The Proposed Use of an Anatomically Marked Presurgically Fitted Prostheses With Infants Who Have Unrepaired Cleft Palates

Amy Moser

Utah State University

The Proposed Use of an Anatomically Marked Presurgically Fitted Prostheses with Infants who have Unrepaired Cleft Palates

Amy Moser

Communicative Disorders
Undergraduate

THE PROPOSED USE OF AN
ANATOMICALLY MARKED PRESURGICALLY FITTED PROSTHESES
WITH INFANTS WHO HAVE UNREPAIRED CLEFT PALATES

Statement of the Problem

Approximately one out of every 750 children are born with some type of an oral cleft (McWilliams, Morris, & Shelton, 1984) Children with clefts of the palate in general have a higher incidence of articulation disorders than do children without clefts. Typical speech problems which tend to occur are hypernasality and multiple articulation errors, often consisting of atypical tongue placement in the mouth or nontypical articulation at sites in the larynx or pharynx. These speech problems can be severe and may require years of expensive, long-term professional treatment to remediate.

It is generally agreed upon that early and complete closure of a cleft palate is associated with better speech results for children than is a later repair. However, it is also agreed upon that the goals of a two-stage repair i.e. repairing the soft palate prior to restoring the hard palate, are noteworthy. These goals are to provide an intact soft palate and a normally functioning velopharyngeal mechanism so speech development can proceed as early as developmentally possible without interrupting facial growth (Gilbert, 1987).

A two-stage surgical management approach can lead to a

second source of speech problems, however. Unless the remaining hard palate cleft is covered with a prosthesis, air loss through the open cleft can result in inadequate oral air pressure being available for correct speech production. Use of a prosthesis acts as a barrier between the oral and nasal cavities to prevent this air loss.

Even when children with clefts of the palate are fitted with palatal prostheses, many continue to show abnormal articulation development. This is primarily due to residual problems with velopharyngeal port closure and/or to other factors present in the hard palate and alveolar ridge areas. One of these possible factors may be that the open hard palate cleft may lack adequate proprioceptive feedback in the area of the open cleft during the time speech is developing. A second possible factor may be that inadequate feedback for the tongue is present due to the smooth, hard prosthesis that covers the open hard palate cleft. The presurgically placed smooth prosthesis typically provides limited anatomical reference points for the tongue as speech sounds are developing.

Therefore, it would be plausible to hypothesize that a less smooth, more natural feeling oral surface on a presurgically fitted prosthesis could stimulate improved speech development in children who have palatal clefts. The purpose of this thesis is to hypothesize how a child's articulation development could benefit if the child were

fitted with a more geographically marked prosthesis from the time of initial fitting in infancy until surgical closure of the hard palate.

Review of Related Literature

When a disruption in facial development occurs during the first trimester of pregnancy, a cleft of the lip and/or of the hard and/or soft palates may result. The traditional method of surgical repair of the palates for these children involves the complete closure of the hard and/or soft palates by age 6-18 months. However, this approach to palatal closure commonly results in severe orthodontic problems, particularly a collapsed maxillary arch on one or both sides of the palate. These resulting dental problems prompted Hermann Schweckendiek to begin performing a two-stage surgical closure of the palates in 1944 (Schweckendiek, 1978).

Herfert (1953, 1958, as cited in Schweckendiek, 1978) proved, by animal experimentation, that early operations on the hard palate nearly always inhibit the growth of the upper jaw in animals. To alleviate this problem, the two-stage repair was developed to close the soft palate only between 6-18 months. The remaining hard palate cleft is then left open for an extended period; the earliest hard palate closure is done at approximately age four or as late as age 14 when maxillary growth is essentially complete. Until

that time, a smooth, acrylic prosthesis is typically placed in the mouth over the open hard palate cleft (McWilliams, Morris, & Shelton, 1984). This prosthetic treatment allows speech to continue to develop more normally in spite of the underlying open hard palate (Schweckendiek, 1978). Schweckendiek (1978) stated that by using his two-stage repair, the cleft will become narrower with growth of the palate by 60-70%; the length of the maxilla, width of the palatine arch, and the base of the skull will be nearly the same as in adults without clefts; and that only 5-10% of the patients will require velophrayngoplasty to correct a short or immobile velum (Schweckendiek, 1978).

Nonetheless, a consensus has not yet been achieved concerning this treatment approach. In a cautionary report, Cosman and Falk (1980) concluded that a majority of their cases who received two-stage repairs failed to develop acceptable speech spontaneously. Further, the researchers found error patterns concerning anterior articulation that were related to anterior palatal defects. Children who have received two-stage repairs appear to be at a greater risk for articulation and phonological skills delay than are those who receive more traditional one-stage palatal surgery (Rasmussen, 1991).

McWilliams, Morris, and Shelton (1984) suggested that if the misarticulations in cleft palate speech were associated primarily with the anatomical defects in cleft

palate speakers, the articulation disorder should be phonetic in nature, which is usually the case. Cleft palate speakers' speech productions tend to maintain manner of production over place of production.

In Cosman and Falk's study (1980), 32 subjects having complete secondary palatal clefts were operated on between 1964-1974. Two surgeons performed the majority of the operations to reduce variability. Without any speech therapy intervention or placement of a prosthesis, "spontaneous" speech development was assessed prior to considering closure of the hard palate. The researchers found that the majority of the children in their study had difficulty producing pressure consonants produced near the cleft site. In an effort to compensate for their anatomical inadequacy, most of the children sacrificed "place" of articulation and preserved the "manner" of articulation. For example, the posterior unvoiced stop [k] was typically substituted for the anterior unvoiced stop [t]. Likewise, the [d] was replaced by a [g]. Only 34% of the subjects were considered to have acceptable speech by age five (Cosman & Falk, 1980).

However, this study also supported the hypothesis that wearing a prosthesis does in fact have a positive effect on speech development. A prosthesis was used by 12 of the patients in Cosman and Falk's (1980) study, but not until they were, on the average, 6.5 years of age. Cosman and

Falk concluded that the "insertion of [an] appliance, if carried out very early, might obviate [the] criticism of [the two-stage repair] technique." Further, the authors referred to the late use of the prosthesis as a salvage method that "permitted the development of acceptable speech in a reasonable number of patients" (Cosman & Falk, 1980).

In a report by Trost (1981) similar findings were noted. By implementing the use of cineradiographic and videofluoroscopic diagnostic procedures with patients who had clefts, it was determined that cleft palate speakers in Trost's study showed a consistent tendency for lingually placed targets to be shifted posteriorly (Powers, 1962; Brooks, et al., 1965, 1966: Lawrence and Philips, 1975, as cited in Trost, 1981).

Additionally, Chapman (1991) compared the vocalizations in unrepaired cleft palate infants to normal infants ranging from 12 to 14 months of age. Differences in the consonant inventories of the subjects were noted. The most frequently appearing sound in the noncleft infants' productions was the alveolar stop [d] (55% occurrence), with [h] occurring 8% of the time. On the other hand, the children with cleft palates most frequently used the glottal fricative [h] (38% occurrence). The [d] was not in the phonetic inventory of any of the cleft toddlers studied. Whether or not a presurgical prosthesis was used with any of the subjects was not specified in the study.

Moll (1968, as cited in McWilliams, Morris, & Shelton, 1984) conducted a thorough review of the pertinent literature available in 1968 and concluded that cleft palate subjects tend to defectively produce sounds which involve lingual contacts. He also concluded that place of articulation is less important to cleft palate speakers than is manner of production.

Further, Bardach et al (1984, as cited in McWilliams, Morris, & Shelton, 1984) directed a study to determine the prevalence of glottal stops and pharyngeal fricatives in cleft palate speakers that had had both types of palatal repair but had not had a prosthesis fitted. The first group of subjects had single-stage palatoplasty at about age 2. The researchers found that glottal stops and pharyngeal fricatives were used very seldom by these subjects. However, in the second group, which had primary veloplasty with hard palate surgery at about age 13, the above errors were used frequently.

The act of speaking requires a vast amount of neuromuscular integration. Some research has been done to indicate the probable role of oral touch receptors in integrating the information needed for learning movements used in speaking. Boyd (1940-41, as cited in McCall, 1968) theorized that it is possible that the superficial sensations from the oral area do have a specific role in the proprioceptive functioning of the tongue.

In normal speakers, the alveolar ridge and other oral landmarks serve as production sites for the anterior lingual sounds. Because the prosthesis used to cover a hard palate cleft is typically made with a smooth surface which has limited anatomical landmarks, it may be difficult for the cleft palate child who is developing speech to locate a discrete place of articulation in the hard palate area, even through direct intervention via speech therapy. If the oral surface of the prosthesis were made with a more natural feeling surface containing lingually identifiable anatomical markings, an improved, more efficient evolution of these anterior sounds might occur in these speakers.

Little research has been done to date concerning the construction of such a prosthesis.

It is hypothesized that placement of an anatomically marked prosthesis in the mouth of infants who have open clefts of the palates would also benefit their neural development. Neural connections in humans are established through maturation. Neural patterns developed during infancy are thought to be more difficult to alter than are those established later through learning. This concept may help account for some of the difficulty speech-language pathologists have when teaching correct phoneme productions to a speaker who has a cleft palate history.

Conclusion

It appears that it would be beneficial for an

anatomically marked prosthesis to be fitted shortly after birth in the mouth of an infant who has an open cleft of the palate(s), in order to aid the infant's first attempts at babbling and experimenting with his/her oral structures. It is hypothesized that utilization of such a prosthesis would lead to better articulation development in children with hard palate clefts.

Purpose and Objectives

The general purpose of this study is to hypothesize about whether the speech development of children with complete clefts of the hard and soft palates would benefit from the fitting of a more anatomically correct presurgical prosthesis from the time of initial fitting soon after birth until the final surgical closure of the hard palate.

Objectives

The three objective of this study are:

1. To summarize the areas of the palate which past research has shown provide anatomical reference sites for the tongue during speech development.

2. To propose oral surface alterations to the standard presurgical palatal prosthesis which could provide heightened feedback to the infant's tongue during speech development.

3. To summarize the feasibility of making such an anatomically marked prosthesis for a cleft infant.

Procedures

Design

Before gaining the cooperation of an orthodontist on Utah's Craniofacial Team in Salt Lake City, Utah, further research will be done to specify which areas of the palate could better contribute to speech development if more extensively represented on the oral surface of a prosthesis. Tongue sensitivity literature will be studied further in order to determine the probable minimal size of such a landmark needed for identification by specified regions of the tongue. Upon completion of this review, the researcher will discuss the possibilities and ramifications of such a design with an orthodontist who specializes in presurgical orthodontic treatment with infants who have cleft palates.

Identification of Studies

Articles and information which are to be included in the proposed review of the literature will meet the following criteria:

1. English written literature will be extracted from a manual search of indexes and abstracts. These will have been published prior to 1992.

2. Other English written literature published prior to 1992 will also be obtained through a manual search of the bibliographies of the journal articles, by completing a computer search of Med-line beginning at 1960, and by manually searching the table of contents of dental texts.

3. Subjects used in each primary report measuring tongue acuity must have normal motor skills reported. If the subjects have any physical handicap reported, the study will not be included in the review. An exception to this criteria would be if the article dealt specifically with tongue acuity in subjects with complete clefts of the hard and soft palate.

4. Personal communication with an orthodontist may also be done to gain information about probable present day costs for making such a prosthesis and the overall feasibility of such a project.

Reports will be identified by searching a variety of literature sources. These will include but not be limited to a computer search of Med-line (1988 through 1992) and a manual search of the Index Medicus references. The words used in searching these sources will include: <u>assistive devices</u>, <u>dental technicians</u>, <u>orthodontic technicians</u>, <u>orthodontics</u>, <u>laboratory technology</u>, <u>dentistry</u>, <u>acrylic-resins</u>, <u>dental-impression technique</u>, <u>orthodontic appliance design</u>, <u>proprioception</u>, <u>palate physiology</u>, <u>tongue physiopathology</u>, <u>tongue acuity</u>, <u>tactual perception</u>,

kinesthetic perception, and sensations perception.

Other sources that will be manually searched will include the table of contents of the Journal of Speech and Hearing Research (1971-1992), the Journal of Speech and Hearing Disorders (1971-1992), the Cleft Palate Journal (1971-1992), the British Journal of Orthodontics (1971-1992), the Journal of Dental Research (1971-1992), Journal of Neurophysiology (1971-1992), Journal of Oral Maxillofacial Surgery (1971-1992), Physiology and Behavior (1971-1992), and the American Journal of Anatomy (1971-1992). References at the end of located articles will be searched for additional relevant reports. Articles will be obtained through the Merrill Library at Utah State University and through the library at the University of Utah.

Data collection

In order to analyze the information obtained through a search of the literature, a coding instrument will be developed. A Tentative Coding Instrument has been developed with the intent to extract the same information from each article and so that more accurate conclusions may be made. The coding instrument for lingual perception will include the following categories: (a) author (s) and year published, (b) subject variables which would include whether the subjects were normal or cleft palate, age, and number of

subjects, (c) dependent variables which would include the unit of measure applied for measuring tongue proprioception, etc. (d) results from the data, and (e) the author's conclusions (See Appendix A).

The coding instrument for analyzing prosthesis design and construction will include the following categories: (a) author (s) and year published, (b) subject variables, including age and number of subjects, (c) procedures, including the materials used for making a presurgical prosthesis (impression material and acrylic used), time required, and the ease or difficulty of alterations, (d) cost, (e) results, and (f) conclusions (See Appendix B).

Data Analysis

Analysis of the data summarized in the coding instruments will then be summarized in the results section in narrative form. Each of the indicators will be discussed in turn in the final report. Finally, the researcher will correlate the information and summarize the information by proposing a surface design for an anatomically marked presurgical prosthesis.

Results

Palatal Reference Sites for the Tongue

The boney hard palate is covered by a gland-filled mucous membrane. The anterior portion of the hard palate hosts several prominent ridges, called rugae, that extend across the anterior and lateral margins of the hard palate. The remaining hard palate is virtually smooth, except for a sometimes narrow ridge which runs anteriorly and posteriorly along the hard and soft palates midlines.

The majority of the speech sounds of English are articulated at the anterior section of the hard palate. Articulation can occur at the central or the lateral margins of the palatal rugae. It is in this area of the palate that many lingua-alveolar sounds are produced (Bateman & Mason, 1984). Examples of lingua-alveolar sounds made at the premaxilla or central ridges include /t/, /d/, /n/, and /l/. Those sounds that are articulated near the lateral margins of the dental ridges include the phonemes /s/ and /z/. The phonemes /t / and /d / are made in a similar manner with the blade and body of the tongue being in contact with the hard palate, often including the alveolar ridge (Creaghead, Newman, & Secord, 1989).

Other sites of articulation include the smooth areas of the hard and soft palates. An example of a lingua-palatal phoneme is the phoneme /j/. This sound is produced with the front of the tongue raised and in contact with the smooth

hard palate. The /j/ sound is produced as the tongue glides toward the following vowel in the word (Creaghead, Newman, & Secord, 1989). The phonemes /k/ and /g/ are examples of phonemes articulated when the tongue and velum are in contact.

It appears that the palatal ridges, or rugae, provide the most anatomical reference sites for the tongue when articulating speech. The lingua-alveolar phonemes /t/, /d/, and /n/, which are produced at these cites, are among the earliest developing sounds in normal children (Saunder, 1972, as cited in Creaghead, Newman, & Secord, 1989)

Tongue Sensitivity

Only limited literature was found which addressed the surface sensitivity of the tongue and palate. One such study, by McCall (1968), presented a summary of several two-point discrimination tests that were given to measure the sensitivity of the tongue. These test results have some direct implications for the construction of an anatomically marked prosthesis.

In one such test, the amount of grove depth needed for normal subjects to discern a "different" from a "smooth" surface was assessed. Tactile acuity of the tongue was generally defined as the ability to determine minimal changes in tactile stimulation. To measure this ability, McCall made several plates engraved with a grove that was an

inch long and 0.004 in. wide, with varying grove depths (ranging from 0.5 mil to 5 mils) on an otherwise smooth surface. These plates were then passed in a vertical direction over the tongue tip of his subjects, who were nine and eleven-year-old children, junior high school students, and adults. Results of this experiment indicated that in normal nine and eleven-year-old children, junior high school students, and adults, the average grove depth required for the tongue to identify a change in tactile stimulation was 1.5 mils.

McCall (1968) also described a test of two-point discrimination. Using the same steps to achieve minimal change, the smallest difference in distance required before two points could be distinctly perceived by the tongue was measured. This test could be directed to the tongue-tip as well as to the lateral margins of the tongue. The age of the subjects that participated in this test was not specified. Results of this type of testing indicated that the tongue tip is able to perceive smaller areas of contrast than are the lateral margins of the tongue. The normal two-point values for the tongue tip is between 1 and 2 mm.

A test of tactile localization (Knight, 1966; McCall & Langhart, 1966; as cited in McCall, 1968) was also described. This test refers to spatial localization of the tongue and is measured by stimulating six areas on the tongue 10 times and in random order. Normal teenagers and

young adults matched the area of the tongue stimulated with a diagram of the tongue. Results of this test indicated that normal teenagers and young adults were able to localize the correct sector of the tongue that was stimulated 80% of the time. Frequently, when in error, the subjects mistook a posterior stimuli for one that was anterior.

As a cautionary note, tactile discrimination of the tongue may differ for babies as compared to the results reported by McCall, who used grade school children, teenagers, and young adults as subjects.

Several authors have mentioned that palatal clefts left untreated are a major contributor to the learned malpositioning of the tongue in many speakers who have clefts.

Stellmach (1963) indicated that gaps in the anterior part of the dental arch also contribute to the malpositioning of the tongue for speech purposes. Stellmach reported that such malpositioning of the tongue makes the lingual phonemes more difficult to produce. Importantly, Stellmach concluded that these errors appear when speech first begins to develop in children who have cleft palates, and he argued that a prosthesis would be beneficial to speech development in these cases (Stellmach, 1963).

Motor development necessary for speech production is a gradual process that occurs during childhood. The amount of skeletal growth and neural maturation that occurs during the

first two years of life will directly affect the cohesiveness of the motor, sensory, and auditory systems used in speech production (Robbins & Klee, 1987).

Robbins and Klee (1987) conducted a study in order to assess the oropharyngeal and motor development of normally developing children between the ages of 2:6 and 6:11, thereby providing the first norms for such abilities at the younger ages. Results of their speech and nonspeech tasks indicated that very little structural change of the vocal tract occurs in children after the age of 2:6. The majority of change in the vocal tract structures occurs during the first year of life. In contrast, functional motor abilities do appear to change significantly with age, indicating that with each year, children gain speech and motor abilities that more closely approximate that of the adult's speech and motor skills (Robbins & Klee, 1987). These results support the need for presurgical prostheses. Speech and motor skills that emerge during the first two years of life are refined for the next six to ten years(Robbins & Klee, 1987). This emergent and refining process should be more achievable if children have the physical structures and feedback system necessary to achieve normal speech development from a very early age.

Construction of Presurgical Prosthesis'

Presurgical orthodontic treatment for children who have

clefts typically begins as soon after birth as possible and continues until the hard palate cleft is adequately narrowed as a result of the prosthesis and the growth of the palate (Treinite, Weil, & Roos, 1990). Serving as a guide for the maxillary segments to follow, the prosthesis is held in place by the gumming and sucking force of the infant and surface tension (Brauer & Cronin, 1963).

In addition to improving dental alignment, a presurgically fitted palatal prosthesis' appears to benefit speech development. The benefits of this procedure are especially important for the speech-language pathologist to consider. Morris (1990, as cited in Johns, 1991) has postulated that once infants who have cleft palates adopt a compensatory pattern for producing speech sounds, these patterns tend to continue, even after the anatomical deficiency created by the cleft is corrected. It has been mentioned in virtually every literature article reported in this paper that a prosthesis stimulates proper oral tongue positioning, which in turn will prevent many articulation difficulties from developing in the child with a cleft. This area will be discussed in further detail later.

One of the primary reasons that early presurgical orthodontic treatment is administered to infants who have clefts of the primary and secondary palates is to stimulate and achieve the best dental arch alignment possible. This type of early care for newborns was pioneered by Dr. McNeil

in Glasgow, Scotland in 1954. Additional contributions to this method of treatment have been contributed by several researchers, including Dr. Burston in Liverpool, England (Shiere & Fisher, 1963; Maisels, 1965; Jacobson & Rosenstein, 1965).

Several types and protocols for constructing presurgically fitted prostheses for infants with cleft palates have been developed in the past. Variances between those that will be presented include: the use of wings for retention in the oral cavity; the use of expansion screws for unrestrained palatal growth; the use of pins for retention combined with expansion screws for unrestrained palatal growth; and the standard prosthesis used today. Each of these types and protocols will be discussed in turn.

Construction of the Prosthesis Models

When presurgical orthodontic treatment was first developed by orthodontists during the 1950's, no commercial trays were available for taking impressions of the infant oral cavity. Often the intervenors had to make their own acrylic maxillary and mandibular trays when working with infants. In these instances, babies with normal oral structures were used as the models (Shiere & Fisher, 1963).

The initial construction of the present day presurgical prosthesis is quite similar in each case. Oral impressions are taken with a warm alginate material that is "accurate,

easy to manipulate, and safe (Shiere & Fisher, 1963)." In addition, using warm water during the impression process hastens the setting time of the alginate (Brauer and Cronin, 1963). A working model is then made from the initial impression, which is then cut with a jigsaw through the area of the cleft impression in order to realign the prosthesis into the desired maxillary alignment. Once this relationship is obtained, the model is poured into stone. At this point, the construction of the prosthesis can vary, as will next be noted.

Prosthesis with Wings for Retention

The most frequently used presurgical prosthesis is a type identifiable as a "prosthesis with wings." This type of prosthesis was described in a preliminary study conducted by Shiere and Fisher in 1963. The immediate advantages and disadvantages of the use of this type of oral appliance for children who have cleft palates was examined by Shiere and Fisher. Nine cleft lip and palate patients were selected and presurgical orthodontic treatment began as early as three days after birth.

Wax was poured on the stone model, obtained by the process described above, including the construction of anterior wings to assist retention. The final prosthesis was ready within 24 hours of the first impression.

Infants fitted with a prosthesis with wings were

required to keep the appliance in place for 23 hours a day. The device was removed one hour of the day for relaxation of the affected oral structures. The infants were retained in the hospital for a few days to correct any areas of the prosthesis which were creating sore spots and to help reduce gagging and to improve feeding. The appliance was then altered every three weeks in order to facilitate oral growth.

The advantages of this type of appliance were found to be facilitation of normal feeding, oral muscle stimulation, and the stimulation of proper tongue placement for speech purposes. The authors hypothesized that because of the prosthesis, the subjects in this study would develop improved speech function, in addition to normal physical growth and development. In contrast, the disadvantage of this treatment, as presented in this study, was that not all infants with cleft palates were considered suitable for this kind of treatment. Other congenital anomalies occurring in a child with a cleft could prevent the use of this method of early presurgical treatment of the oral cleft (Shiere & Fisher, 1963).

In a report by Maisels (1965), a protocol for early orthopedics using a similar "winged" prosthesis was also described. The protocol began with the fitting of a prosthesis that would not assist maxillary alignment, call an "uncorrected feeding plate," that was used primarily for

purposes of accustoming the baby to wearing the prosthesis, as well as to assist with feeding. Approximately two weeks later, impressions of the maxillary arches were taken from which a correcting plate was made.

The above type of prosthesis described by Maisels and Shiere and Fisher involves several unique features. First, the prosthesis is made of clear acrylic in order that the prosthodontist may visualize any pressure effects the prosthesis may be having on the mucous membranes of the palate. Second, this type of prosthesis contains wings on the anterior portion of the plate to help facilitate insertion and to prevent swallowing of the plate. Occasionally, tape is also stretched around the head from one wing to the other wing to help prevent the tongue from extruding the prosthesis.

In Maisels report, open palatal clefts were found to narrow and the mucoperiosteum of the palate appeared to thicken when this type of presurgical prosthesis was used. Maisels concluded that these changes were due to the prosthesis stimulating the palatal blood supply and excluding the tongue from the area of the open cleft (Maisels, 1965).

Prosthesis with Expansion Screws

Another technique of presurgical prosthesis construction was described by Brauer and Cronin (1963).

This intervention began when the infant was one to two weeks of age. The unique feature of this type of prosthesis was the addition of an expansion screw. This expansion screw served as a way to alter the size of the prosthesis as the infant's palate grew. Poly-grip was used for retention of the prosthesis instead of wings. One turn of the screw was equal to .25 mm. The screw was typically given one turn every five to seven days. The prosthesis construction required three days. When the prosthesis was delivered, the parent(s) was/were instructed in proper removal and cleaning techniques, which was to be done twice a day.

This type of appliance was typically used in preparation for maxillary bone grafts, which can be done as early as four months of age. The prosthesis helped to reduce the size of the cleft, as well as move back protruding premaxillary segments of the palate (Brauer & Cronin, 1963).

As a note, the human maxilla is attached to the nasal septum. The nasal septum is therefore partly responsible for the maxillae's forward and downward growth with age (Maisels, 1965). If there is any disturbance in this growth pattern, normal facial growth will not occur (Trenite, Weil, & Roos, 1990). Because of this relationship, it has argued that a prosthesis that acts as a restraint for the premaxilla should be used with caution (Trenite, Weil, & Roos, 1990).

A similar prosthesis design to Brauer and Cronin's (1963) was the "combination appliance" described by Jacobson and Rosenstein (1965). This appliance also contained an expansion unit, called a jack-screw. Embedded in the prosthesis during construction, the screw could be activated for maxillary segment expansion by splitting the acrylic, if its use was so desired. Every available undercut from the impression was reproduced on the appliance for retention purposes. These undercuts were maintained by using both soft and hard acrylics, with an alternating liquid-powder spray technique.

Feeding and tongue posture and function have reportedly been affected favorably by this device, as well as has speech development "if it is used for a prolonged period (Jacobson & Rosenstein, 1965)". With the help of a denture adhesive, the appliance could remain in position without removal for up to three weeks. In the situations described, the prothesis did not appear to irritate the palatal tissue or to accumulate debris. Parents were instructed to remove the prosthesis for cleaning purposes only (Jacobson & Rosenstein, 1965).

Prosthesis with Pins for Retention and Screws for Expansion

Another type of presurgical prosthesis used with infants who have cleft palates was proposed by Mylin, Hagerty, and Hess (1966). This prosthesis differs from

those previously mentioned in that it had two pins which extended horizontally through the palatal bone for purposes of retaining the prosthesis. This placement was accomplished through general anesthesia. The adult-child cooperation that was required of the other models was not required with this device since the prosthesis could only be removed by a dentist or surgeon. Care was taken to prevent disturbing the developing dentition when the pins were placed. In addition, the pin on each side of the mouth was hypothesized not to inhibit the forward and downward growth of the palate. Other areas were considered in the construction of the palate so that the growth of the oral structures would not be restrained.

Reported results from using this type of prostheses have included improved feeding, speech development, dentition, hearing, and facial growth.

Mylin et al stated that early mechanical restoration of the palate will greatly reduce or even eliminate related secondary problems, i.e. articulation development, commonly associated with speakers who have cleft palates. Specifically, the authors stated that the "...potentially valuable influence of the pin-retained expandable prosthesis on early speech development cannot be overemphasized (Mylin, Hagerty, & Hess, 1966)."

A prosthesis containing expansion screws could also be viewed as a detriment to articulation development, however,

in that the screw would extend into the available articulation space and thereby interrupt articulation development at that site.

Standard Prosthesis

Despite all the earlier variations reported in the literature, the most popular prosthesis construction technique of today involves constructing a smooth, acrylic prosthesis that is retained by way of surface tension and infant tongue pressure. This prosthesis uses a hard acrylic for the roof of the mouth and a soft cure acrylic that extends into the open cleft for retention purposes. The design of such a prosthesis is easily adjustable to the changing size of an infant's growing oral structures by conducting appropriate chairside relining of the prosthesis. There appears to be only a limited risk of disrupting anterior facial development with such a design.

Conclusion

The standard design for a presurgical prosthesis that is commonly used today would appear to be adaptable to the minor modifications that are hypothesized as being needed in this paper. The smooth oral surface of the hard palate prosthesis could be altered relatively easily. The variations that are proposed include placing raised areas on the central and lateral ridges of the prosthesis that are

located over the anterior portion of the infant's hard palate. In cooperation with an orthodontist, a device would be designed that would fabricate such ridges on the prosthesis. In addition, it is proposed that these added areas be at least 1.5 mils in height, referring to McCall's study (1968) which concluded that the minimal depth required for the tongue tip to detect a "difference" was 1.5 mils in depth. It could reasonably be hypothesized that height and depth are somewhat synonymous when referring to tongue perception. Further, it is proposed that these markings be between 1 to 2 mm. apart, again referring to McCall's results of his test of two point discrimination.

The construction of an anatomically marked prosthesis appears feasible and worth further study. The next step of the study would be to actually construct such a devise and to then follow its presurgical fitting and use in an infant who has a cleft palate. The impact of such a device on the child's speech could then be determined and any needed modifications to the device could be proposed for further study.

REFERENCES

Bateman, H.E. & Mason, R.M. (1984). Applied Anatomy and Physiology of the Speech and Hearing Mechanism. Springfield, Illinois: Thomas.

Brauer, R.O. & Cronin, T.D. (1963). Maxillary orthopedics and anterior palate repair with bone grafting. Cleft Palate Journal, 31-42.

Creaghead, N.A., Newman, P.W. & Secord, W.A. (1989). Assessment and Remediation of Articulatory and Phonological Disorders (2nd ed.). Columbus, Ohio: Merrill.

Chapman, K.L. (1991). Vocalizations of toddlers with cleft lip and palate. Cleft Palate-Craniofacial Journal. 28(2), 172-178.

Cosman, B. & Falk, A.S. (1980). Delayed hard palate repair and speech deficiencies: A cautionary report. Cleft Palate Journal, 17(1), 27-33.

Gilbert, C.L. (1987). A review of effects of two-stage palatal closure on speech and facial growth. Unpublished master's thesis, Utah State University, Logan, UT.

Jacobson, B.N. & Rosenstein, S.W. (1965). Early Maxillary Orthopedics: A combination appliance. Cleft Palate Journal, 2, 369-376.

Johns, D.F. (1991). Commentary (on Articulation caused by abnormal lingual-palatal contact in patients with cleft palate with adequate velopharngeal function. Yukari & Michi, (1991). Cleft Palate Journal, 28(4), 367-368.

McCall, G.N. (1968). The assessment of lingual tactile sensation and perception. Journal of Speech and Hearing Disorders, 34(2), 151-156.

McWilliams, B.J., Morris, H. L., & Shelton, R. L. (1984). Cleft Palate Speech. Philadelphia, PA: B. C. Deker Inc.

Maisels, D.O. (1965). Early orthopaedic treatment of clefts of the primary and secondary palates: A surgeon's view. Cleft Palate Journal, 2, 76-86.

Mylin, W.K., Hagerty, R.F., & Hess, D.A. (1966). The pin-retained prosthesis in cleft palate orthopedics. Cleft Palate Journal, 3, 219-227.

Rasmussen, M.G. (1991). The assessment of articulation and phonological skills in preschool cleft palate children. Unpublished master's thesis, Utah State University, Logan, UT.

Robbins, J., & Klee, T. (1987). Clinical assessment of oropharyngeal motor development in young children. Journal of Speech and Hearing disorders, 52, 271-277.

Schweckendiek, W. (1978). Primary veloplasty: Long-term results without maxillary deformity. A twenty-five year report. Cleft Palate Journal, 15(3), 268-274.

Shiere, F.R., & Fisher, J.H. (1963). Neonatal orthopedic correction for cleft lip and palate patients: A preliminary report. Cleft Palate Journal, 17-24.

Stellmach, R. (1963). Prosthetic replacement of absent deciduous teeth for improvement of speech in children with cleft lip and palate. Preliminary report. Deutsche Zeitschrift fur Zahnheilkunde, 18, 1000-1004.

Treinite, G.L., Weil, J., & deRoos, P. (1990). Observation: A comment on "a discussion of presurgical orthodontics in patients with clefts." Cleft Palate Journal, 27(4), 419-424.

Trost, J.E. (1981). Articulatory additions to the classical description of the speech of persons with cleft palate. Cleft Palate Journal, 18(13), 193-203.