Proplast as a Pharyngeal Wall Implant to Correct Velopharyngeal Insufficiency

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Proplast I was used as posterior pharyngeal wall implant to correct velopharyngeal insufficiency (VPI) in 26 patients. Specific criteria were followed in patient selection. Follow-up ranged from 4 months to 124 months. Postoperatively, 18 patients had elimination of VPI and three patients had minimal residual VPI. Four patients lost the implants secondary to infection with residual VPI. One patient had significant residual VPI without the loss of the implant. Based on long-term follow-up, no migration of the implant was seen and there was no detectable effect on subsequent facial growth. Predictably better results were achieved with younger patients in whom smaller implants were used. Conclusions from this study indicate that Proplast I is an acceptable pharyngeal wall implant material to correct VPI when the specific criteria are met and good surgical technique is used.

KEY WORDS: *posterior pharyngeal implant, velopharyngeal incompetence, Proplast, cleft palate, hypernasality*

Velopharyngeal insufficiency is often treated with pharyngeal flap surgery (Shprintzen et al, 1979; Schneider and Shprintzen, 1980). In some patients, VPI is not corrected because of risks related to pharyngeal flap surgery, such as obstructive sleep apnea (Orr et al, 1987; Shprintzen, 1988). Surgeons may be reluctant to perform pharyngeal flap surgery for patients with mild VPI. For cases with small insufficiencies, posterior pharyngeal wall implants may be appropriate. The objective of using a posterior pharyngeal wall implant is to move the posterior pharyngeal wall forward to provide a competent velopharyngeal mechanism for speech (Fig. 1).

Many materials have been suggested for providing anterior displacement of the posterior pharyngeal wall, including petroleum jelly (Gersuny, 1900), paraffin (Eckstein, 1922), cartilage (Hollweg and Perthes, 1912; Lando, 1950; Hagerty and Hill, 1961; Hess et al, 1968; Calnan, 1971a), fat (Von Gaza, 1926), adjacent soft tissues (Passavant, 1879; Wardill, 1928; Bentley, 1947; Hynes, 1950), Silastic (Blocksma, 1963; Blocksma and Braley, 1965; Brauer, 1973), and Teflon (Lewy et al, 1965; Ward et al, 1966; Ward, 1968; Bluestone et al, 1968a, 1968b; Calnan, 1971b; Sturim and Jacob, 1972; Kuehn and Van Demark, 1978). Many techniques have been abandoned because of unpredictable results, complications, or restrictions imposed by the Food and Drug Administration. Silastic and Teflon implants are still used by some surgeons and although tissue compatibility is acceptable, the problem of migration exists. With the injectable forms of these substances, the potential is present for embolism or transport of increments to regional lymph nodes or organs. Mortality associated with the use of injectable Teflon has been reported (Kuehn and Van Demark, 1978).

The use of pharyngeal flaps in growing patients has been hypothesized to cause significant alteration in facial growth and maxillary development (Subtelney and Nieto, 1978; Long and McNamara, 1985). Therefore, a safe and effective posterior pharyngeal wall implant to resolve VPI in at least some cases would be advantageous.

The purpose of this paper is to discuss the criteria for the use of Proplast pharyngeal wall implants. Surgical technique and long-term results will be presented.

METHODS

Subjects

Twenty-six consecutive patients who received Proplast pharyngeal wall implants were the subjects in this study. Subjects ranged in age from 5.3 to 35.9 years (Table 1). Twelve patients were between 5 and 10 years of age, six were between 10 and 20 years of age, and eight were over 20 years of age (Table 2).

Preoperative Assessment of VPI

The evaluations for VPI on all patients in the study included the following:

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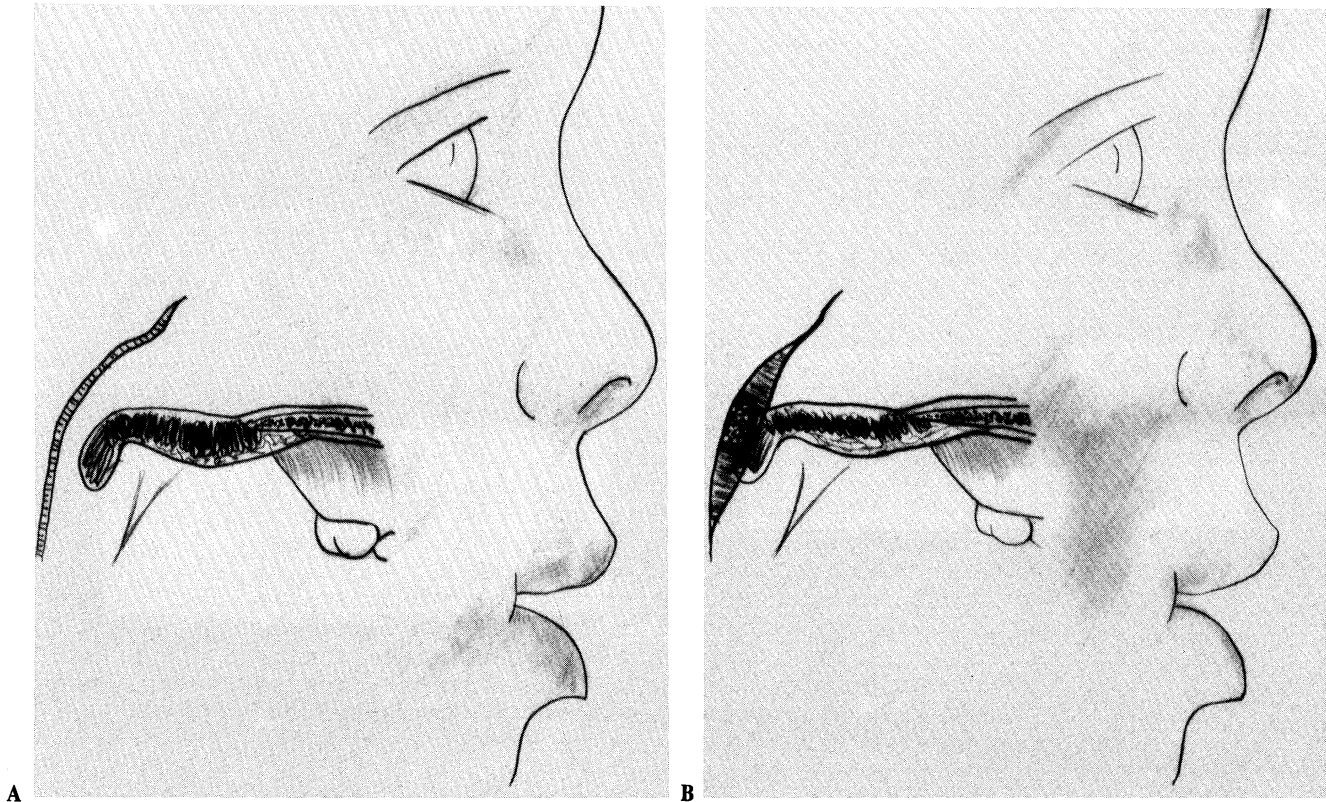
FIGURE 1 Velopharyngeal insufficiency is illustrated. *A*, Good function of the soft palate. *B*, The pharyngeal implant is shown moving the posterior pharyngeal wall forward to come in contact with the moving soft palate.

1. Speech evaluation of nasality and articulation. Ratings of nasality were performed independently by two of the authors (M.O. and R.D.) from tape recorded speech samples. Nasal resonance was rated on a five-point scale as follows: denasal, normal, mildly hypernasal, moderately hypernasal, and severely hypernasal. The speech samples used for the rating of nasality consisted of the isolated vowels /u/ and /i/, as well as the sentences "give Gary the chocolate cake" and "Suzie sees the sun in the sky." Only the sentences were rated for articulation proficiency. Articulation was rated as good, fair, or poor. No attempt was made to categorize specific articulation errors. Interjudge agreement was 100 percent.
2. Mirror test to detect nasal emission.
3. Videofluoroscopic studies in lateral and base views.
4. Nasopharyngoscopy.
5. Lateral cephalometric radiographs taken with the soft palate at rest and during sustained /i/ and /ʃ/.

Patient Selection

Patient selection was based on documented VPI and perceived hypernasality. Patients had to display the following features: (1) good velar movement; (2) a velopharyngeal gap of less than 5 mm in an anteroposterior dimension; (3) a small to moderate adenoid mass; and (4) anterior movement of the posterior pharyngeal wall (Passavant's ridge) of less than 4 mm.

Implant Material

Proplast I is an open pore implant of vitreous carbon and Teflon. Seventy to 90 percent of its total volume is pore space with a pore size of 100 to 500 microns. The variable pore size uniquely permits soft tissue ingrowth into the implant or capsulization around the implant that stabilizes its position. Proplast is free of observable systemic or cytoxic effects (Kent et al, 1972; Homsy et al, 1973) and has been used extensively and successfully for facial and cranial augmentations (Janeke et al, 1974; Kent et al, 1975; Bell, 1976; Freeman, 1976; Janeke and Shea, 1976; Dann and Epker, 1977). It is manufactured in block form of various thicknesses (6, 8, and 10 mm) and is easily contoured with a scalpel blade.

Surgical Technique

Surgery was done under general anesthesia with a spiral anode oral endotracheal tube. The Dingman Mouth Prop was used to open the mouth, retract soft tissues, and stabilize the tube (Fig. 2). A red rubber catheter was passed through the nose into the oropharynx and retrieved through the oral cavity. Silk sutures (0–0) were placed through the posterior aspect of the soft palate lateral to the uvula on both sides. The free ends were placed through holes in the end of the red rubber catheter, then pulled through the nose to retract the soft palate in an anterosuperior direction (Fig. 3). This technique improved visibility and access to the posterior pharyngeal wall area. Local anesthesia of 1 percent xylocaine with 1:200,000 epinephrine was injected in a vertical direction in the midline of the posterior pharyngeal wall, extending from the base of the adenoid mass inferiorly to the level of the tongue. Ideally, local anesthesia was injected between the superior constrictor muscles and the prevertebral fascia. A scalpel blade or diathermy knife was used to make an incision down the midline of the posterior

TABLE 1   Proplast Pharyngeal Wall Implants: Subject Data

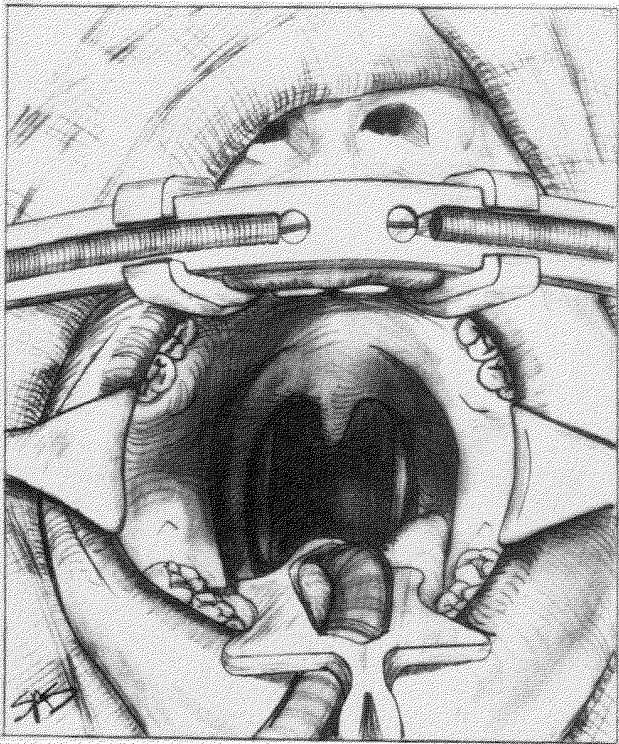| Patient	Age (yrs)	Sex	Implant Size (mm)	Follow-up (mo)	Postoperative Complications	Preoperative Speech Hypernasality	Postop VPI Evaluation Speech Pathology	Postop VPI Evaluation Nasopharyngoscopy Mirror Test
1	23.7	F	6	67	Implant too low Repositioned	Severe Severe	Severe Normal	Severe None
2	6.4	M	8	82	None	Severe	Normal	None
3	7.7	M	6	76	None	Moderate	Normal	Mild
4	6.2	M	6	12	None	Severe	Normal	None
5	13.3	F	6	65	None	Moderate	Normal	None
6	35.1	M	6	62	None	Moderate	Normal	None
7	12.9	M	6	9	None	Moderate	Mild	Mild
8	5.9	M	6	7	None	Moderate	Normal	None
9	26.1	M	10	24	None	Severe	Normal	None
10	11.3	F	6	56	None	Severe	Normal	Mild
11	8.8	M	6	120	None	Moderate	Normal	None
12	7.9	F	8	124	None	Severe	Normal	None
13	9.7	M	6	50	None	Moderate	Normal	None
14	33.6	F	8	7	None	Severe	Normal	None
15	6.1	M	8	4	Scarring of soft palate with repositioning of levator palatini muscles	Severe	Severe	Severe
16	8.0	F	6	39	None	Moderate	Normal	None
17	35.9	F	8	6	Implant lost 6 weeks postoperatively	Severe	Severe	Not done
18	20.1	M	10	4	Implant lost 4 weeks postoperatively	Severe	Severe	Not done
19	9.5	M	6	6	Implant lost 4 weeks postoperatively	Moderate	Moderate	Not done
20	8.1	F	6	23	None	Moderate	Normal	None
21	16.1	M	8	20	Implant lost 20 weeks postoperatively	Severe	Severe	Not done
22	32.0	F	8	20	None	Severe	Mild	Mild
23	26.3	F	8	63	Implant rotated Repositioned	Severe Moderate	Moderate Mild	Moderate Mild
24	17.4	F	6	19	None	Moderate	Normal	None
25	5.3	M	8	48	None	Severe	Normal	None
26	18.6	F	8	15	None	Severe	Normal	None

pharyngeal wall, extending 2 cm inferiorly from the base of the adenoid. The incision was extended to the depth of the prevertebral fascia. Skin hooks or retraction sutures were used to help elevate the mucosa and constrictor muscle from the fascia. Right angle scissors were used to dissect between the constrictor muscle and prevertebral fascia, in a blunt manner, toward the lateral pharyngeal wall and then superiorly underneath the adenoid tissue (Fig. 4).

The thickness of Proplast used was determined by measuring the anteroposterior length of the VPI as measured from the cephalogram, then doubling that distance (Table 3). The double thickness of Proplast was chosen to compensate for expected soft tissue compression and atrophy caused by the implant. If a Passavant's ridge was present, its anteroposterior dimension was added to the thickness of the implant because its function is nullified by the surgical procedure. The width of the implant equaled the distance between the lateral pharyngeal walls during phonation, as estimated from nasopharyngoscopy and videofluoroscopic base view studies. This measurement was usually 20 to 25 mm. The height of the implant was approximately 10 to 15 mm. An implant that is too narrow transversely may result

**TABLE 2   Results of Proplast Implantation by Subject Age**

| Age	Female	Male	No. of Patients	Implants Lost	Preoperative Speech Hypernasality Mod	Preoperative Speech Hypernasality Severe	Postoperative Speech Hypernasality Normal	Postoperative Speech Hypernasality Mild	Postoperative Speech Hypernasality Mod	Postoperative Speech Hypernasality Severe
5–10	3	9	12	1	6	6	10	0	1	1
10–20	4	2	6	1	3	3	4	1	0	1
20–36	5	3	8	2	1	7	4	2	0	2

FIGURE 2   Dingman Mouth Prop is used to provide access to the posterior pharyngeal wall.

in residual VPI because the soft tissues conform closely to the implant shape, which could leave lateral areas of insufficiency.

The Proplast was carved appropriately, impregnated with penicillin or another antibiotic, and placed beneath the constrictor muscles and against the prevertebral fascia at the level of the palatal plane as high as possible beneath the inferior aspect of the adenoid tissue (Fig. 5). Once posi-
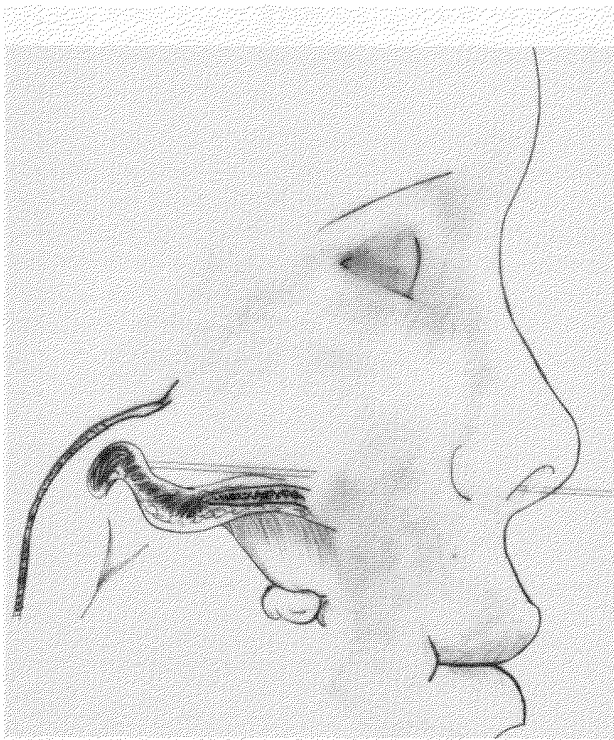
FIGURE 3   Sutures are placed through the soft palate and brought out through the nose to retract the soft palate in an anterosuperior direction.
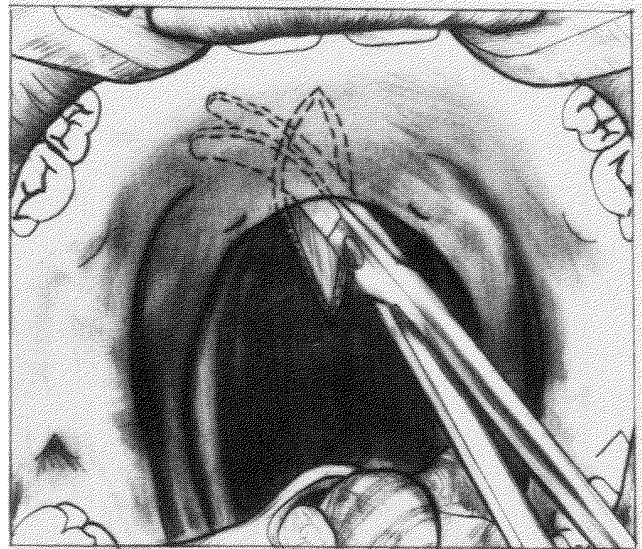
FIGURE 4   Right-angled scissors are used to dissect, in a blunt manner, laterally and superiorly between the superior constrictor muscle and the prevertebral fascia.

tioned, the overlying soft tissue holds the implant in place during healing because of the Proplast texture. However, tack sutures through the Proplast, which secured the implant to the prevertebral fascia, were used in some cases to aid in stability and to prevent subsequent displacement. The soft tissue flaps were then pulled over the implant and sutured under minimal tension with interrupted or continuous horizontal mattress sutures, followed by a running over-and-over suture using 000 or 4–0 Dexon; this technique ensured a watertight closure with minimal tension (Fig. 6). Significant tension would increase the possibility of suture breakdown and implant loss. Further lateral undermining may be necessary to relieve tension prior to suturing. The Dingman Mouth Prop was removed following completion of the surgery.

Although some operations were performed on a day surgery basis, most patients were hospitalized overnight. There were 14 patients who had other major procedures performed at the same operation, including lip and nose revision, closure of oronasal fistulae, bone grafting of alveolar clefts, or orthognathic surgery.

Postsurgical Evaluation

Postsurgical cephalometric radiographs were taken in the same manner as those done preoperatively. Postoperative cephalograms were taken at 3 months and 1 year after surgery and at subsequent long-term follow-up appointments. Cephalometric tracings were superimposed to evaluate migration, soft tissue change, osseous resorption beneath the implants, and subsequent facial growth.

Speech evaluations were done by two experienced speech pathologists. Ten patients were evaluated independently by both speech pathologists with direct clinical evaluations and recorded speech samples for interobserver reliability, which was 100 percent. The remaining subjects were assessed by only one of the speech pathologists. Resonance was rated as preoperatively. Mirror tests were done at most postoperative visits.

Nasopharyngoscopy was performed under 4 percent co-

TABLE 3   Results of Proplast Implantation by Implant Size

Size of Implant	Female	Male	No. of Patients	Implants Lost*	Preoperative Speech Hypernasality		Postoperative Speech Hypernasality†			
					Mod	Severe	Normal	Mild	Mod	Severe
6 mm	6	8	14	1	11	3	12	1	1	0
8 mm	6	4	10	2	0	10	5	2	0	3
10 mm	0	2	2	1	0	2	1	0	0	1

* Implants lost, 3 males and 1 female.
† Average follow-up (26 patients), 39.4 months; average follow-up of successful implants (21 patients), 46.9 months.

caine topical nasal spray anesthetic to evaluate soft palate, lateral and posterior pharyngeal wall function, and the presence or absence of velopharyngeal competence. This test was performed no sooner than 6 months after surgery. Patients 15, 17, 18, 19, and 21 did not undergo endoscopy postoperatively for the following reasons: patient 15 was lost to follow-up 4 months after surgery, whereas patients 17, 18, 19, and 21 lost their implants.

A clinical inspection of the position of the implant was undertaken to evaluate any detectable displacement of it. This was performed at all routine follow-up visits. Follow-up ranged from 4 to 124 months, with a mean of 39.4 months.

## RESULTS

Preoperative Assessment

Preoperative speech evaluation determined that 15 of the 26 patients had severely hypernasal speech and 11 had moderately hypernasal speech. The preoperative size of the velopharyngeal gaps ranged from 3 to 5 mm. Therefore, implant size ranged from 6 to 10 mm in anteroposterior thickness (see Table 1).

Postoperative Assessment

Follow-up evaluations demonstrated that 18 patients had normal speech without hypernasal or hyponasal resonance. Three patients had mildly hypernasal speech, one had moderate hypernasality, and four had severe hypernasality postoperatively. There were four patients (three males and one female) who extruded their implants, presumably secondary to infection, with three of the patients having residual severe hypernasality and the other with moderate hypernasality.

Patient Age

Of the 12 patients from 5 to 10 years of age, six were severely hypernasal and six were moderately hypernasal preoperatively. Postoperatively, 10 had normal speech, one had moderate hypernasality, and one had severe hypernasality. One patient (19) extruded the implant and had no change in his moderately hypernasal speech. Patient 15 had simultaneous soft palate surgery that resulted in hypertrophic scarring. The velar scarring may have contributed to this patient's severe hypernasality postoperatively. Of the six patients between 10 and 20 years of age, three had severe hypernasality and three had moderate hypernasality
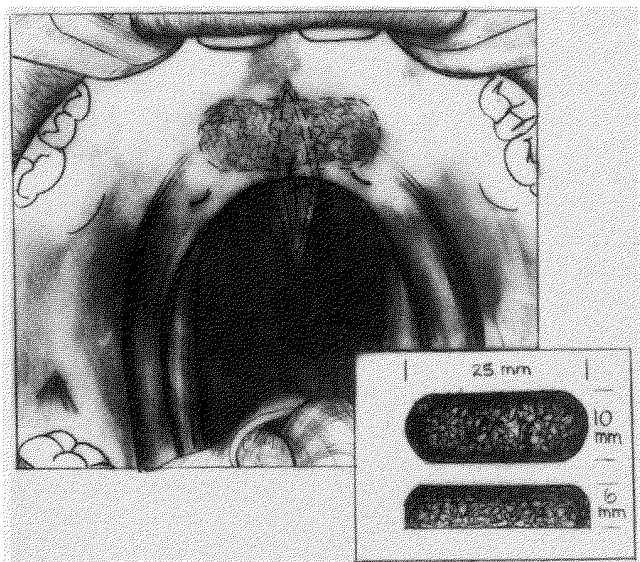
FIGURE 5   A Proplast implant is placed in the soft tissue pocket between the superior constrictor and prevertebral fascia. It is positioned as high as possible toward the basicranium.
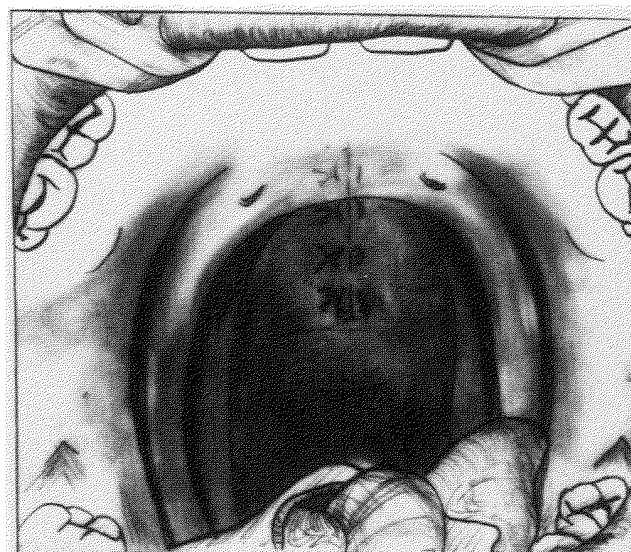
FIGURE 6   The soft tissues overlying the implant are closed with horizontal mattress sutures, which are then followed by a running continuous over-and-over suture. Watertight closure is critical for successful retention of the implant.

preoperatively. One patient (21) lost the implant and remained severely hypernasal. One patient (7) had moderate preoperative hypernasality and mild postoperative hypernasality. Four patients had normal speech postoperatively. The subjects over 20 years of age were the poorest responders. Preoperatively, seven patients had severe hypernasality and one had moderate hypernasality. Postoperatively, only four patients—half of the eight in this age group—had normal speech. Two were mildly hypernasal and two remained severely hypernasal. Two patients in this group, both of whom were severely hypernasal postoperatively, lost the implants.

Size of Implants

Fourteen of the patients had 6 mm pharyngeal wall implants placed (Table 3). There was one 6 mm implant lost secondary to infection, which resulted in moderate residual VPI. Twelve patients had normal speech and one had mild hypernasality. Ten patients had 8 mm implants placed and two of these implants were lost. Five patients had normal speech, two had mild hypernasality, and three patients had severe hypernasality, including two who lost implants (17 and 21) and 15, who had undergone simultaneous soft palate surgery with postoperative scarring that resulted in severe hypernasality. Two patients had 10 mm thick implants, one of which was extruded with severe hypernasality remaining postoperatively. The other patient had normal speech.

Twenty-one patients (80.8 percent) were judged to have had a successful result, with 16 having normal speech and five having mild hypernasality. Fifteen patients, ages 5.3 to 13.3 years, had long-term cephalometric evaluation post-

D.G.

—·— 6-28-76   (Pre-op)
---- 9-30-76   (3 mo. post-op)
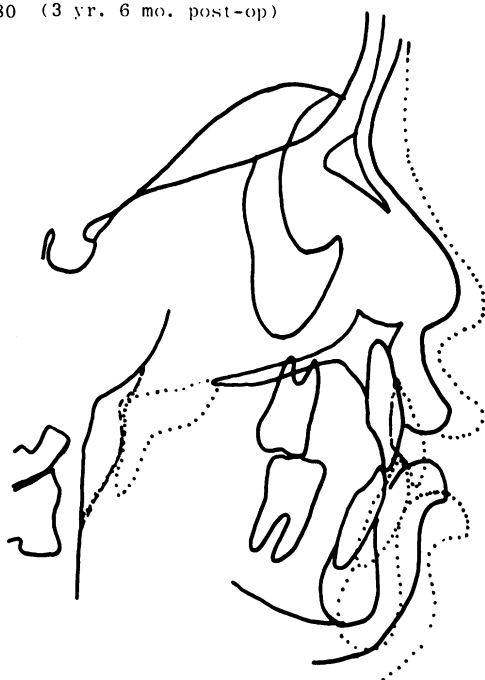···· 3-24-80   (3 yr. 6 mo. post-op)

FIGURE 7   Superimposition of lateral cephalometric tracings demonstrates stability of the implant as well as harmonious facial growth after surgery.

surgically to determine whether there was evidence of alteration in facial growth (Fig. 7); none was found. There was no detectable radiographic evidence of cervical resorption beneath the implants and no evidence of implant migration.

Complications

Complications were encountered in seven patients (Table 4). Patient 21 lost the implant 5 months after surgery. Patients 17, 18, and 19 lost their implants at approximately 4 to 8 weeks after surgery. In all cases of lost implants, hypernasality was unchanged postoperatively. All four patients who lost the implants declined further treatment. The loss of four implants represents 14.3 percent of the total number of cases.

Two cases (1 and 23) with significant postoperative hypernasality had problems associated with malpositioning of the implant. Patient 1 had the implant placed too low—below the functional level of the soft palate—and had residual severe hypernasality. The implant was later repositioned vertically, with normal speech postoperatively. Patient 23 did not have the implant secured to the prevertebral fascia, and immediately postsurgically, the implant rotated into a vertical position that resulted in residual moderate hypernasality. The implant was repositioned secondarily and secured to the prevertebral fascia. There was still residual mild hypernasality, but this patient would not participate in postsurgical speech therapy. Patient 15, who had undergone simultaneous soft palate surgery, was last seen at 4 months postoperatively, then lost to follow-up.

DISCUSSION

Proplast I is an implant material of vitreous carbon and Teflon and has been shown to be an effective and safe implant material in craniofacial reconstruction (Janeke et al, 1974; Kent et al, 1975; Bell, 1976; Freeman, 1976; Janeke and Shea, 1976; Dann and Epker, 1977). It is biocompatible and appears to generate no inflammation when used as an augmentation or recontouring material. It does not work well under loading (functional pressure placed on an implant as in a joint), where it tends to fragment with subsequent giant cell reaction (Timmis et al, 1986). However, when this material is used as a pharyngeal implant, it is under no stress or loading forces. Although this study reports the use of Proplast I as the pharyngeal implant material, the senior author now prefers to use Proplast II. Other materials have been used for pharyngeal implants, but poor predictability, migration, and a failure to be approved by the Food and Drug Administration have limited their usefulness. Proplast, when placed into soft tissues, appears to have some soft tissue ingrowth or develops a capsule surrounding it. Once the initial healing phase occurs, there does not seem to be any migration of the implant at a later time. The reason for placing pharyngeal implants is that of moving the posterior pharyngeal wall forward to correct small velopharyngeal insufficiencies. In our experience, gaps of up to 5 mm in the anteroposterior plane can be corrected with pharyngeal implants.

We have found it ideal to position Proplast implants on the prevertebral fascia as far superior in the posterior pha-

TABLE 4   Evaluation of Cases with Poor Results

Patient	Complication	Reason	Management
1	Residual severe VPI	Implant positioned too low	Repositioned implant further superiorly, which corrected VPI
15	Residual severe VPI	Simultaneous repositioning of levator palatini muscle with resulting scarring of soft palate	Patient subsequently had a pharyngeal flap procedure
17	Implant lost 6 weeks postoperatively	Probably secondary to poor soft tissue closure	Patient desired no further treatment
18	Implant lost 4 weeks postoperatively	Probably secondary to poor soft tissue closure	Patient desired no further treatment
19	Implant lost 4 weeks postoperatively	Probably secondary to poor soft tissue closure	Patient desired no further treatment
21	Implant lost 20 weeks postoperatively	Deep crypts in adenoid tissue probably seeded implant	Patient desired no further treatment
23	Implant rotated vertically postoperatively	Lack of implant stabilization	Repositioned implant and stabilized to prevertebral fascia, which significantly improved speech quality

ryngeal wall as possible. Although one patient (1) had an implant placed too low, we have never experienced an implant being placed too high in the posterior pharyngeal wall. Another consideration is the width of the implant, which should equal the functional width of the posterior pharyngeal wall during speech. If the implant is too small in a transverse dimension, the soft tissues, which adhere relatively tightly to the implant, could create voids between the lateral aspect of the implant and the lateral pharyngeal walls that could result in residual VPI. Therefore, the distance between the lateral pharyngeal walls during speech must be carefully assessed by nasopharyngoscopy and videofluoroscopic studies in base view. For optimal results, the incision must be closed under minimal tension, with a watertight closure. It is recommended that interrupted or continuous horizontal mattress sutures be used, followed by a continuous over-and-over suture.

We have observed one unusual phenomenon. It must be noted that correction of VPI with pharyngeal implants does not result in an immediate correction of hypernasal speech. It has been our experience that most postoperative patients continue to sound the same as they did prior to surgery. Consequently, it often takes 4 to 6 months of speech therapy following surgery for the individuals to learn how to use the implant mechanism. Young children usually adapt more readily than do adult patients. Speech therapy appears to be imperative postsurgically to assist the patients in learning to use this mechanism.

Pre- and postoperative speech therapy was provided by many different speech pathologists. Therefore the exact nature of postoperative speech therapy could not be fully determined. Further investigation is needed to determine the possible effects of both preoperative and postoperative speech therapy on ratings of nasality and articulation proficiency.

Superimposition of cephalometric radiographs, including presurgical, immediate postsurgical, and long-term follow-up, have demonstrated no change in position of the pharyngeal implants and no apparent effect on facial growth (see Fig. 7). There appears to be minimal atrophy of soft tissues overlying or underneath the pharyngeal implants. A number of patients had 3 month postsurgical films and long-term follow-up that showed essentially no soft tissue change. It is

felt, however, that the larger the implant, the more tissue thinning can be expected over the implants. We feel that there should be, on average, less than 10 percent atrophy of tissue overlying the implants. The sole exception may be patients with large adenoid masses, who may have atrophy of the adenoid tissue overlying the implants. We do not recommend the use of this procedure when large adenoid masses are present.

In our experience, the following criteria should be met if a patient is to be considered for a Proplast pharyngeal implant:

1. Good velar movement during speech
2. A gap of 5 mm or less in the anteroposterior plane
3. Small to moderate adenoid size without deep crypts
4. Less than 4 mm compensatory posterior pharyngeal wall movement (Passavant's ridge formation).

Insertion of a Proplast pharyngeal wall implant will eliminate all conpensatory superior constrictor muscle function (Passavant's ridge). To compute the needed implant thickness, the following formula should be followed:

$$\text{Thickness of Passavant's Ridge} + 2(\text{Size of VP Gap}) = \text{Implant Thickness}$$

For example, a patient with a 2 mm Passavant's ridge during speech and 3 mm of VPI will require an implant of

$$2 \text{ mm} + 2(3 \text{ mm}) = 8 \text{ mm Implant Thickness.}$$

It is interesting to note that young patients seem to benefit most from pharyngeal implants (see Table 2). Two patients (11 and 12) have been followed for ten years postoperatively and have maintained their speech results and had no negative side effects. The poorest results were seen in adult patients. Results were also better when implants were smaller; fewer implants were extruded and postoperative speech results were better when implants were 6 mm or less in thickness.

Although the patient numbers in each group are too small to arrive at a significant statistical analysis, it appears from these data that the larger the implant is, the greater the probability for loss of that implant. The younger the patient is, the less chance for loss of the implant, whereas the older

the patient is, the greater the chance for implant loss. Young patients with 6 mm implants had the best results.

The advantages of this technique are as follow:

1. It is a simple procedure that can be done on a day surgery basis;
2. There is no apparent alteration of the functional nasal airway;
3. Normal physiologic function of the velopharyngeal mechanism is maintained;
4. There is no apparent effect on facial growth; and
5. Velopharyngeal insufficiency can be eliminated in properly selected cases.

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Commentary

A variety of procedures have been advocated for the treatment of velopharyngeal insufficiency (VPI), including a large assortment of surgical procedures. In the preceding article, Wolford and colleagues have proposed that Proplast implants are a safe and effective treatment approach for patients with mild VPI. VPI is the failure of the velopharyngeal valve to close completely during normally nonnasal speech. A variety of speech disorders have been associated with VPI. It is understood that hypernasal resonance, audible nasal air emission, and weak oral pressure during consonant production are the direct consequences of VPI, whereas compensatory articulations, such as glottal stops, pharyngeal fricatives, and perhaps some voice impairments, are secondary to VPI. The rationale for surgical treatment of VPI is to eliminate those symptoms directly caused by VPI. In the overwhelming majority of cases, the secondary disorders would not be expected to be eliminated spontaneously following surgical treatment of VPI and would require speech therapy.

In many treatment centers, patients with symptoms of

minimal VPI are not treated surgically because the surgical risks may exceed the potential speech benefits. In cases in which traditional reconstructive procedures, such as pharyngeal flap surgery, represent an unacceptable cost-to-benefit ratio, augmentation of the posterior pharyngeal wall has enormous appeal and is a treatment option that warrants further investigation.

Although Proplast may be a safe and effective method of posterior pharyngeal wall augmentation, it is unfortunate that the paper by Wolford et al has some methodologic limitations that prevent the reader from reaching a definitive conclusion regarding the full effectiveness of this procedure in eliminating VPI and the speech symptoms associated with it. It should be pointed out to the reader that these same limitations are frequently found in the surgical literature that deals with the treatment of VPI. Nonetheless, the flaws discussed below restrict our ability to endorse fully Proplast augmentation, in spite of its intrinsic appeal.

In the Results section, the authors report that

Follow-up evaluations demonstrated that 18 patients had normal speech without hypernasal or hyponasal resonance. Three patients had mildly hypernasal speech, one had moderate hypernasality, and four had severe hypernasality postoperatively.

The authors then report in the Discussion section that

We have observed one unusual phenomenon. It must be noted that correction of VPI with pharyngeal wall implants does not result in an immediate correction of hypernasal speech. It has been our experience that most postoperative patients continue to sound the same as they did prior to surgery. Consequently, it often takes 4 to 6 months of speech therapy following surgery for the individuals to learn to use the implant mechanism.

From the present report, it is unclear exactly what has been corrected. To their credit, the authors indicate that three evaluation methods were used postoperatively to assess the results, as follows: cephalometric radiographs, nasopharyngoscopy, and perceptual speech evaluations. However, in the Results section Wolford et al present no data from the radiographs or endoscopy to document the change in the size of the velopharyngeal gap or the pattern of closure. Instead the authors report their results of perceptual analysis of resonance as their only measure of surgical success. It is therefore somewhat confusing how the authors arrived at their conclusion that Proplast successfully corrected VPI but did not result in an immediate correction of hypernasality. Additionally, no data are available in the paper to clarify how much time elapsed between the surgery and postoperative evaluations. We also cannot determine how much—or what type—of speech therapy was administered.

How then can the reader conclude (as the title suggests) that Proplast or the technique described for its application as a posterior pharyngeal wall implant corrects VPI if (1) the only reported measure of VPI is the perceptual judgment of nasality and (2) the authors report that "most postoperative patients continue to sound the same as they did prior to surgery"? It might be possible that a comparison of preoperative and postoperative radiographic and endoscopic measures would have shown a reduced velopharyngeal gap with continued abnormal speech. These data, however, are not reported. Speech, and particularly hypernasality, was the

only reported measure of VPI, and it was not often improved postoperatively. It cannot be concluded from the data reported that the operative procedure was responsible for correcting the VPI.

Similarly, because a period of 4 to 6 months of postoperative speech therapy was necessary for "individuals to learn how to use the implant mechanism," another question must be raised. Would these patients have shown equal or similar improvements in their speech with speech therapy alone? It is a common clinical observation among speech pathologists familiar with VPI that some speakers will often demonstrate variable velopharyngeal closure during speech depending on a number of variables, such as phonetic context, speaking rate, and effort (to name only a few). Abnormal speech patterns associated with VPI may be the result of a true physiologic limitation or of inappropriate articulation and/or faulty learning. The data reported by Wolford et al concerning preoperative speech assessments are incomplete. It is unclear whether the patients received speech therapy (and if so, what type) prior to surgery. A more serious problem is that the types of articulation problems shown by the patients preoperatively are not specified. The reader cannot determine whether any or all of the patients had compensatory articulation patterns. It is now well recognized that patients with compensatory substitutions almost always have VPI during production of those substitutions that may be eliminated once normal articulation is established (Henningsson and Isberg, 1986; Hoch et al, 1986). It should also be noted that, in some patients with oronasal fistulae, VPI is demonstrated with the fistula open but not when the fistula is closed or covered. In the series reported by Wolford et al, some patients had fistula repair at the time of implant surgery. Therefore, the reader must question whether the preoperative symptoms of VPI were the result of a true structural limitation or whether the patients were simply failing to make use of the system preoperatively, just as they failed to make use of it postoperatively without a 4 to 6 month course of speech therapy. In fact, Wolford et al specifically report one patient (23) who declined speech therapy and had residual mild VPI after the successful repositioning of the implant. Because postoperative endoscopy was not performed until at least 6 months after surgery (presumably after speech therapy had already been initiated), it is not possible for the reader to distinguish the effects of surgery from those of speech therapy. It should be noted, however, that the poorest results in the series of patients reported by Wolford et al were in adults, who tend to be the most resistant to speech therapy.

Morris (1984) describes two groups of patients with "marginal" VPI based on speech assessment. One group shows slight, but consistent nasalization and is not stimulable for improvement. The other group shows inconsistent nasalization but is usually stimulable. Morris (1984) suggests that patients in the consistent nonstimulable group are appropriate candidates for physical management, whereas patients in the inconsistent stimulable group are candidates for speech therapy. This second group of patients would also be good candidates for other nonsurgical forms of treatment, such as speech bulb reduction or biofeedback. Differentiation between these two groups can only be made by a comprehensive diagnostic battery, which includes direct observation of velopharyngeal valving during a varied sam-

ple of dynamic speech, and by observing and documenting the patient's response to behavioral therapy (i.e., speech therapy, bulb reduction, or biofeedback). If the patient shows a true minimal velopharyngeal gap and is not responsive to behavioral therapy, it is likely that a surgical procedure such as posterior wall augmentation may be of value. Therefore, as the authors suggest, Proplast implants may be beneficial in a select group of patients who meet specific criteria for treatment. However, it may be that the criteria discussed by Wolford et al require modification to include a patient's response to behavioral therapy. While the reader should also be aware that behavioral therapy is not without financial, emotional, and temporal cost, treatment centers must determine where the most favorable cost-to-benefit ratio lies. Proplast augmentation requires both a general anesthetic and pharyngeal surgery and is therefore not without risk.

Because relatively few clinicians have extensive experience with the use of Proplast in the pharynx for VPI, it is difficult to assess the significance of the extrusion rate of the implants. It is to be expected that early efforts with a promising procedure may yield less than ideal results. However, implants may extrude as a result of impingement on their edges by the medially moving lateral pharyngeal walls. Wolford et al assessed preoperative lateral pharyngeal wall movement with the combined use of nasopharyngoscopy and base view fluoroscopy. Neither of these procedures is the best method for assessing the true extent of lateral pharyngeal wall motion (see the commentary by Skolnick on p 91). Shprintzen (1983) has reported the importance of using frontal view videofluoroscopy for assess-

ing both the extent and vertical level of lateral wall movement. It might be suggested that the preoperative protocol be revised to include this view in order to have a better estimate of the transverse width of the implant.

Dr. Wolford and his colleagues are urged to examine their data with respect to the criticisms listed above. His considerable experience with this promising procedure will benefit us all if we are able to target a well defined patient group to whom it can be applied. In the Discussion section, the authors note the importance of explaining the effects of speech therapy. This may be particularly important for patients with smaller velopharyngeal gaps. It is hoped that we will see additional reports on efforts in this area.

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