalatal arch (TPA) in the maxilla, and passive lingual arch or lower lingual holding arch in the mandible.[14] The Nance and TPA appliances use a large wire (0.036 inches) to connect the banded primary teeth on both sides of the arch distal to the extraction site.

Transpalatal arch: The transpalatal arch is utilized in the maxilla. It is an appliance that has a 0.036- or 0.040-inch wire that crosses the palate, which is closely contoured to the posterior hard palate, and is soldered to the lingual surfaces of the bands that are to be cemented to the first permanent molars.[9,12] This appliance prevents mesial tipping of the first permanent molar and is typically used after unilateral loss of a second primary molar after eruption of first permanent molars. The remaining second primary molar assists in reducing the tendency of the maxillary first permanent molar to rotate around its palatal root. An omega loop may be incorporated in the transpalatal bar for placing a light distal force, curtailing tipping and/or rotation of the first permanent molars.[12]

Nance appliance: The Nance appliance is used for unilateral or bilateral loss of maxillary second primary molars or multiple molars. This appliance consists of a 0.036- or 0.040-inch wire soldered to the palatal aspect of the first permanent molar bands; the wire is directed from the molars anteriorly and is attached to an acrylic button that rests against the palatal rugae. The advantage of the Nance appliance over the TPA is that additional anchorage is gained from the palatal rugae, which helps to resist mesial movement of the terminal molars. This appliance should be monitored frequently, since it can cause soft tissue irritation due to food impaction under the acrylic button.[9,12,15]

Lower lingual holding arch: The lower lingual holding arch is used in the mandibular arch in the mixed dentition phase for unilateral or bilateral loss of multiple primary molars. It consists of a 0.036- inch or 0.040-inch wire that has been soldered to the lingual surfaces of the bands previously placed and fitted on the permanent mandibular first molars, extending to contact the lingual surfaces of all the mandibular permanent incisors.[9,12] The mandibular first permanent molars and the mandibular permanent incisors must have erupted to use the lower lingual holding arch. If this appliance is placed before the eruption of the permanent incisors, it may interfere with normal mandibular permanent incisor eruption and displace erupting teeth lingually to the wire. In some clinical cases, multiple band and loop appliances may be indicated until the permanent molars and incisors erupt, when a lower lingual holding arch replacement can be considered.

Other approaches

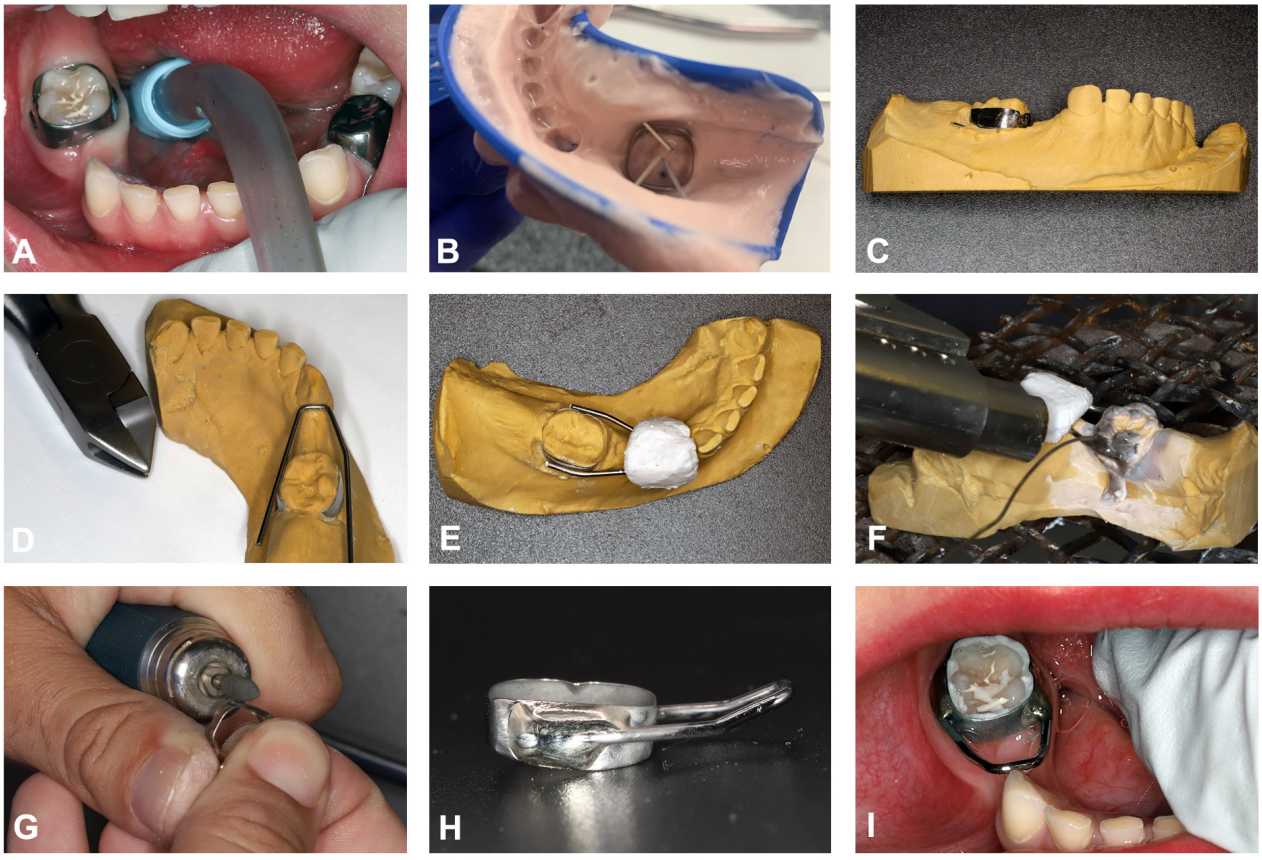
Other approaches for space maintenance may be considered and include removable unilateral and bilateral appliances and direct bonded techniques.

Removable unilateral and bilateral appliances: Removable unilateral appliances present swallowing and choking hazards for children due to their small size, and they are rarely used because of this risk.[15] Removable bilateral appliances are typically used when more than one tooth has been lost in a quadrant. This appliance may include wire stops mesial and distal to the edentulous space. These are the most common partial dentures but can include orthodontic appliances such as a Hawley retainer. Their success is limited by patient compliance and complicated by loss of the appliance and exfoliation and/or eruption of teeth. Periods of poor compliance can lead to an ill-fitting appliance and loss of space. Some children may be compliant in wearing the appliance but not in cleaning the appliance or underlying tissue, potentially resulting in decay, tissue irritation and hyperplasia.[9]

Direct bonded techniques: Direct bonded techniques are indicated when the abutment teeth are non-carious or only minimally restored. These can be used when there are teeth present on either side of the space to bond to and should be placed under rubber dam isolation for better retention. Direct bond spaces maintainers are easily prepared at chairside without the need for laboratory work, but present with a concerningly high failure rate.[14,16]

(Continued on Page 50)

Figure 2 — Lab-fabricated band and loop (in office)



A) Band try-in on distal abutment. B) Band secured in the impression with light wires. C) Trim cast and remove excess materials to exposed the cervical margin of the band. D) Adapt wire with 0.032" standard round wire. E) Secure wire to the cast with plaster. F) Solder round wire to the band. G) The outer surfaces is are polished with green polishing bur H) Buccal view of band and loop. I) Band and loop cemented to the abutment tooth.

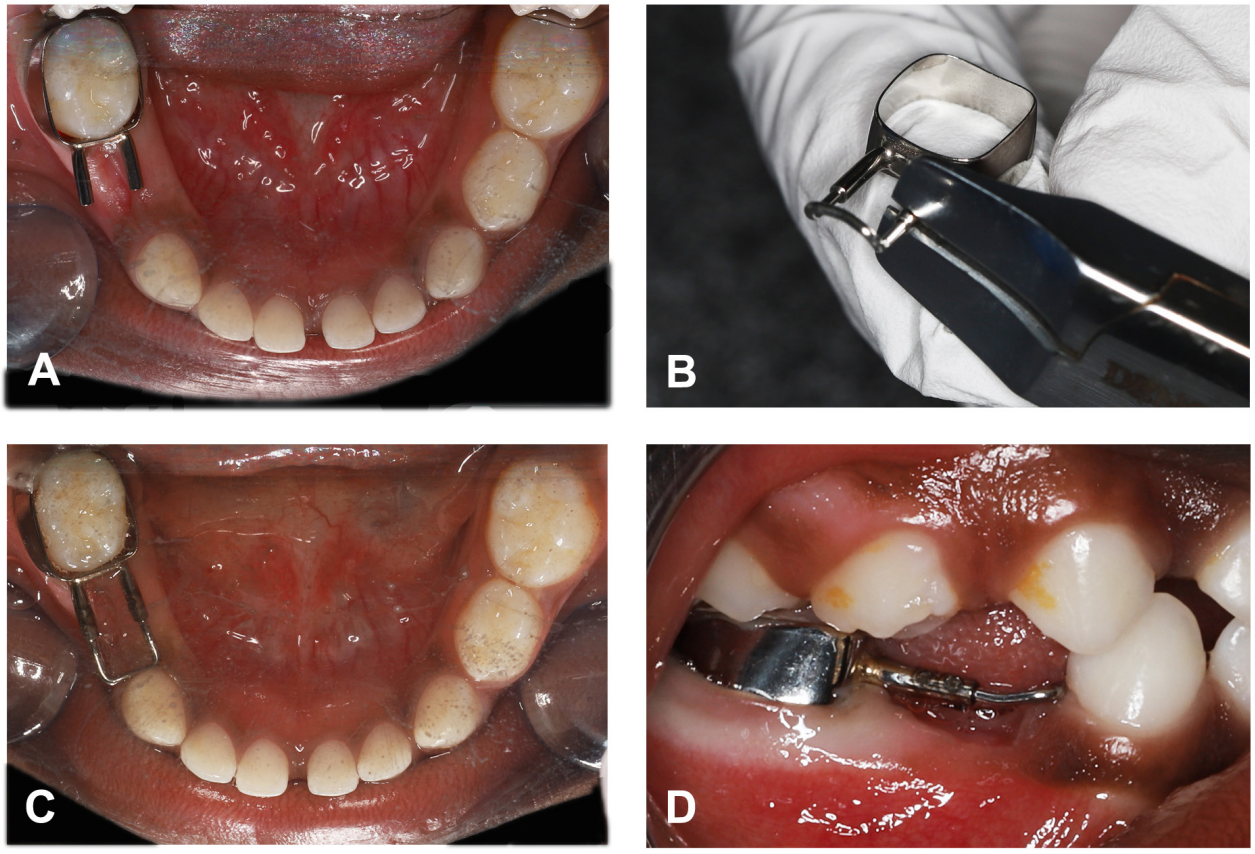
Band and loop clinical steps

Unilateral space maintainers could be fabricated in multiple ways. They could be made chairside (e.g., DeNovo immediate-placement band and loop), fabricated in the lab by the clinician in-office, or sent to an outside lab technician. Clinical steps of lab-fabricated band and loop and DeNovo band and loop are listed as below.

Lab fabricated band and loop (in office):

- Band try-in on distal abutment (Figure 2A, see Page 49).
- Take an impression with alginate impression material (the impression could be taken with a full arch tray or a quadrant tray).
- Remove the band from the patient's mouth and place it on the impression. The occlusal side of the band would be facing toward the impression material. A small amount of wax could be placed inside the band next to the future soldering site to aid soldering. Less heat is needed if less stone material is next to the soldering site and can reduce risk of overheating.
- After securing the band in the impression with staples (Figure 2B, see Page 49), light wire, straight pins, or sticky wax, pour the cast with dental stone.
- Trim cast and remove excess materials. Stone covering the buccal side of the band should be removed

Figure 3 — Immediate-placement DeNovo space maintainer



A) Band try-in on distal abutment with the DeNovo pre-sized molar bands. B) Crimp tubes to secure the relative location of the wire and the band portion of the space maintainer. C) Occlusal view of DeNovo space maintainer try-in. D) Buccal view of cemented DeNovo space maintainer.

until the cervical margin is exposed (Figure 2C, see Page 49).

■ Adapt wire with standard round wire ranging from 0.030", 0.032" and 0.036." The wire should passively touch the distal of the anterior abutment tooth and the middle of the facial and lingual of the band (Figure 2D, see Page 49). The wire should be closely adapted near the gingiva although not in contact. The bucco-lingual width of the loop should be wide enough to provide adequate room for tooth eruption in the event the appliance is not removed prior to eruption. The distal extension of the wire should be at the distal line angles of the band.

■ Secure wire to the cast with plaster (Figure 2E, see Page 49). If wax was used in step 3, remove wax from the inner side of the band. If wax was not used, stone from the inner side of the band adjacent to the soldering site could be partially removed to prevent overheating if desired.

■ Apply flux in the area to be soldered and dip solder into flux. The blue flame (or reducing flame) is used to heat the metal. The solder will then flow to the hottest part which coats the joint between the wire and the band (Figure 2F, see Page 49).

■ Band and loop is removed from the cast. After gross reduction to blend the sharp ends, the inner surface of the band is sandblasted and the outer surfaces are polished with white, brown and green polishing burs (Figure 2G, see Page 49). Rag wheels can also be used for final polishing.

■ Check clinical adaptation and cement the band and loop on the abutment tooth with glass ionomer or resin-modified glass ionomer cement (Figure 2I, see Page 49).

Lab-fabricated band and loop. Either a stone model or digital impression can be sent to a dental laboratory for fabrication of a band and loop space maintainer.

Stone model for delivery to lab:

■ Band try-in on distal abutment.

■ Many labs prefer the preformed band not be poured up on the model; inquire with the fabricating lab as to their preference. Attach the band to the prescription slip after fitting if not pouring up the impression with the band in position.

■ Take an impression with alginate impression material (impression could be taken with a full arch tray or a quadrant tray). If attaching the band to the prescription slip, take the impression without the band in place. An accurate cast is necessary and teeth to be banded must be fully exposed for proper fit.

■ After casting, send cast with band to lab to complete fabrication.

Intraoral scan for delivery to lab:

■ Band try-in on distal abutment.

■ Scan quadrant with oral scanner. Scan could be completed with or without band on the abutment tooth depending on the lab that the clinician is working with.

■ Send the oral scan to the lab. While some labs have bands in the lab and only require the scan, some may prefer that the band be mailed to the lab for appliance fabrication.

Immediate-placement band and loop. DeNovo (DeNovo Dental, Baldwin Park, Calif.) has developed a chairside approach to fit and deliver unilateral space maintenance without laboratory fabrication. DeNovo bands come with pre-soldered tubes into which DeNovo wire loops can be placed and adjusted to fit the length of the space. Immediate-placement space maintainers have the advantage of reduced chair time, but adaptation of the loop for optimal outcomes is necessary. Steps for placement of an immediate-placement DeNovo space maintainer are described below:

■ Band try-in on distal abutment with the DeNovo pre-sized molar bands (Figure 3A).

■ Insert wire into tubing and size the gap of the edentulous space. DeNovo wire loops are often too long for primary molar spaces and can be cut with a DeNovo wire cutter or trimmed with a high-speed carbide bur to allow for appropriate fit.

■ Once ideal length is achieved, crimp the buccal tube with tube crimping plier before removing the band and loop from the oral cavity.

■ Crimp both tubes to secure the wire and the band portion of the space maintainer (Figure 3B). Spot solder could also be used to provide further rigidity.

■ Final adjustments with pliers should be made to ensure optimal fit and adaptation along the gingival ridge.

■ Cement the DeNovo space maintainer on the abutment tooth with glass ionomer or resin-modified glass ionomer cement (Figure 3C-D).

Bilateral appliance clinical steps

Though bilateral space maintainers such as Nance appliance and lower lingual holding arch do not have a premade chairside fabrication option such as the DeNovo band and loop, they can be made in the lab in a similar manner as unilateral space maintainers. A passive fit is critical to prevent unintended tooth movement. Clinical steps of lab fabricated lower lingual holding arch are listed as below.

Lab fabricated lower lingual holding arch (in office):

■ Band try-in on bilateral distal abutments (Figure 4A, see Page 52).

■ Take an impression with alginate impression material with a full arch tray.

■ Remove the bands from the patient's mouth and place them on the impression. The occlusal side of the bands would be facing toward the impression material. Wax could be placed inside the bands next to the future soldering site to aid in soldering.

■ After securing the bands with staples, light wire, straight pins, or sticky wax, pour the cast with dental stone.

■ Trim cast and remove excess

(Continued on Page 52)

Space Maintenance

(Continued from Page 51)

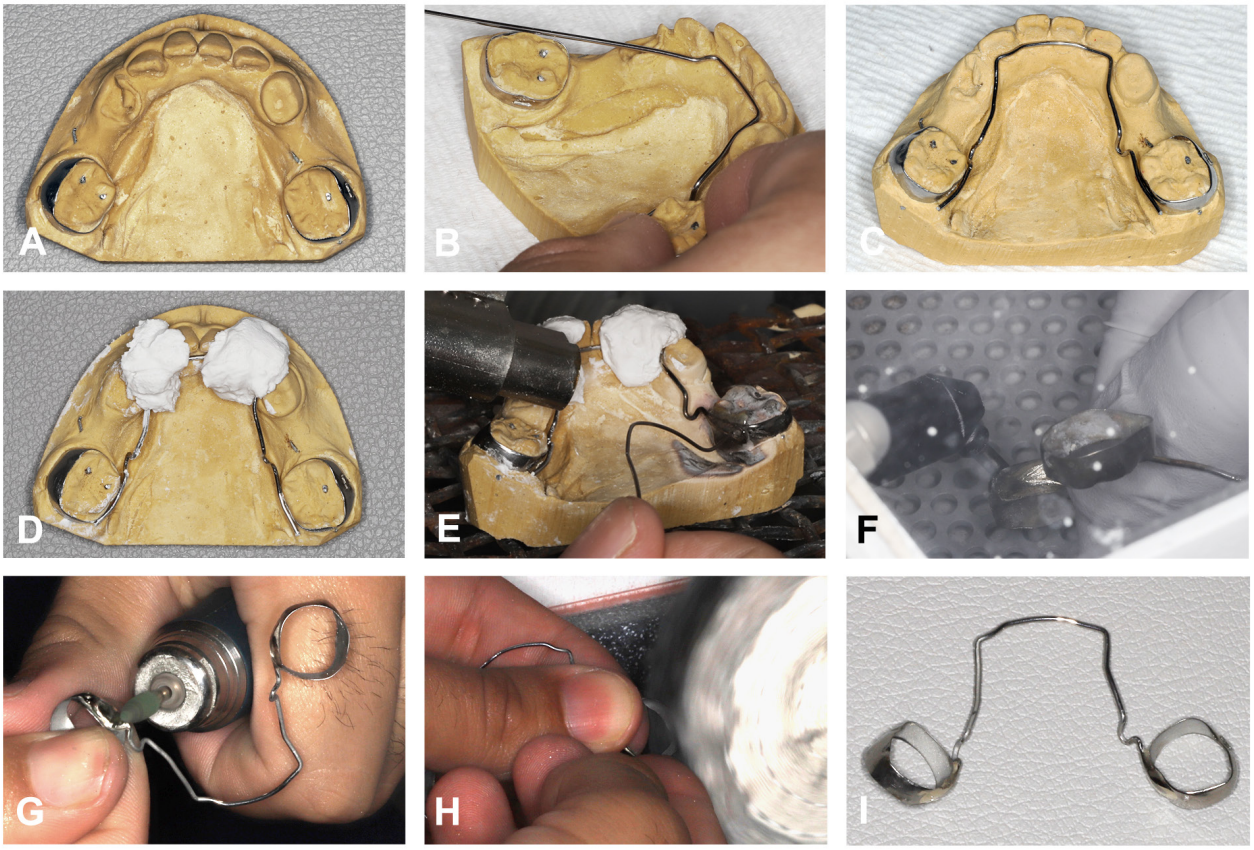
material. Stone covering the buccal side of the bands should be removed until the cervical margin is exposed.

■ Bend wire with standard round wire (size selection: 0.030", 0.032" or 0.036") (Figure 4B). The wire should passively touch the lingual aspect of the four mandibular incisors and the middle of the lingual aspect of the bands (Figure 4C). The wire should be as close to the soft tissue as possible without making contact, and include an upward U-shape bend on each side. A bend toward the midline in the canine area is usually needed to provide adequate room for permanent canine eruption. The distal extension of the wire should be at the distal line angles of the molar band.

■ Secure wire to the cast with plaster (Figure 4D). If wax was used, remove wax from the inner side of the bands. If wax was not used, stone from the inner side of the bands adjacent to the soldering sites could be partially removed to prevent overheating if desired.

■ Apply flux in the area to be soldered and dip solder into flux. The blue flame (or reducing flame) is used to heat the metal. The solder will then flow to the hottest part which coats the joint between the wire and the band (Figure 4E).

Figure 4 — Lab-fabricated lower lingual holding arch (in office)



A) Model poured with bands after alginate impression with bands stabilized as in Figure 2-C. B) 0.032" standard round wire adapted to cingulum of mandibular incisors. C) The wire passively touches the lingual aspect of the four mandibular incisors and the middle of the lingual aspect of the bands. D) Secure wire to the cast with plaster. E) Solder wire to the bands. F) Sandblast the inner surfaces of the band to enhance cementation. G) The outer surfaces are polished. H) A final polish is completed with rag wheel. I) Occlusal view of completed lower lingual holding arch.

■ Lower lingual holding arch is removed from the cast. After gross reduction to blend the sharp ends, the inner surfaces of the band are sandblasted (Figure 4F) and the outer surfaces are polished with white, brown and green polishing bur (Figure 4G). A rag wheel can also be used for final polishing (Figure 4H).

Lab-fabricated lower lingual holding arch. Either a stone model or digital impression can be sent to a dental laboratory for fabrication of a bilateral space maintainer.

Option 1 — Send poured up cast to dental laboratory:

■ Band try-in on bilateral distal abutment.

■ Take an impression with alginate impression material with a full arch tray.

■ Remove the bands from the patient's mouth and place them on the impression. The occlusal side of the band would be facing toward the impression material. After securing the bands with staples, light wire, or straight pins, pour the cast with dental stones. Alternatively, remove bands after fitting and prior to impression if the lab prefers to have bands not poured on model.

■ Send the cast with bands poured into the model, or bands and impression separately, to the lab to complete fabrication.

Option 2 — Intraoral scan:

■ Band try-in on bilateral distal abutment.

■ Scan with oral scanner with bands fitted on the tooth (Figure 5A). Scan could be completed with or without band on the abutment tooth depending on the lab that the clinician is working with.

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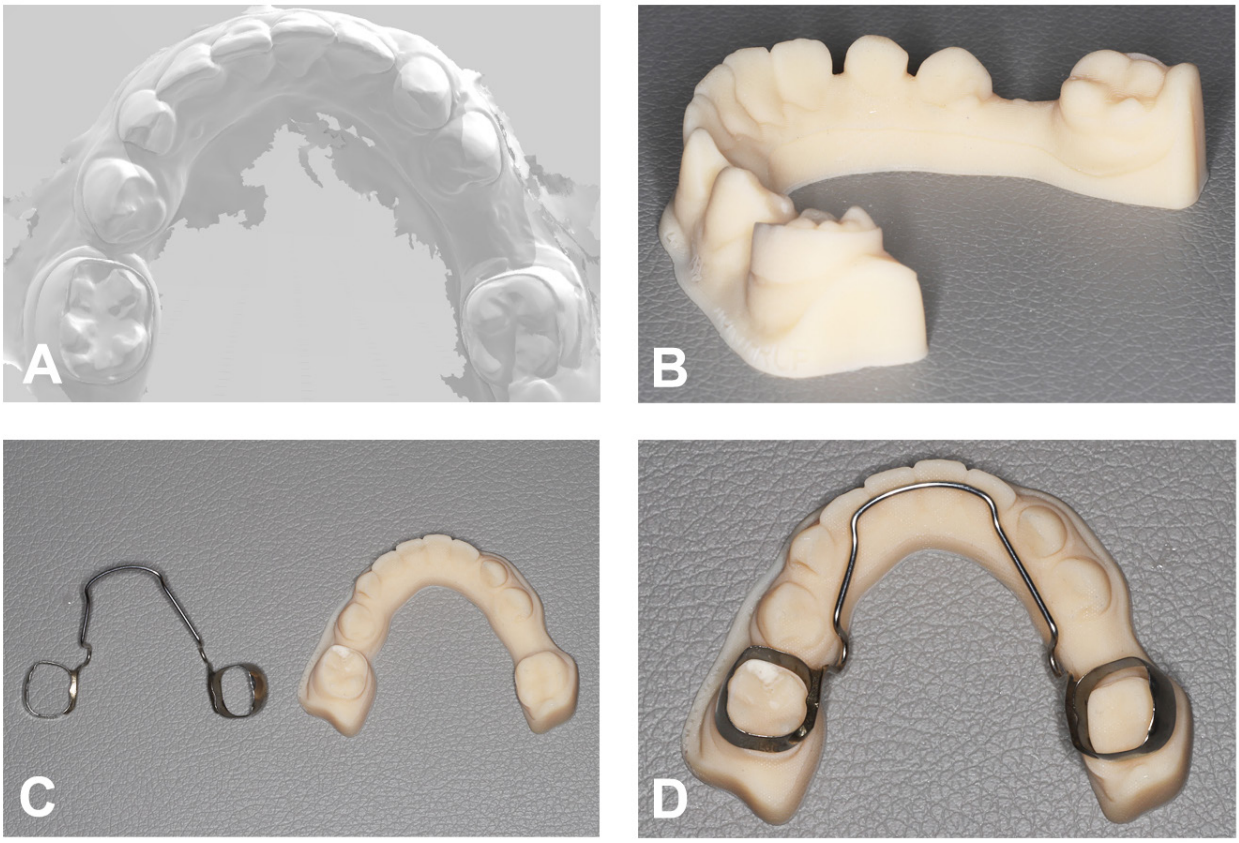
Figure 5 — Lab-fabricated lower lingual holding arch (outsource lab technician with intraoral scan)



A) Oral scan with bands fitted on the distal abutment teeth. B) 3D printed dental model from oral scan. C) Occlusal view of lower lingual holding arch (left) and printed dental model (right). D) Lower lingual holding arch placed on top of the printed cast to show adaptation of wire and passive fit.

Space Maintenance

(Continued from Page 53)

■ Send the oral scan to the lab. While some labs have bands in the lab and only require the scan, some may require the bands to be mailed to the lab. The lab will print the model (Figure 5B, see Page 53) and fabricate the lower lingual holding arch space maintainer (Figure 5C-D, see Page 53).

Conclusion

Primary teeth serve many important functions; space maintenance is primary among them. When loss of arch perimeter is a concern with early loss of a primary tooth, all attempts to maintain the primary tooth should be prioritized. In instances when premature loss in unavoidable, consideration of space maintenance can be important to prevent adverse tooth movement and maintain the position of adjacent teeth. Consideration of the specific tooth lost, time elapsed since tooth loss, present occlusion and space assessment, root development of and amount of alveolar bone covering permanent successor, and the child's health history, oral habits, oral hygiene, and cooperative ability are all important. In instances when space maintaince is indicated, ongoing follow-up and assessment are necessary for optimal outcome. ●

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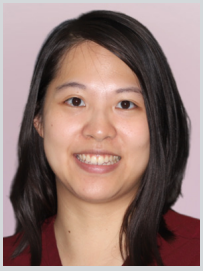
About the Authors

Medeiros



Tsai

Giovana Anovazzi Medeiros, DDS, MSc, PhD, is a clinical assistant professor of dentistry at the University of Michigan School of Dentistry in Ann Arbor. She is dual-trained in pediatric dentistry and periodontics, and has experience in dental research. She is involved in the education of pre-doctoral and graduate students at School of Dentistry.

Chia-En Tsai, DDS, is a current third-year pediatric dentistry resident at the University of Michigan School of Dentistry. She completed her dental school and GPR training in Taiwan. She is enthusiastic about dental prevention for children and enjoys exploring the differences and similarities between the East and the West.

Boynton

James Boynton, DDS, MS, is a clinical professor of dentistry, Pediatric Dentistry Division head, and director of the Pediatric Dentistry Residency Program at the University of Michigan School of Dentistry. He is involved in clinical care and education at the School of Dentistry at Mott Children's Hospital, and maintains an active private practice in Ann Arbor.