Effect of a Palatal Lift Prosthesis in Individuals with Velopharyngeal Incompetence

Hema Raju, MDS[a]/Thallam Veeravalli Padmanabhan, MDS[b]/Arvind Narayan, MDS[c]

Purpose: The aim of this study was to assess the effect of a palatal lift prosthesis (PLP) on the speech intelligibility of cleft palate patients treated with pharyngeal flap surgery, the minimum duration required for improvement in nasality, and the sustenance of speech improvement after removing the appliance. ***Materials and Methods:*** Seven patients ranging between 16 and 26 years of age were recruited for this study. These subjects had velopharyngeal dysfunction secondary to a surgically corrected cleft palate, which failed to improve following pharyngeal flap surgery. A PLP was given to these patients and improvements in speech intelligibility were assessed using two speech examinations: perceptual analysis and nasometry. The nasal resonance, nasal air emission, and articulation were measured prior to the insertion of the prosthesis and at the end of every month for the next 3 months, following which the prosthesis was removed and the tests were repeated. ***Results****:* There was a statistically significant decrease in nasalance percentage at the end of the 3 months, and it was found that this improvement in speech persisted even after the removal of the prosthesis. ***Conclusions:*** A PLP, when used for a minimum duration of 3 months, causes a significant decrease in nasal resonance, thereby improving speech intelligibility in patients who failed to see improvement following pharyngeal flap surgery for velopharyngeal incompetence. *Int J Prosthodont 2009;22:579–585.*

Velopharyngeal incompetence (VPI) is a contributing factor of speech disorders that frequently accompanies conditions such as cleft palate, congenital paralysis of the soft palate, and cerebrovascular disease.[1] Treatment of VPI includes both surgical and prosthetic procedures. Hypernasality, nasal air emission, and decreased speech intelligibility due to weak consonant production occur as a result of palatopharyngeal insufficiency or palatopharyngeal incompetency in patients with a cleft palate. Secondary surgery, commonly using a superiorly based pharyngeal flap, is done to improve the VPI in these patients. Alternatively, a palatal lift prosthesis (PLP) is also effective in the correction of this condition.[2] Even following pharyngeal flap surgery, 20% to 34% of patients require revision surgery for lack of improvement in VPI.[3,4] Unfortunately, revision surgeries usually result in hyponasal speech.[4] Hence, prosthetic rehabilitation might be a better option in such cases.

Evaluation of speech using perceptual analysis in patients with a cleft palate is subjective and can vary on a number of factors, such as experience of the judges and the selection of speech samples.[5] The objective evaluation using a nasometer provides an instrumental analysis of nasality by measuring nasal acoustic output relative to nasal and oral acoustic output and is expressed as a nasalance percentage. It is a useful clinical tool for the assessment and diagnosis of nasality problems when used in addition to perceptual analysis because it is noninvasive and nonintrusive.[6,7] This study aimed to evaluate improvement in speech by using a PLP in patients who failed to improve following superiorly based pharyngeal flap surgery. Articulation, nasal resonance, nasal air emission, and intelligibility, along with the nasalance percentage, were measured across five conditions: pre–prosthesis insertion and 1, 2, and 3 months post–prosthesis insertion, following which the prosthesis was removed and the tests repeated.

[a]*Senior Lecturer, Department of Prosthodontics, Indra Gandhi Institute of Dental Sciences, Pondicherry, India.*
[b]*Professor and Head, Department of Prosthodontics, Sri Ramachandra Medical College and Hospital, Porur, Chennai, India.*
[c]*Senior Lecturer, Department of Oral and Maxillofacial Surgery, Indra Gandhi Institute of Dental Sciences, Pondicherry, India.*

Correspondence to: *Dr Hema Raju, 106 Chetty Street, Pondicherry 605001, India. Fax: 91-413-2336579. Email: hemaarvindnarayan@gmail.com*

Table 1 Perceptual Analysis Rating Scale

Rating no.	Articulation	Resonance	Nasal air emission	Intelligibility
0	Normal	Hyponasal	None	–
1	Mild	Normal	Mild	Intelligible
2	Moderate	Mild	Moderate	Listener's attention needed
3	Severe	Moderate	Severe	Occasional repetition of words needed
4	–	Severe	–	Repetitions or rephrasing necessary
5	–	–	–	Isolated words understood
6	–	–	–	Occasionally understood by others
7	–	–	–	Unintelligible

– = not applicable.

Materials and Methods

Seven patients ranging between 16 and 26 years of age (three males and four females) were recruited from the Department of Plastic Surgery, Sri Ramachandra University, Chennai, India, and served as subjects for the study. These subjects had velopharyngeal dysfunction secondary to a surgically treated cleft palate followed by pharyngeal flap surgery for the correction of palatopharyngeal insufficiency. Patients underwent a complete ear, nose, and throat examination, including assessment of speech and video nasoendoscopy.

Subjects fulfilling the following criteria were selected:

- Adequate cognitive and language abilities and had previously undergone two to four sessions of demonstration therapy for correction of articulatory errors and reduction of hypernasality, but were not undergoing therapy during their participation in the study
- No improvement in hypernasality and speech intelligibility following pharyngeal flap surgery completed 12 to 18 months earlier
- Normal hearing with no symptoms of a cold, allergies, or sinus infections
- Able to speak Tamil fluently
- A nasoendoscopic examination in the presence of a plastic surgeon, prosthodontist, and a speech pathologist

After the members of the team concluded that the patient could benefit from the prosthetic treatment, ethics committee approval and the patient's consent for the study were obtained.

Methodology

Prior to the insertion of the prosthesis, patients underwent speech examinations via perceptual analysis, nasometry (Nasometer II 6400, Kay Elemetrics), and video nasoendoscopy (ENF-P4, Olympus).

Judgments were made after listening to connected free speech including counting from 1 to 10 and reading tasks aloud. Subjects were made to repeat 10 sentences, of which 2 sentences contained purely nasal consonants, 2 contained purely oral consonants, and the other 6 had both oral and nasal consonants.[8] The subjects' speech samples were recorded using a voice recorder under a noise-free environment. The samples were recorded across five conditions and collected and randomized with no information on whether it was pre– or post–prosthesis insertion to overcome experimental bias. The samples were then presented to two judges (qualified speech language pathologists trained in the area of articulation and nasality assessment of individuals with cleft lip and palate) for perceptual analysis. The judges were instructed to analyze the nasality using a rating scale (Table 1).[9,10]

Prosthetic Procedure

The speech-aid prosthesis was fabricated in successive stages to enhance patient adjustment and acceptance of the prosthesis. A stone cast was made from an irreversible hydrocolloid impression and used to fabricate the maxillary section from heat-polymerizing acrylic resin with retentive clasps on the left and right first premolars and first molars. A 0.9-mm stainless steel wire of approximately 10 cm was bent in the shape of a "U" and adjusted to conform to the vault of the soft palate (Fig 1). Two retentive loops were made and connected to the posterior border of the maxillary section with autopolymerizing acrylic resin. A minimal amount of autopolymerizing acrylic resin was added to the posterior end of the wire to serve as a tray for the nasopharyngeal impression. A functional impression was made with mouth-temperature wax (Korecta) and a cast was poured using the altered cast technique. This impression was then replaced in the office by a quick-setting autopolymerizing acrylic resin (Fig 2). After insertion of the PLP (Figs 3 and 4), adequate velopharyngeal closure was verified using video nasoendoscopy and the device was delivered to the patient after checking that it did not interfere with the nasopharyngeal airway or cause any respiratory discomfort.[1,11]

Fig 1 *(left)* U-shaped wire attached to the prosthesis.

Fig 2 *(right)* The PLP.

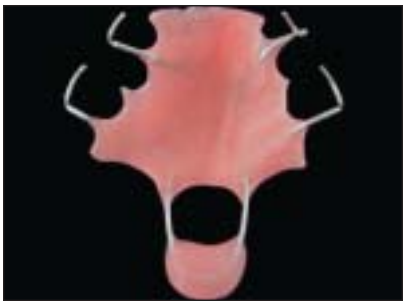

Fig 3 *(left)* Intraoral view pre–prosthesis insertion.

Fig 4 *(right)* Intraoral view with the PLP in place.

Table 2 Perceptual Analysis for Each Subject Using the Rating Scale

Patient	Age (y)/ Sex	Articulation					Resonance					Nasal air emission					Intelligibility				
		Pre	P1	P2	P3	P4	Pre	P1	P2	P3	P4	Pre	P1	P2	P3	P4	Pre	P1	P2	P3	P4
1	16/F	2	2	2	2	2	4	4	3	3	3	2	2	2	2	2	4	3	3	3	3
2	24/M	1	1	1	1	1	4	4	4	4	4	1	1	1	1	1	2	2	2	2	2
3	20/F	2	2	2	2	2	4	4	3	3	3	1	1	1	1	1	3	3	2	2	2
4	26/M	2	2	2	2	2	4	4	4	4	4	1	1	1	1	1	4	4	4	4	4
5	26/M	1	1	1	1	1	4	4	4	4	3	1	1	1	1	1	4	4	4	4	4
6	22/F	3	2	2	2	2	4	4	3	3	3	1	1	1	1	1	5	4	4	4	4
7	22/F	1	1	1	1	1	4	4	3	3	3	2	2	2	2	2	5	5	4	4	4

Pre = preprosthesis; P1 = 1 month postinsertion; P2 = 2 months postinsertion; P3 = 3 months postinsertion; P4 = 1 month after prosthesis removal; M = male; F = female.

Postprosthesis Evaluation

Lateral cephalograms of the patients were made after the insertion of the PLP to ensure adequate elevation of the soft palate (Figs 5a and 5b).[12] Speech evaluation and video nasoendoscopy were performed with and without the speech-aid prosthesis in the mouth. Video nasoendoscopy permits visual scanning of the port from above and does not interfere with the oral structures involved in the production of speech, in contrast to oral endoscopy, which does.[13,14] Patients were then referred to the Department of Speech and Language Pathology where speech pathologists performed the two speech tests: nasometry and perceptual analysis. The patients had to wear the prosthesis for a minimum duration of 3 months, during which a home-training speech therapy program was given. Speech examinations were done after insertion of the prosthesis to check for any reduction in nasality and increase in speech intelligibility. Recordings of the patients' speech were compared between the initial examination and the end of months 1, 2, and 3 and 1 month after removal of the PLP (after completion of the 3 months).

The subjective evaluation was statistically analyzed using a paired *t* test and the different variables in each parameter were compared (Table 2). Two statistical tests were used for nasometry: analysis of variance, where the differences between three groups of sentences were analyzed, and paired sample *t* tests,

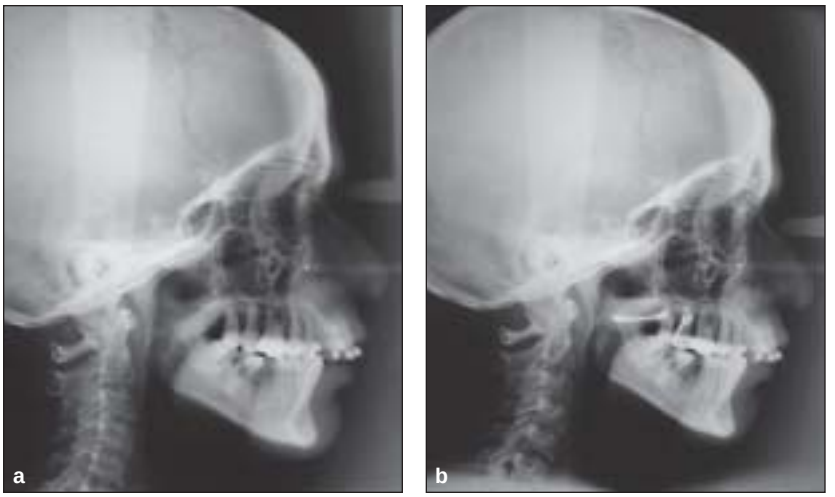

Fig 5 Lateral cephalogram **(a)** before and **(b)** after insertion of the PLP.

Table 3 Nasometry Sample Patient Reading

	Sentences (%)*									
	1	2	3	4	5	6	7	8	9	10
Pre	22	38	44	43	36	43	42	34	32	48
P1	16	24	53	54	24	29	22	34	24	28
P2	23	36	29	43	36	40	41	31	29	44
P3	15	27	35	37	29	34	31	26	31	40
P4	20	33	38	40	33	38	31	30	31	41

Pre = preprosthesis; P1 = 1 month postinsertion; P2 = 2 months postinsertion; P3 = 3 months postinsertion; P4 = 1 month after prosthesis removal.
*1 and 2 were sentences that had purely oral consonants; 3 and 4 were sentences that had purely nasal consonants; 5 through 10 had a mixture of both oral and nasal consonants.

where the different variables in each parameter were compared (Table 3). A *P* value less than .05 was considered statistically significant in all tests.

Results

Nasometry showed a statistically significant decrease in nasalance percentage (Tables 4 to 6, Fig 6). This was seen at the end of the third month and it was found that this improvement in speech persisted even after the removal of the PLP. It was determined that a minimum duration of 3 months was required for the prosthesis to cause a significant improvement in nasality. In the perceptual analysis, five patients showed an improvement in nasal resonance and four patients showed improvement in speech intelligibility, which again persisted after removal of the PLP after 3 months, but this improvement was not deemed to be statistically significant (Table 7).

Discussion

Cleft palate is responsible for major physiologic disorders. Normal speech cannot be produced without a competent velopharyngeal mechanism. Children learning to talk who suffer from VPI will develop compensatory mechanisms in an attempt to deal with the loss of oral pressure.[15] If the VPI is treated early, the compensatory mechanisms will be less established and the prognosis for speech better. Pharyngeal flap surgeries have been the mainstay of treatment for VPI for many years and remain a standard and acceptable approach.[15] Prosthodontic management may be necessary when surgical results are less than desirable.[16]

The patients in this study underwent pharyngeal flap surgery for correction of VPI, but this surgery failed to produce marked improvement in resonance and speech. It has been found that lack of a pharyngeal flap movement is associated with defective speech more

Table 4 Statistical Analysis for Nasometry

	N	Mean	SD	SE	95% CI Lower	95% CI Upper	Minimum	Maximum
P3*								
S1&S2	7	27.14	9.74	3.68	18.14	36.15	13	40
S3&S4	7	42.86	12.73	4.81	31.08	54.63	20	56
S5–S10	7	35.57	9.91	3.75	26.40	44.74	17	48
Total	21	35.19	12.24	2.67	29.62	40.76	13	56
P4*								
S1&S2	7	29.71	5.53	2.09	24.60	34.83	23	40
S3&S4	7	44.43	9.11	3.44	36.01	52.85	30	58
S5–S10	7	36.57	6.70	2.53	30.37	42.77	25	47
Total	21	36.90	9.25	2.02	32.70	41.11	23	58

SD = standard deviation; SE = standard error; CI = confidence interval. P3 = 3 months posinsertion; P4 = 1 month after prosthesis removal.
*S1 & S2 = sentences that had purely oral consonants; S3 & S4 = sentences that had purely nasal consonants; S5–S10 = mixture of both oral and nasal consonants.

Table 5 Results of Analysis of Variance for Nasometry

	Sum of squares	*df*	Mean square	F	*P*
P3					
Between groups	865.810	2	432.905	3.656	.047*
Within groups	2,131.429	18	118.413		
Total	2,997.238	20			
P4					
Between groups	758.952	2	379.476	7.184	.005*
Within groups	950.857	18	52.825		
Total	1,709.810	20			

P3 = 3 months postinsertion; P4 = 1 month after prosthesis removal.
*Statistically significant.

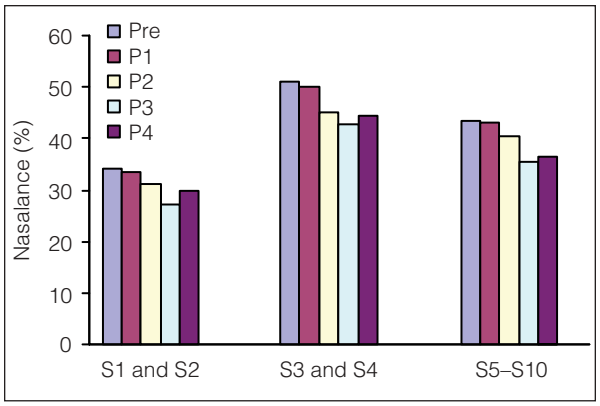

Fig 6 Nasometry results for all patients. (S1 and S2 = sentences that had purely oral consonants; S3 and S4 = sentences that had purely nasal consonants; S5–S10 = mixture of both oral and nasal consonants. Pre = preprosthesis; P1 = 1 month postinsertion; P2 = 2 months postinsertion; P3 = 3 months postinsertion; P4 = 1 month after prosthesis removal.)

Table 6 Combined Nasometry Readings Compared Before and After Insertion of the PLP and After the Removal of the PLP

	Mean	SD	SE	95% CI Lower	95% CI Upper	*t*	*df*	*P*
Pair 1 (P1)	−3.00	4.93	1.86	−7.56	1.56	−1.609	6	.159
Pair 2 (P2)	5.86	7.20	2.72	−.80	12.51	2.153	6	.075
Pair 3 (P3)	8.00	3.83	1.45	4.46	11.54	5.527	6	.001*
Pair 4 (P4)	6.43	4.89	1.85	1.90	10.95	3.475	6	.013†
Pair 5 (P1–P2)	8.86	5.70	2.15	3.59	14.13	4.112	6	.006
Pair 6 (P1–P3)	11.00	3.37	1.27	7.89	14.11	8.645	6	.000
Pair 7 (P1–P4)	9.43	5.65	2.14	4.20	14.66	4.413	6	.005
Pair 8 (P2–P3)	2.14	4.49	1.70	−2.01	6.29	1.263	6	.253
Pair 9 (P2–P4)	.57	7.18	2.72	−6.07	7.22	.210	6	.840
Pair 10 (P3–P4)	−1.57	4.54	1.72	−5.77	2.63	−.916	6	.395

SD = standard deviation; SE = standard error; CI = confidence interval; Pre = preprosthesis; P1 = 1 month postinsertion; P2 = 2 months postinsertion; P3 = 3 months postinsertion; P4 = 1 month after prosthesis removal.
*Significant improvement after 3 months of wearing the PLP.
†Speech improvement sustained.

Table 7 Perceptual Analysis: Results of the Paired *t* test

				95% CI				
	Mean	SD	SE	Lower	Upper	*t*	*df*	*P*
Pair 1 (Res Pre–Res P1)	.43	.79	.30	–.30	1.16	1.441	6	.200*
Pair 2 (Res Pre–Res P2)	.57	.79	.30	–.16	1.30	1.922	6	.103*
Pair 3 (Res Pre–Res P3)	.57	.79	.30	–.16	1.30	1.922	6	.103*
Pair 4 (Res Pre–Res P4)	.57	.79	.30	–.16	1.30	1.922	6	.103*
Pair 5 (Res P1–Res P2)	.14	.38	.14	–.21	.49	1.000	6	.356*
Pair 6 (Res P1–Res P3)	.14	.38	.14	–.21	.49	1.000	6	.356*
Pair 7 (Res P1–Res P4)	.14	.38	.14	–.21	.49	1.000	6	.356*

SD = standard deviation; SE = standard error; CI = confidence interval; Res = resonance; Pre = preprosthesis; P1 = 1 month postinsertion; P2 = 2 months postinsertion; P3 = 3 months postinsertion; P4 = 1 month after prosthesis removal.
*Statistically significant (two-tailed *P* test).

often than movement. Further, the flap must be wide enough and at a proper superior-inferior level to permit closure of the two lateral ports during speech by medial movement of the lateral pharyngeal walls.[16] In the present study, a PLP was given to such patients whose speech was severely hypernasal, despite the pharyngeal flap surgery. The other option for such failed surgical attempts is a revision surgery, which as mentioned earlier usually results in hyponasal speech.[4] Thus, a PLP would serve as a less radical and viable alternative.

The effect of a PLP intended to normalize speech for speakers with VPI may be related to an increase in muscle activity during speech. Increased levator activity enables the velopharyngeal mechanisms to maintain a tight closure without encountering muscle fatigue.[17,18] It has been reported that there are variations in muscle response to mechanical stimulation of the soft palate. Shortly after placement of a PLP, the soft palate may become more active. Frequently after 6 months to 1 year of use, the prosthesis can be removed due to tissue response from prosthetic stimulation or neuromuscular recovery.[19]

Nasal resonance was analyzed using a rating scale. A clinically significant improvement was seen in five patients; these patients showed a decrease in nasality and increased speech intelligibility. No improvements in articulation and nasal air emission could be seen since these are a learned process and speech therapy would be needed for correction of the articulatory errors. It has been suggested that if the prosthesis is used prior to the development of meaningful speech, normal articulation is possible.[20] If the PLP is placed after speech development has begun, speech therapy is needed in conjunction with the use of the prosthesis.

Though the stability of the PLP has been questioned and a modification in the design has been suggested,[21] the authors encountered no such difficulties with the prosthesis. Patient acceptance and compliance remains a significant challenge when using a PLP. Problems such as dysphagia and lack of significant improvement in speech over the short term have often been cited as reasons for this.[21] Despite the inconvenience associated with the prosthesis, motivation and counseling of patients on the obvious advantages of the treatment helped in creating a better compliance. Further, a perceived improvement in speech within a period of 3 months may convince patients towards continuing the prosthesis if needed.

The limitations of this study were the small number of subjects and the follow-up period of only 4 months. These patients could not undergo continuous speech therapy during the course of this study, only a home-trainer program was given. The diligent response towards this program could not be monitored and this might have had a direct impact on the speech improvement. The female patients who were unemployed and thus had more time for the home training showed marked improvement compared to the males who were employed full-time.

Conclusion

This study emphasizes the importance of a PLP in treating VPI following failed pharyngeal flap surgeries. In a period of 3 months, most patients exhibited a decrease in hypernasality, thereby improving speech. The improvement in nasalance scores persisted even after removal of the PLP, thus proving that it is a viable alternative to revision surgeries to correct VPI.

Acknowledgments

The authors would like to thank Dr Jyotsna Murthy and Dr Altaf Hussain of the Department of Plastic and Reconstructive Surgery and Ms Roopa Nagarajan and Mr Karthik of the Department of Speech and Language Pathology, Sri Ramachandra Medical College and Hospital, for their valuable help in the video nasoendoscopy and speech examinations.

References

1. Shifman A, Finkelstein Y, Nachmani A, Ophir D. Speech-aid prostheses for neurogenic velopharyngeal incompetence. J Prosthet Dent 2000;83:99–106.
2. Lang BR. Modification of the palatal lift speech aid. J Prosthet Dent 1967;17:620–626.
3. Kuehn DP, Moller KT. Speech and language issues in the cleft palate population: The state of the art. Cleft Palate Craniofac J 2000;37:348–383.
4. Witt PD, Myckatyn T, Marsh JL. Salvaging the failed pharyngoplasty: Intervention outcome. Cleft Palate Craniofac J 1998;35:447–453.
5. Keuning KH, Wieneke GH, Dejonckere PH. The intrajudge reliability of the perceptual rating of cleft palate speech before and after pharyngeal flap surgery: The effect of judges and speech samples. Cleft Palate Craniofac J 1999;36:328–333.
6. Sweeney T, Sell D, O'Regan M. Nasalance scores for normal-speaking Irish children. Cleft Palate Craniofac J 2004;41:168–174.
7. Nellis JL, Neiman GS, Lehman JA. Comparison of Nasometer and listener judgments of nasality in the assessment of velopharyngeal function after pharyngeal flap surgery. Cleft Palate Craniofac J 1992;29:157–163.
8. Dalston RM. Prosthodontic management of the cleft-palate patient: A speech pathologist's view. J Prosthet Dent 1977;37:190–195.
9. Seifert E, Runte C, Riebandt M, Lamprecht-Dinnesen A, Bollmann F. Can dental prostheses influence vocal parameters? J Prosthet Dent 1999;81:579–585.
10. Dotevall H, Lohmander-Agerskov A, Ejnell H, Bake B. Perceptual evaluation of speech and velopharyngeal function in children with and without cleft palate and the relationship to nasal airflow patterns. Cleft Palate Craniofac J 2002;39:409–424.
11. Birnbach S. Physiologic recording of the soft palate for fabrication of obturator speech prostheses. J Prosthet Dent 1978;39:539–545.
12. Gibbons P, Bloomer H. A supportive-type prosthetic speech aid. J Prosthet Dent 1958;8:362–369.
13. Karnell MP, Rosenstein H, Fine L. Nasal videoendoscopy in prosthetic management of palatopharyngeal dysfunction. J Prosthet Dent 1987;58:479–484.
14. Turner GE, Williams WN. Fluoroscopy and nasoendoscopy in designing palatal lift prostheses. J Prosthet Dent 1991;66:63–71.
15. Malek R. Velopharyngeal incompetence. In: Malek R. Cleft Lip and Palate: Lesions, Pathophysiology and Primary Treatment. London: Martin Dunitz, 2001:128–130.
16. McKinstry RE, Aramany MA. Prosthodontic considerations in the management of surgically compromised cleft palate patients. J Prosthet Dent 1985;53:827–831.
17. Tachimura T, Nohara K, Fujita Y, Hara H, Wada T. Change in levator veli palatini muscle activity of normal speakers in association with elevation of the velum using an experimental palatal lift prosthesis. Cleft Palate Craniofac J 2001;38:449–454.
18. Tachimura T, Nohara K, Fujita Y, Wada T. Change in levator veli palatini muscle activity for patients with cleft palate in association with placement of a speech-aid prosthesis. Cleft Palate Craniofac J 2002;39:503–508.
19. Mazaheri M, Mazaheri EH. Prosthodontic aspects of palatal elevation and palatopharyngeal stimulation. J Prosthet Dent 1976;35:319–326.
20. Dorf DS, Reisberg DJ, Gold HO. Early prosthetic management of cleft palate. Articulation development prosthesis: A preliminary report. J Prosthet Dent 1985;53:222–226.
21. Ueda N, Sato Y, Senoo Y, Mori T, Moriguchi T, Nakagawa H. New design of a palatal lift prosthesis combined with a palatal bar. Cleft Palate Craniofac J 2002;39:12–17.

Literature Abstract

Shear bond strength of four resin cements used to lute ceramic core material to human dentin

This study evaluated the shear bond strength of four resin cements used to lute ceramic core material to dentin. Four resin systems were used: Super-Bond C&B, Chemiace II, Variolink II, and Panavia F. One hundred twenty cylindrical-shaped ceramic cores (2.7-mm wide, 3-mm high) were made from heat-pressed IPS Empress. These cores were then cemented onto the dentin of 120 molars that were embedded in a self-curing acrylic resin. Specimens were randomly divided into four equal groups. All specimens were stored in distilled water at 37°C for 1 day, but only half of them were tested after 24 hours. The other half were thermocycled 1,000 times between 5°C and 55°C prior to testing. The shear bond strength of each specimen was measured using a universal testing machine at a crosshead speed of 1 mm/min. Values were calculated in MPa, and the results were statistically analyzed using the two-way analysis of variance and Tukey tests. Variolink II and Panavia F systems showed higher shear bond strength values than the other two systems. The values of bond strength after thermocycling were not remarkable, as compared to the corresponding prethermocycling groups. Specimens luted with Variolink II showed the highest shear bond strength. Most failures in the Variolink II and Panavia F systems were cohesive in nature within the cement. Adhesive failure occurred more in the other two systems, especially at the cement-dentin interface. The Variolink II and Panavia F systems remain very reliable as luting cements. However, the results of this study should be taken with discretion when dealing with a different ceramic core material.

Altinas S, Eldinez AU, Usumez A. *J Prosthodont* 2008;17:634–640. **References:** 38. **Reprints:** Dr Aslihan Usumez, Gaziantep Universitesi, Dishekimligi Fakultesi, Protetik Dis Tedavisi Anabilim Dalı, Kampus, Gaziantep, Turkey. Email: asli_u@hotmail.com—*Majd Al Mardini, Hamilton, Ontario, Canada*