A Tendon Transplant Pharyngopalatoplasty

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A new *pharyngopalatoplasty* procedure utilizing a *palmaris longus tendon graft* has achieved consistently gratifying results in selected patients with functional palatal musculature. Although originally proposed as a dynamic pharyngopalatoplasty, this technique may also be successfully used as an aid in the salvage of the multiply operated, extensively scarred, and still incompetent palate.

This paper describes the evolution of the current procedures and details of the operative technique. Intraoperative photographs of an illustrative case are included.

Experience with a preliminary series of thirteen varied patients with follow-ups ranging from seven years, eight months, to one year, eight months, is reported. The results are discussed. The apparent advantages and disadvantages and the indications for the use of the procedure in selected cases are discussed.

Introduction

Several investigators have attempted to devise a dynamic, physiologically-based, velopharyngeal sphincter reconstruction for correction of velopharyngeal insufficiency in the cleft palate patient (Browne, 1935; Broadbent and Swinyard, 1959; Hynes, 1950; Thompson, 1974). Thompson (1971) reported successful free muscle transplantation by non-microsurgical means with a number of promising possible applications. Prompted by his work, Song and Bromberg (1974) used free autogenous transplantation of the denervated palmaris longus muscle and tendon unit in an attempt to produce a dynamic sphincter mechanism. As a result of their investigations, three important conclusions were reached: 1) They were unable to reproduce Thompson's results of successful free-muscle transplantation. Postoperative biopsies of the area into which the muscles had been transplanted showed no significant muscle remaining. After long term follow-up, no significant posterior pharyngeal wall augmentation was noted. 2) The lengthening of the soft palate achieved with the Wardill push-back procedure, which was an integral part of their technique, was very well maintained. It was their impression that this was due to the tendinous traction provided by their muscle and tendon unit. 3) There was marked improvement in the velopharyngeal competency and an apparent augmentation of palatal and pharyngeal movements, although there was no significant survival of the transplanted muscle.

These findings prompted some reworking of the original operative design by the senior author of this paper and led to the evolution of our current operative technique.

Procedure

OPERATIVE TECHNIQUE. Taking care to identify the eustachian tube orifices and to avoid incision and dissection in their area, two parallel vertical incisions 0.5 cm. in length were made as high in the posterolateral pharyngeal wall as possible (Figure 1). These incisions were carried down to the prevertebral fascia and were connected by a tunnel at this level through the posterior pharyngeal wall. A length of 2-0 silk suture was then passed into one incision and drawn through

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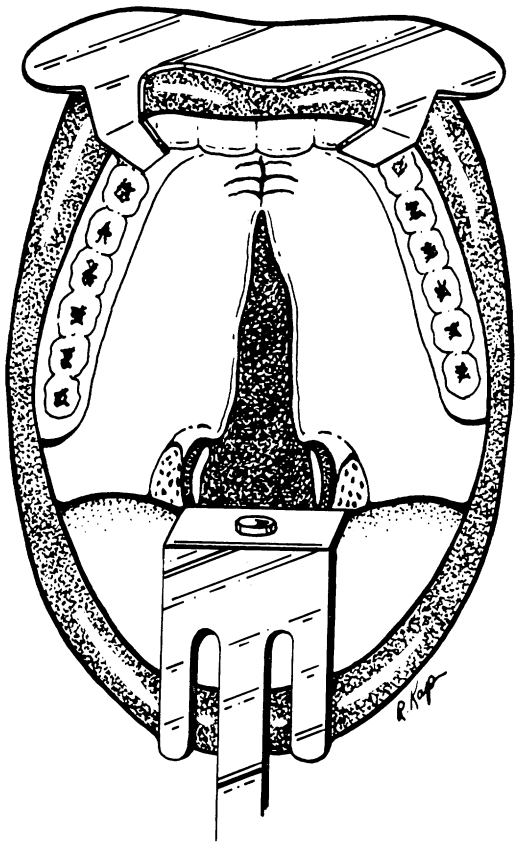

FIGURE 1. Two parallel incisions, 0.5 cms. in length, are made as high in the lateral posterior pharyngeal wall as possible. Care is taken to avoid the area of the eustachian orifices.

the tunnel and out through the other incision (Figure 2).

Attention was then directed to the palate itself. If the palate had been previously repaired, the cleft deformity was recreated and approached as a new cleft. A Wardill push-back palatoplasty was designed and the anterior, lateral, and medial incisions made (Figure 2). The muscle layer was dissected free from the nasal and oral mucosa for a distance of at least 1.0 cm. from the open edge of the cleft and was freed from its abnormal insertion into the hard palate if such insertion still remained. Dissection at the level of the prevertebral fascia was resumed, now lateral to the original posterior pharyngeal wall incisions. This dissection was continued laterally beneath the pharyngeal wall musculature and anteriorly into the muscle layer of the soft palate. The 2-0 silk suture was then passed into the more lateral tunnels and brought out through the open cleft margin in the muscle layer. The palatal flaps were then elevated and mobilized and the nasal mucosa and muscle closed in separate layers with 5-0 Dexon sutures.

A palmaris longus tendon graft was then taken from either forearm exactly as it would be for use in reconstruction in the hand. One end of the graft was tied to the 2-0 silk suture, and the tendon was carefully drawn into the tunnel which extended through the muscle layer of the soft palate along the lateral and posterior pharyngeal walls at the level of the prevertebral fascia. The graft was then passed through the muscle layer of the contralateral side of the palate (Figure 3) and was drawn, in purse-string fashion, as tightly as possible (Figure 4). It was sewn into the contralateral muscle layer with 4-0 white nylon sutures. The tendon ends were then brought out through stab wounds in the oral palatal mu-

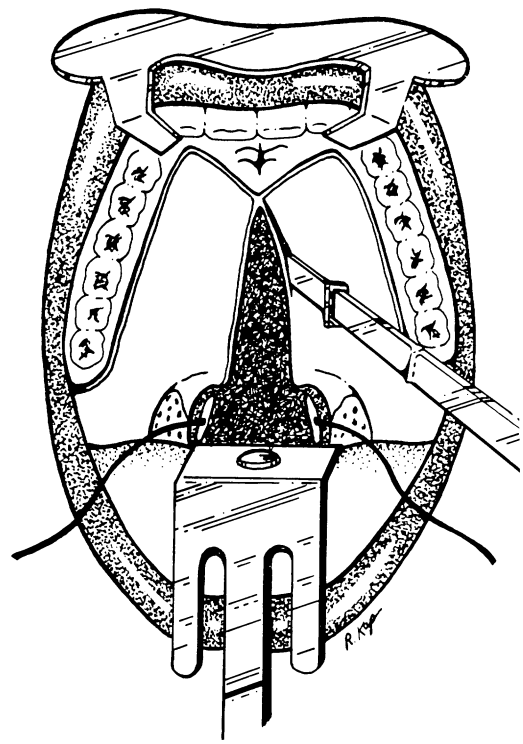

FIGURE 2. A 2-0 silk suture is passed through the posterior tunnel. A Wardill push-back palatoplasty is designed and incised.

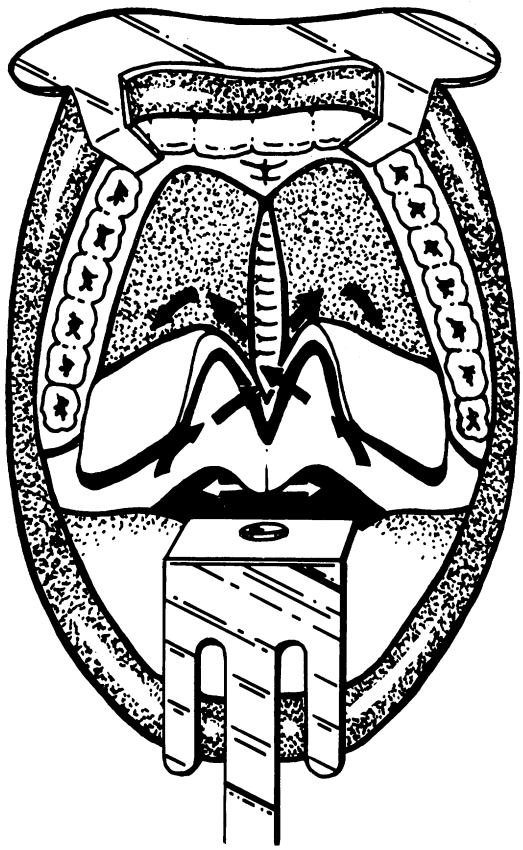

FIGURE 3. Dissection continues around the lateral pharyngeal walls lateral to the pharyngeal musculature and into the muscular layer of the soft palate. With the nasal mucosa closed, the arrows show the path to be taken by the tendon graft.

cosa and secured with 4-0 Dexon sutures. The oral palatal mucosa was then closed with 5-0 Dexon (Figure 5). Intraoperative photographs of this procedure being used in the salvage of a scarred, incompetent palate (Figures 6, 7, 8, 9), serve to illustrate this technique in detail.

PATIENT POPULATION. The series consisted of 13 patients who had been operated upon since 1972. Free transplantation of the denervated muscle with its tendon split was used in the first six patients in keeping with our earlier technique (Song and Bromberg, 1974). The palmaris longus tendon alone was used in the last seven cases according to the method described. (Although no functional transplanted muscle remained in the first group, continuity of the tendon sling was apparently maintained by fibrosis. Reporting of the two groups together would, therefore, seem justified). Six of the patients were male; seven were female. Nine were born in the United States and four in other countries. Six had bilateral cleft lip and palate; two had unilateral cleft lip and palate; five had clefts of only the secondary palate. Ten had had one or more previous palatal procedures (most had had at least two) with persistent velopharyngeal incompetence prior to our palmaris tendon pharyngopalatoplasty. Three patients with clefts of the secondary palate alone had our technique used in conjunction with their initial palatal repair. The age of the patients at the time of this procedure ranged from two years, eight months, to 22 years, two months, with an average age of 11 years, five months.

One major criterion for the selection of candidates for this procedure was that they have functional, viable palatal musculature. If the tendon sling indeed functions actively to augment velopharyn-closure, it does so only

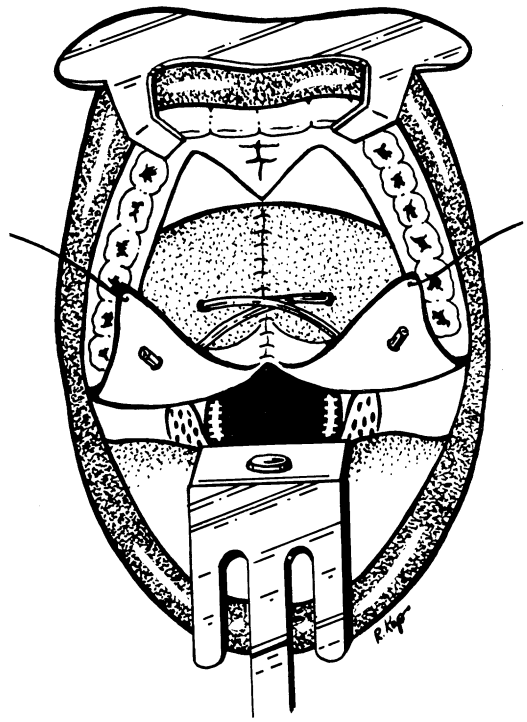

FIGURE 4. The muscle layer has been repaired, and the tendon has been drawn through the formed tunnels and sutured to the muscle of the contralateral palate. The oral mucosa is turned down to better demonstrate the course of the tendon.

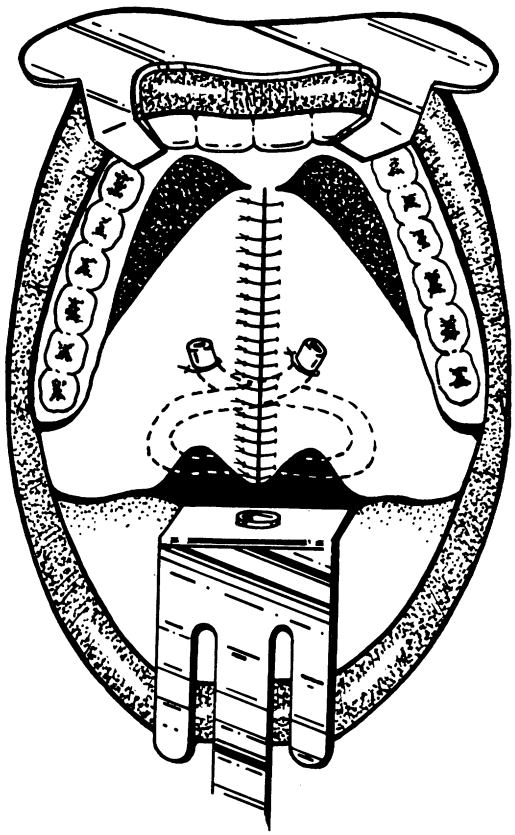

FIGURE 5. The completed repair demonstrating the final position of the tendon graft. Notice the tendon ends protruding through the oral mucosa. This allows visual confirmation that the graft is remaining in place during the healing period. These ends will eventually slough and the oral mucosa rapidly obliterates their exit points.

through the transmitted contraction of the repositioned palatal musculature. Freeing and retrodisplacement of the abnormally inserted palatal musculature with an "intravelarveloplasty" is, we feel, mandatory in all cleft palate repairs (Braithwaite, 1964; Braithwaite, 1968; Kriens, 1969; Edgerton and Dellon, 1971; Honjo et al., 1980). Because of the multiple previous operative procedures which most of our patients had had, preoperative electromyography of the palate was performed to assess the contractility of the palatal musculature. This was admittedly accomplished with some difficulty in our younger patients but was thought to be necessary in order to confirm the functional status of the muscle in these often extensively scarred palates. This is, of course, not part of our routine evaluation of the patient with cleft palate or of those patients in whom palatal muscle formation is clinically obvious. It was not performed in those patients even in this series when they had not been operated upon before.

Postoperative electromyography was performed only in those six patients who had had free muscle transplantation in order to determine the viability of the transplant. It was not considered necessary to reconfirm the contractility of the repositioned intrinsic palatal musculature.

Results

OUTCOME. The velopharyngeal competency and speech of our patients were evaluated preoperatively and postoperatively by our cleft palate team. Follow-up in these patients ranged from seven years, eight months, for our first case, to one year, eight months, for the most recent case included in this report.

There was only one complication and subsequently less than a satisfactory result in our group. This occurred in our fourth patient, in whom the flexor carpi ulnaris muscle and tendon unit was transplanted because of a bilaterally absent palmaris longus. Apparently, because of the greater bulk of this muscle, there was exposure of the muscle belly through the posterior pharyngeal wall. Although his palatal competency was somewhat improved, he had persistently poor palatal motion which we feel resulted from delayed healing, excessive scarring, and possible disruption of the continuity of the sling of the muscle-tendon unit.

The three patients in whom no previous palatal surgery had been performed obviously showed a dramatic improvement in their speech. Unfortunately, no reasonable assessment could be made of the contribution of the palmaris tendon graft to this improvement beyond that which would have resulted from a routine palatal repair alone.

All of the remaining patients were judged by our cleft palate team to have had good or excellent speech improvement. The possible ratings were "unimproved," "fair," "good" or "excellent." Their evaluation was based upon a subjective review of comparative preoperative and postoperative single sound, word, and connected speech recordings, physical ex-

FIGURE 6. As an illustrative case, this patient is male aged 9 years, eight months, with a complete unilateral cleft lip and palate deformity repaired in multiple stages at other institutions. One previous procedure was an island palatal flap. This shows his extensively scarred and incompetent palate prior to tendon transplant pharyngopalatoplasty.

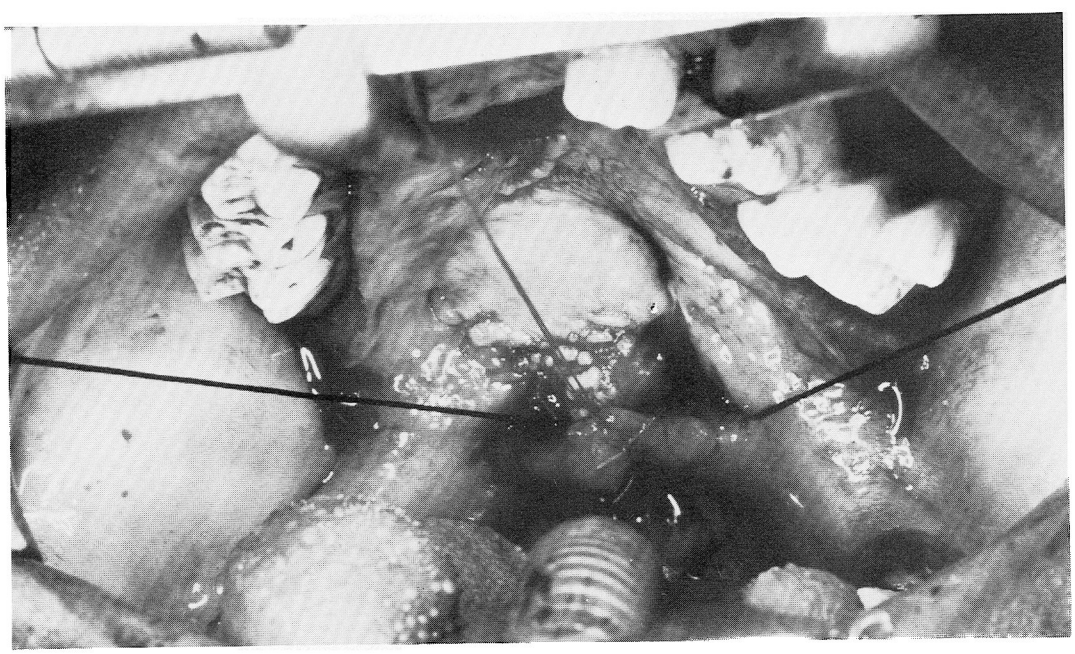

FIGURE 7. Temporary traction sutures retract the repaired uvula. The 2-0 silk suture is seen emerging through the muscle layer of the soft palate.

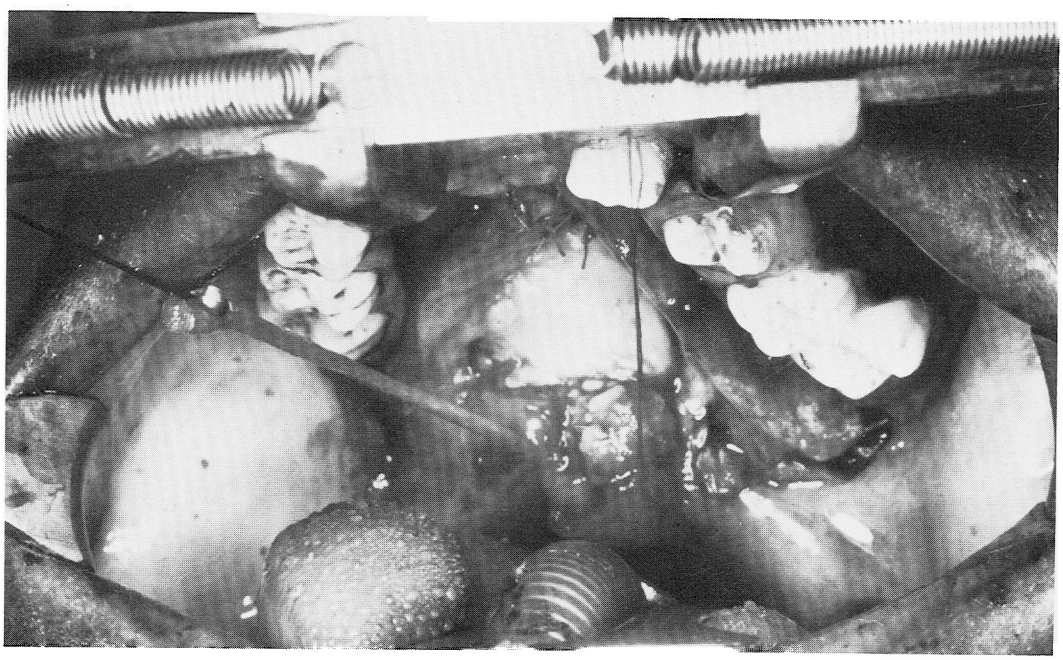

FIGURE 8. The tendon graft is shown being drawn through the pharyngeal and palatal tunnels.

amination, direct observation of palatal and pharyngeal wall motion and, in some cases, comparative cineradiography.

Postoperative photographs of some of our earlier patients showing what was felt to be the purse-string effect of the intact muscle-tendon unit have appeared in an earlier publication (Song and Bromberg, 1974).

There are a number of unfortunate inadequacies in the evaluation of our results which should be examined. One reviewer of this paper aptly pointed out that we shared a chronic problem of many papers dealing with correction of velopharyngeal incompetency. That is, reference is made to speech improvement, but the measures used to determine competency, as distinguished from other elements of speech, are not specified or objectified. Other than the subjective assessment of decreased nasal air escape, increased intelligibility of speech, and improved palatal motion on physical examination, we had no objective measures of improvement in velopharyngeal closure.

Unfortunately, flexible fiberoptic nasendoscopy was not available at our center during the years in which our study was performed, and our several cineradiographic examinations were not found to be particularly enlightening. Nasal airflow measurements were not taken.

Like the overwhelming majority of those who now perform cleft palate surgery, we feel that freeing, retrodisplacement, and reconstruction of the palatal musculature is mandatory in all cases. Unfortunately, it has not, therefore, been possible to isolate the effects of the tendon transplant alone from the action of the reconstructed palatal musculature. Although objective demonstration of the theoretical augmenting and of the dynamic benefits of the procedure has not been possible, subjective improvement in palatal competency and speech has been observed with this procedure in patients who had had previous muscle reconstruction along with persistent palatal incompetency.

We acknowledge that our patient series is too small and the deformities and velopharyngeal insufficiencies too varied to permit us to draw statistically significant conclusions at this time. However, our clinical results and initial subjective impressions appear encouraging enough for us to continue to recommend consideration of this procedure for salvage in selected cases. The procedure is no

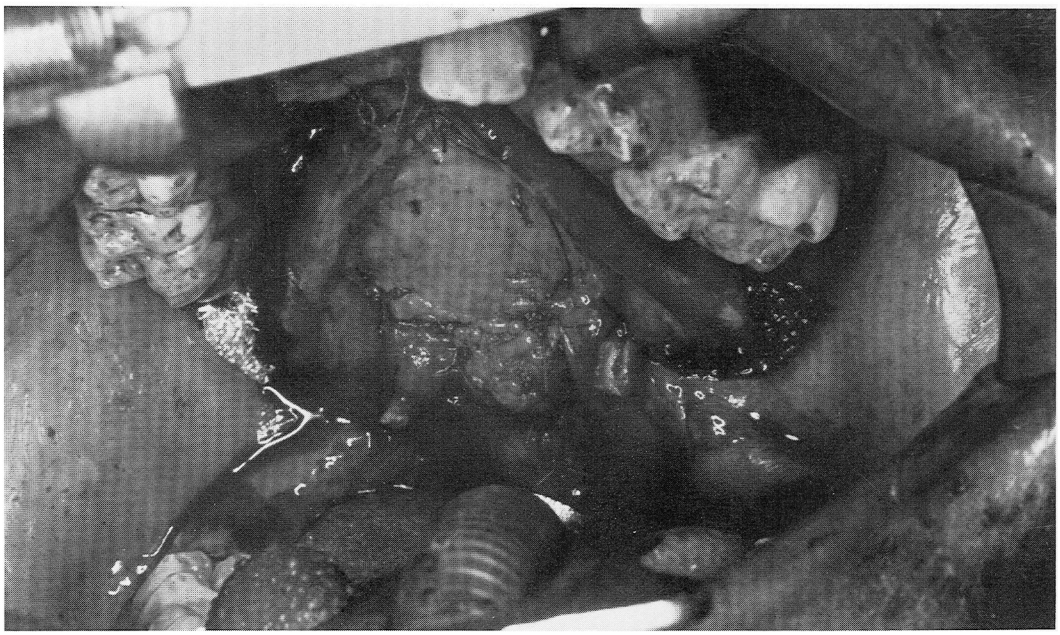

FIGURE 9. The completed pharyngopalatoplasty showing marked retrodisplacement of the soft palate and narrowing of the velopharyngeal port. Note the two tendon ends which have been brought out through the oral palatal mucosa.

longer performed as part of a primary palatal repair.

DISADVANTAGES. What, if any, are the disadvantages of this technique? There seem to be only three.

First, in the procedure described, there is no *objective* means of controlling the size of the velopharyngeal port produced. It should be noted that, since the tendon passes deep to the pharyngeal musculature, no excessive force is exerted against the pharyngeal mucosa; it is the full-thickness of the pharyngeal wall and not just the mucosa that is being displaced anteromedially. The retrodisplacement of the palate combines with this to make the narrowing circumferential. This disadvantage might be obviated by the introduction of a catheter or calibrated spacer through the nose and into the pharynx so that the new pharyngeal opening can be more accurately measured, much as in the lateral port control technique (Hogan, 1973).

Secondly, in order for this technique to *augment* the dynamic sphincter mechanism, there must be functional, contractile muscle in the soft palate. In addition, the muscle sling must be reconstructed. If, as a result of the scarring of previous surgical procedures or of an intrinsic disease state, this is not the case, then certainly only a static sling effect will result.

Thirdly, it introduces no new tissue into the palate. If there is a marked tissue deficiency due to previous surgery, trauma, etc., then a tissue adding procedure (traditional pharyngeal flap, etc.) must be employed.

ADVANTAGES. There are five major advantages to this technique. 1) It protects the palatal repair by relieving tension on the suture line. By being sutured to the *contralateral* palatal musculature, the end of the tendon sling is pulled toward the midline rather than away from it. This internal "splinting effect" is a particularly important benefit in the scarred, multiply operated, poorly vascularized palate which so many of our patients have had. 2) It acts as a "biological retention suture" and maintains the soft palate in the desired retrodisplaced position.This appearance may be in part because of anterior displacement of the posterior pharyngeal wall, but it seems to be greater than that achieved with reconstruction of the muscle sling alone. 3) It *circumferentially* narrows the pharyngeal

port, which would theoretically seem to be particularly important in those patients with lateral insufficiency. With the degree of retrodisplacement of the velum possible and the full thickness of the pharyngeal wall (muscle and mucosa) being medially and anteriorly displaced as well, almost any desired port size can be achieved. 4) Violation and scarring of the posterior pharyngeal wall is minimal. 5) Importantly, *in the presence of functioning palatal musculature only*, we feel the tendon sling may augment the dynamic action of "normal" velopharyngeal closure by assisting the posterosuperior elevation of the soft palate and anteromedial pharyngeal wall motion with normal palatal muscle contraction.

Summary

We have presented a pharyngopalatoplasty procedure utilizing a palmaris longus tendon graft in conjunction with available functioning palatal musculature with which we have achieved consistently gratifying results in selected cases. We have utilized this approach in a variety of cleft situations in 13 patients since 1972. We do not suggest that this technique is indicated or necessary in all cases or that it should be used in conjunction with primary palatal repair. An analysis of our results, however, would indicate that this is a technique which could be quite beneficial when utilized in selected problem cases and that it is one which may be a meaningful addition to our cleft palate reconstructive armamentarium.

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