Use of a Hinge-Type Speech Prosthesis

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This report describes a hinge-type speech prosthesis and its owner's use of the two halves of her cleft velum to elevate the velar section of the prosthesis. With the prosthesis, her speech is free from articulation errors, audible nasal emission, and hypernasality. Acquisition of the ability to move the velar section is discussed.

A woman, KD, with an un-repaired cleft palate volunteered for study in the hope of being helpful to other persons with clefts. She used a hinge-type speech prosthesis of a type that has been described by Platt (1947), Olinger (1952), and Adisman (1971), but is now seldom used. The purpose of this report is to describe the prosthesis, which is of historical interest, and especially to describe the woman's remarkable use of the two halves of her cleft velum to move the velar section of the prosthesis. The movements were studied through use of per oral and oral endoscopic videorecordings made in 1978, 1983, and 1985. The development of oral motor skills is of abiding clinical significance, and variables that may have influenced the movements described are discussed.

BACKGROUND AND PROSTHESIS

KD is a Caucasian woman who was born in 1908 with a cleft of the secondary palate. The family physician advised her parents that the cleft was too wide for surgical correction. At the present time the patient has only five natural teeth; the four cuspids and the left central incisor. She attributes loss of teeth to wearing the appliance over the years. Except for the cleft and the loss of teeth, no abnormality of the speech mechanism was identified in our examinations. She breathes through her nose. Her cleft palate is shown in Figure 1.

KD is a college graduate who has worked as a dental technician and as a salesperson. She is the mother of one son; her late husband was a business man. She recollects receiving no medical, dental, or speech treatment related to her cleft palate until age 9 when she was examined by Dr. Vetlake E. Mitchell, a New York City orthodontist. Mitchell, whose prostodontic work was cited by Platt (1947), widened her maxillary arch and straightened her teeth. When KD was 11 or 12 years of age, Mitchell fitted her with a hinge-type speech prosthesis.

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FIGURE 1 The volunteer's cleft palate.
KD recalled that the construction of the prosthesis required about a year of fittings and modifications and that initially she could tolerate the prosthesis for only brief periods because of gagging. She believed that it took her 2 or 3 years to learn to wear and speak with the prosthesis without gagging when the velar section touched the posterior wall of the pharynx.

According to KD, the original prosthesis was replaced over the years by similar prostheses—two made by Mitchell and five or six made after 1932 by a dentist in San Francisco. In 1978, KD was satisfied with her prosthesis as well as with her speech. During later visits, the prosthesis sometimes fell from the roof of the mouth, but KD is reluctant to have an unfamiliar dentist attempt to modify the prosthesis or to construct a replacement.

All of the replacement prostheses, including the one illustrated here (Figure 2A, B, and C), were patterned after the original Mitchell appliance. Each had a hinged velar section and a plate intended to substitute for the vomerine segment of the septum. According to Platt (1947), Mitchell believed that the septum acts as a sounding board. This is consistent with Olinger (1952) who suggested that the vomerine segment of a prosthesis serves a resonating function and collects particles of moisture which trickle down and lubricate the pharynx.

**Speech**

After adjusting to her first prosthesis, KD received speech and singing lessons from a classical singing teacher in New York City. She recalls work was directed to sound production and not to use of the velar section of the appliance, and she remembers having difficulty producing /k/. She was instructed to say “‘hook” while drawing in her stomach muscles and to practice saying: “Ku Klux Klan.” She also reported that she was taught to control facial grimacing by palpat ing the facial muscles and deliberately “turning them off” during speech. Prior to obtaining and learning to use the prosthesis, KD was sometimes teased about her speech by classmates who thought she was tongue-tied. KD reports that since she has learned to use her prosthesis, adverse reaction to her speech has disappeared. Friends and acquaintances of her adult years, according to KD, are unaware that she had a speech disorder in childhood.

KD’s speech was audiorecorded with and without the prosthesis as she conversed with the authors and as she imitated the Measure Why passage (Fairbanks, 1960), the Zoo passage (Fletcher, 1978), and items from the 223 Item Articulation Test (Turton, 1973). Neither of two speech pathologists who studied the segment of the recordings made with the appliance in place identified articulation errors, audible nasal emission, or hypernasality. They considered KD’s speech to be normal. With the appliance removed, KD continued to be free from articula-
tion errors and audible nasal emission; however, hypernasality was present. The two raters employed a nasality scale, described by Subtelny et al. (1972), with values ranging from 1 (hyponasal) to 3 (normal) to 7 (hypernasal with reduction in intelligibility). The raters independently rated KD’s nasality 3 with the prosthesis in place and 5 and 6 with it removed.

**MOVEMENT OF THE VELAR SECTION OF THE PROSTHESIS**

KD is able to elevate the velar section of her prosthesis by movement of the two halves of the cleft velum. This was photographed per orally with a 35 mm camera. Figures 3 and 4 show the prosthesis in KD’s mouth while she was silent and as she phoned /ɑ/. During phonation, the two halves of the cleft velum supported the velar section in an elevated position.

**Per Oral Video Observations**

KD was also videorecorded per orally with a Sony AV-3200 camera and a Sony AV-3600 recorder during productions of /ɑ/ in isolation and in strings produced at different rates. Rate was controlled by use of a metronome plus instructions to increase or decrease rate. The rate of vowel production actually uttered was determined through use of a stop watch and count. These recordings showed that movement of the halves of the velum toward midline elevated the velar section of the prosthesis. As the velar halves moved medially, their uvular ends angled upward medially. The uvular ends were positioned ventrad to the velar section of the prosthesis. Continued movement of the velar halves toward midline appeared to squeeze the velar section of the prosthesis higher. Often, KD initiated strings of vowels by hitting the velar section of the prosthesis with her tongue and then supporting it with the halves of the velum. However, following an isolated vowel she would sometimes partially lower the velar section by moving the velar halves laterally. Then, in apparent anticipation of another utterance, she would maintain contact between velar halves and velar section. With the velar section partially elevated, she raised it further for another /ɑ/ without assistance from the tongue.

Further study of the per oral videotapes showed that in imitating isolated /ɑ/, KD raised and lowered the hinged velar section for each vowel. At a rate of approximately 0.8 to 0.9 vowel syllables per second, the velar section was sometimes, but not always, dropped between syllables. At 1.1 syllables per second, KD showed slight relaxation of the halves of the velum between syllables, but not enough to let the velar section fall. At faster vowel syllable rates (2.2, 3.8, and 4.4 syllables per second) there was progressively less movement of the halves of the velum between syllables, and the velar section never descended within a syllable string.

A Passavant’s ridge was evident per orally during some syllables; it was located just below the lower margin of the elevated velar section of the appliance.

KD was also photographed and videotaped intraorally with the appliance removed. Figure 5 shows her phonating /ɑ/ with the appliance removed. The velar halves are displaced toward midline, and their uvular ends appear to be positioned much as they are when used to elevate the velar section of the appliance. At syllable rates of 0.8 to 0.9 /ɑ/ syllables per second, the uvular halves moved toward midline for phonation.
and returned to the rest position between syllables. At faster syllable rates, the velar halves maintained the "toward midline" position throughout the syllable string. As syllable rate increased from about 1.3 to 3.3 syllables per second, less motion of the velar halves was evident within the syllable string. Bosma (1953) illustrated movements of the two halves of a cleft velum similar to those produced by KD.

The relationship between movement of the velar section of the prosthesis and rate of syllable production is generally compatible with the data of Thompson and Hixon (1979). Those data show that in some normal speakers the velopharyngeal port opens between oral syllables produced at rates slower than 1.5 syllables per second. In the data reported here, the velopharyngeal port appeared to open between oral syllables produced at rates below 1.5 per second and to remain closed at faster rates.

**Oral Endoscopic Observations**

We observed KD’s production of /p a m a/ in a string of eight syllables produced at a rate of 1.6 syllables per second with the appliance in the mouth. As the lips opened, whether after /p/ or /m/, the velar section was elevated. She may have maintained the velar section in an elevated position during /m/. We tested this possibility by recording movement of the velar section through a Storz 8702D oral endoscope with 558 light source as KD repeated strings of /p a m a p a/ at rates of 1.9 to 2.3 syllables per second. The velar section of the prosthesis was maintained in an elevated position during the /m/ portion of each string. Small openings into the nasopharynx were also evident on each side of the appliance in the region of the hinge when the velar section was elevated. Similar openings, evident in Figure 3, indicate that contact between the prosthesis boundary and the pharyngeal walls is incomplete. These openings may be sufficient to permit normal sounding nasal consonants even with the velar section elevated.

Observation of the velar halves and their uvular ends through the endoscope with the prosthesis removed showed that the uvular ends continued the movement toward midline after the more anterior portions of the velar halves had ceased medialward movement. The velar ends sometimes tipped toward the front of the mouth after reaching the midline position. One sequence recorded through the endoscope with the prosthesis in place showed the uvular ends of the velum to move toward midline during /a/ carrying the velar section to closure.

**DISCUSSION**

We believe that the observations reported are representative of KD’s use of her prosthesis. Some of the observations may be relevant to how she acquired the ability to use her hinged prosthesis. Variables that may have influenced her use of the prosthesis include muscle strengthening, use of conscious effort to move the velar section of the appliance, fitting the prosthesis to take advantage of existing movements, unconscious development of the needed movements through speech practice, or a combination of those and perhaps other variables.

Muscle strengthening is sometimes considered to contribute to development of velopharyngeal movements. Olinger (1952) indicated that a patient’s successful use of a hinge-type prosthesis is a function of fitting and muscle strengthening. Over the course of each clinic visit, Olinger alternated trial fitting and strengthening exercises involving blowing. According to Olinger, “The object of these exercises is to strengthen and develop the pharyngeal and palatal muscles so they will firmly and involuntarily close around the artificial velum” (p 133). He also recommended sound production exercises.

It seems unlikely that KD’s proficient use of her prosthesis is explained either by muscle strengthening exercises or instruction intended to teach her to deliberately elevate the velar section of the appliance through use of stimuli, feedback, and reinforcement on a trial by trial basis. KD has no recollection of any such activities in her therapy. Rather, her therapy involved speech practice. Increase in muscle strength may have occurred as a by-product of speech and other movements made with the appliance in place.
The prosthesis may well have been constructed and fitted to take advantage of already occurring movements of the two halves of the cleft velum. However, observations reported above suggest that learning did influence KD's movement of the velar section of her prosthesis. Her use of the tongue to bump the velar section to be caught by the velar halves appears to reflect learned behavior—so may her use of a readiness posture involving contact between velar halves and a slightly elevated pharyngeal section. Similarly, KD's maintenance of velar section elevation during /m/ embedded in strings of oral sounds seems to reflect the influence of learning. The speech training that KD received may have given her the opportunity to discover without conscious attention how to use the appliance to solve the problem of achieving velopharyngeal closure (McWilliams et al., 1984). That is, she may have indirectly hit upon skilled movement of the velar section as she worked to develop good speech.

Prospective study of an individual's development of the ability to use a hinged prosthesis could contribute to understanding of the development of velopharyngeal movements. Perhaps a single subject research design could be employed to tease out the influence of such variables as prosthesis fitting, muscle strengthening, deliberate attempts to move the velar section, and speech practice. This would be difficult research if development of the desired skill is slow, and such a study is unlikely since hinged appliances are now little used. Similar research could be attempted with subjects wearing newly fitted first obturators; however, response definition would be difficult.

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References


