Location of the Levator Veli Palatini Insertion following Levator Retropositioning, Palatal Pushback, and Pharyngeal Flap Procedures

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Introduction

Previous studies have stressed the relationship between an anteriorly located levator veli palatini insertion and velo-pharyngeal incompetence in patients with repaired cleft palate, submucous cleft palate, or "neuromuscular" palatal deficiency (*4*, 8). Evaluation of the palatopharyngeal complex using cineradiographic technique is a documented objective method for determining the location of the levator veli palatini insertion, assessing palatal length and excursion velocity, and measuring nasopharyngeal depth (*7*). The position of the levator insertion following various operative procedures has not been documented on a long term basis.

Material

The study group included twenty patients ages 6–18 (average12 years). Twelve patients underwent combined levator retropositioning, palatal pushback, and pharyngeal flap procedures. Two patients underwent levator etropositioning alone. Six patients underwent superiorly based pharyngeal flap procedures; in two of the six patients, a palatal pushback was performed as well. The maximum post-operative follow-up was 5.5 years, and the minimum was 1 year (average 3.25 years).

Intra-operative estimates of levator retropositioning ranged from 5 to 20 mm (average 10 mm).

Method

The technique and instrumentation for cineradiographic evaluation of the palatopharyngeal complex has been described in detail (*4*, *8*, *7*). This

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Presented at the Annual Meeting, American Cleft Palate Association, New Orleans, 1975.

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FIGURE 1A

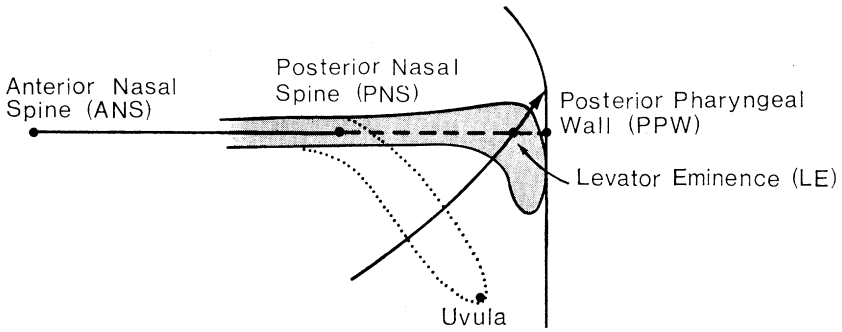

FIGURE 1B

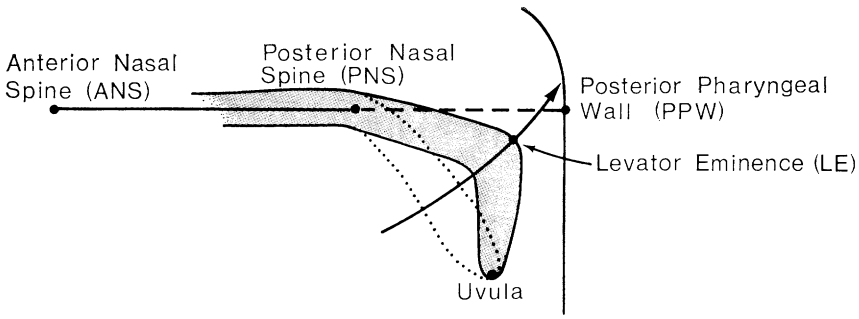

FIGURE 1A. (above) Schematic illustration of the levator eminence arc traversed in sequential frame analysis demonstrating anatomical reference points.
FIGURE 1B. (below) If velum failed to reach palatal plane, levator eminence (LE) measured at the point of highest elevation.

cineradiographic technique was utilized in a retrospective, pre- and post-operative, study of 20 patients undergoing levator retropositioning, palatal pushback, and/or pharyngeal flap procedures. Measurements were made in accordance with the earlier reports (Figure 1A) except for the determination of the levator eminence: in some cases, we found the upper limit of velar excusion failed to intersect the plane of the hard palate. The levator "knee" was, therefore, measured at its highest elevation during phonation (Figure 1B) whether or not it actually crossed the palatal plane (ANS-PNS). The distance from the posterior nasal spine to the levator eminence (PNS-LE) locates the insertion of the levator veli palatini. The normal levator insertion, in a variety of age groups, was determined by Hoopes *et al.* (*9*) to be 25 $\pm$ 2 mm. All measurements were corrected for magnification. We accepted a measurement of $\pm$ 2 mm. as being within the error of the method used to evaluate the cineradiographs; therefore a change in levator location of 4 mm. was considered remarkable.

Pre- and post-operative speech performance was assessed on the basis of pre-operative cine-sound studies and post-operative recordings and interviews.

TABLE 1. Cineradiographic measurements and speech evaluations.

PATIENT	DIAGNOSIS	OPERATION	LEVATOR INSERTION PRE-	POST-(mm.)	CHANGE IN LEVATOR INSERTION ±(mm.)	SPEECH RATING PRE-	POST-
E.M.	Congenital	Pushback, levator retropositioning, & pharyngeal flap	15.0	20.9	* + 5.9	3	2
C.W.	Post T&A	"	17.8	17.3	- 0.5	4	0
H.B.	CP	"	18.2	19.9	+ 1.7	4	0
D.E.	CP	"	18.6	16.2	- 2.4	4	0
E.P.	Congenital	"	18.7	20.8	+ 2.1	4	0
J.A.	CP	"	18.9	21.1	+ 2.2	4	0
K.G.	CP	"	19.9	23.2	+ 3.3	4	0
J.F.	CP-submucous	"	21.9	30.5	* + 8.6	3	0
C.A.	CP	"	24.3	25.9	+ 1.5	4	1
R.K.	CP	"	24.5	21.5	- 3.0	4	1
E.S.	CP	"	27.1	26.0	- 1.1	4	0
R.F.	Congenital	"	31.0	23.4	- 7.6	1	0
		Mean	21.3 ± 1.3	22.2 ± 1.1			
W.F.	CP	Levator retropositioning	15.0	29.8	* +14.8	4	3
B.W.	CP	"	22.2	28.4	* + 6.2	2	0
S.B.	Congenital	Pharyngeal flap	16.3	24.9	* + 8.6	4	1
B.B.	CP	"	20.5	18.2	- 2.3	4	0
B.S.	Congenital	Pharyngeal flap & pushback	22.7	15.1	- 7.6	3	0
J.H.	Congenital	"	26.3	20.9	- 5.4	4	3
S.N.	Congenital	Pharyngeal flap	27.2	18.3	- 8.9	4	0
L.H.	Post T&A	Pharyngeal flap	34.0	19.5	-14.5	2	0
		Mean	24.5 ± 2.3	19.5 ± 1.7			

Results

Values for the various parameters studies are provided in Table 1. The change in levator insertion is indicated as either a positive number posterior displacement or negative number anterior displacement. The pre-/post-operative levator positions and direction of change are graphically seen in Figure 2. Four of the 14 patients undergoing levator retropositioning, either alone (Group II) or in combaination with pushback and pharyngeal flap (Group I) had normal levator insertions on pre-operative ciné measurements (CA., R.K., E.S., & R.F). Four of 6 patients undergoing pharyngeal flap, either alone or in combination with pushback (Group III) had normal or posterior levator insertions (B.S., J.H., S.N., & L.H.)

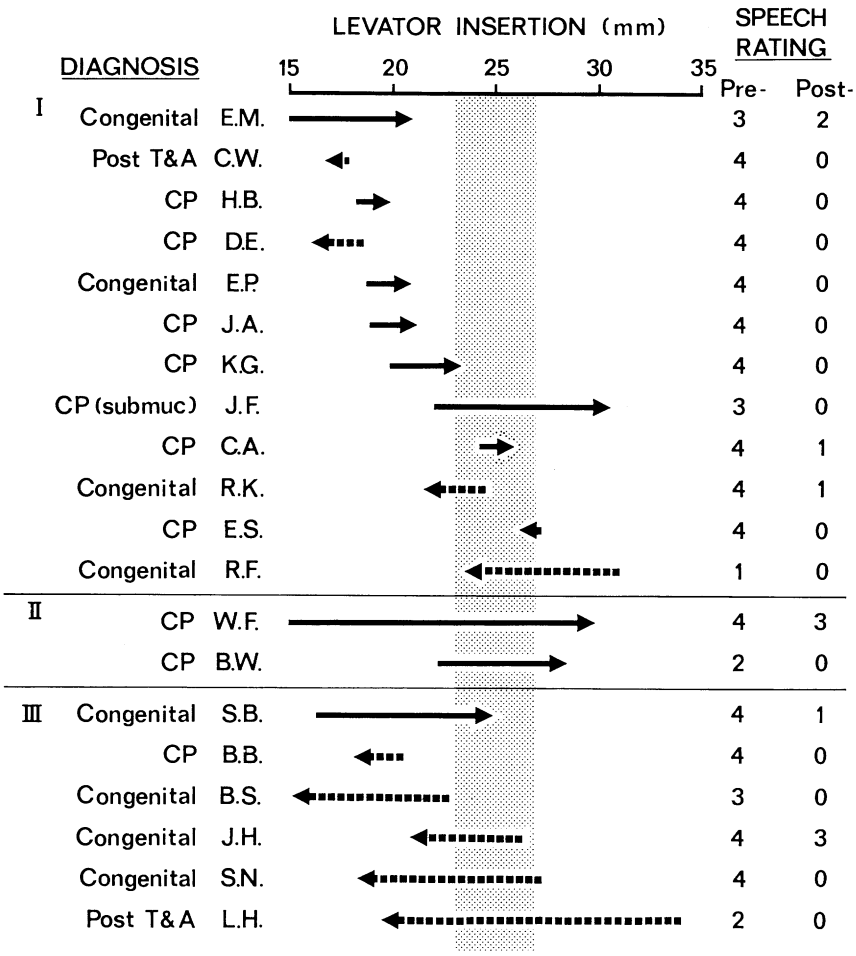

FIGURE 2. Graphic illustration of pre- and post-operative levator insertion in Group I (combined procedure), Group II (simple levator retropositioning), and Group III (pharyngeal flap)—solid arrows to right indicate posterior displacement, broken arrows to left indicate anterior displacement.

In Group I, 12 patients undergoing levator retropositioning in combination with pushback and pharyngeal flap, only two patients demonstrated remarkable posterior displacement post-operatively (E.M. & J.F.). In Group II, two patients undergoing levator retropositioning alone (W.F. & B.W.), both demonstrated post-operative posterior displacement (6 mm. and 15 mm., respectively). In Group III, 6 patients undergoing pharyngeal flap procedures, the 4 with normal levator insertions pre-operatively demonstrated post-operative *anterior* displacement ranging from 5.4 mm. to 14.5 mm. One patient with an anterior pre-operative position of the levator underwent a pharyngeal flap and on post-operative study, the levator insertion was determined to be 10 mm. retrodisplaced (S.B.)

There was no consistent post-operative change in the relative depth of the nasopharynx. Velar ascent rate was less than normal in all patients preoperatively and remained decreased in all patients post-operatively. The soft palate length, relative to the depth of the nasopharynx, remained unchanged or increased in all patients except for the two patients undergoing levator retropositioning alone; the relative length of the soft palate decreased post-operatively in these two pateints (W.F. & B.W.).

Speech rating, using the Bloomer Scale (*1*), indicated significant improvement in all except three patients (E.M., W.F., & J.H.); two of these three patients demonstrated significant levator retropositioning (E.M. & W.F.).

Discussion

Ruding (*10*), Braithwaite (*2*), and particularly Kriens (*5*, *6*) have emphasized the importance of posterior displacement of the levator "sling" during cleft palate repair. Recent studies have documented an anterior location of the levator insertion and related the magnitude of this displacement to the degree of velopharyngeal incompetence (*8*), providing the soft palate was of sufficient length to reach the posterior pharyngeal wall. A "preliminary report" (4 months follow-up) on 4 patients undergoing levator retropositioning demonstrated levator displacement in all 4 patients (4, 11, 4, and 5 mm.) (*4*). There was no significant change in the relative length of the soft palate, and the degree of velo-pharyngeal closure improved in all 4 patients. One patient had a palatal cleft; the other patients had velopharyngeal insufficiency without evidence of submucous cleft.

Dellon *et al.* studied 4 patients pre- and post-operatively (12–19 months follow-up) with hypernasal speech secondary to submucous cleft palate (*3*). These patients were treated by means of combined island flap push-back and pharyngeal flap; cineradiographic studies demonstrated the following:

1) no change in relative depth of nasopharynx
2) average increase in absolute length of soft palate of 10 mm.
3) average posterior displacement of levator insertion of 6 mm.
4) moderate decrease in velar excursion with no change in rate of ascent

In our institution, over the past five years, the levator retropositioning

procedure was combined with standard Veau-Wardill-Kilner pushback and superiorly-based pharyngeal flap procedure for velo-pharyngeal incompetence; in most instances, anterior displacement was documented on pre-operative ciné study. This retrospective evaluation of our 20 pateints has revealed the following:

1) Combined palatal pushback, levator retropositioning, and pharyngeal flap procedure does not give a change (over 4 mm.) in levator insertion. Only 2 of 12 patients demonstrated remarkable retrodisplacement, and one of these had little improvement in post-operative speech. Yet $^{10}/_{12}$ patients demonstrated satisfactory improvement in speech.
2) Levator retropositioning when employed alone resulted in significant retrodisplacement (W.F. & B.W.), but the subjective improvement in speech was minimal.
3) Pharyngeal flap, either alone or when combined with palatal pushback, resulted in anterior levator displacement in $^{4}/_{6}$ patients with normal or posterior pre-operative levator position. Yet, speech improvement occurred in all 4 patients.
4) The post-operative rate of velar ascent was slowed or unchanged following all operative procedures.

These observations indicate that when correcting a pre-operative anterior levator position, the post-operative location of the levator insertion is unpredictable—with the possible exception of levator retropositioning alone (4). Earlier studies suggest that island flap pushback and pharyngeal flap also may give predictable levator retrodisplacement (3).

Perhaps the pushback procedure, with creation of a raw nasal surface, negates eventual posterior displacement of the levator insertion because of eventual contracture pivoted on the fixed bony edge of the hard palate. Thus, if a pharyngeal flap is to be performed, it should be unnecessary to include pushback and/or levator retropositioning in the operative procedure.

When the levator insertion is normal or posterior in pre-operative position, a pharyngeal flap displaces the levator anteriorly. This phenomenon may be explained on the basis of division and anterior retraction of the levator sling during insetting of the pharyngeal flap. This explanation is supported by the one patient undergoing pharyngeal flap with a pre-operative anterior levator insertion and posterior shift on follow-up ciné (S.B., Group III). Careful examination of this patient's operative note revealed that the soft palate was divided "half-way" in preparing to receive the flap. Perhaps, in this case, the markedly anterior levator sling was spared and "tethered" posteriorly by the pharyngeal flap.

Conclusion

A long-term cineradiographic follow-up study of twenty patients with velo-pharyngeal incompetence fails to demonstrate predictable retrodis-

placement of the levator insertion following combined levator retropositioning, pushback, and pharyngeal flap procedures. Simple levator retropositioning gave posterior displacement in the two patients evaluated.

Patients with normal or posterior levator insertions pre-operatively all demonstrated post-operative anterior displacement following pharyngeal flap procedures, either alone or in combination with pushback.

Anterior levator displacement may be the result of scar contraction or division of the levator sling (during insetting of a pharyngeal flap).

Pre-operative and post-operative speech evaluation demonstrated substantial improvement in all except 3 patients; 2 of the poor speech results were patients with demonstrated levator retrodisplacement on post-operative cineradiography.

Acknowledgement: This work was supported by funds made available by The Golfers' Charitable Association, The Children's Hospital, Baltimore, Maryland.

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