The Effects of Le Fort I Osteotomy With Maxillary Movement on Articulation, Resonance, and Velopharyngeal Function

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Articulation, resonance, and velopharyngeal function were evaluated before and after Le Fort I maxillary advancement in 16 patients (seven with cleft lip and palate, one with cleft lip only, and eight without clefts). On the postoperative evaluation, seven of 11 patients with preoperative articulation errors showed an improvement in articulation after surgery. Two patients without clefts showed slight changes in nasal resonance, and two patients (one with cleft lip and palate and one with cleft lip only) developed mild nasal emission. Nine patients showed diminished velopharyngeal contact during speech on videofluoroscopic studies. Compensatory changes in velopharyngeal function were also observed, which included velar stretching and lengthening and increased lateral pharyngeal wall movement.

KEY WORDS: *cleft lip, cleft palate, maxillary advancement, Le Fort I, velopharyngeal closure, speech, articulation*

The Le Fort I maxillary osteotomy is a frequently performed operation used to resolve abnormalities of jaw relationships in patients with and without clefts. Articulation may improve following maxillary surgery (Schwarz and Gruner, 1976; Witzel et al, 1980; Ruscello et al, 1986). The normalization of dental occlusion has been shown to result in an improvement in the production of those speech sounds that require bilabial, labiodental, linguadental, and alveolar articulation. In her unpublished dissertation, Witzel (1981) found a significant relationship between articulation errors and horizontal discrepancies in the relationship between the maxillary and mandibular incisors. This was noted to be particularly true for the production of sibilant sounds (i.e., s, z sh, ch, j). Witzel reported improved articulation in most, but not all, patients in her study following surgical improvement of occlusal defects.

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Although the Le Fort I osteotomy with maxillary movement may result in improved articulation, it may also alter velopharyngeal relationships. Movement of the maxilla results in movement of the posterior border of the hard palate with its soft palate attachment. One might question whether velopharyngeal closure could be compromised by displacement of the velum relative to the posterior and lateral pharyngeal walls (Schuchardt, 1954; Converse et al, 1974; Bralley and Schoeny, 1977; Witzel and Munro, 1977; Schendel et al, 1979). Patients with palatal clefts would have a higher risk for developing velopharyngeal insufficiency (VPI) after maxillary advancement, especially if velopharyngeal closure was borderline preoperatively (Epker and Wolford, 1976).

The development of VPI after maxillary advancement has been previously described. Epker and Wolford (1976) reported that patients with borderline velopharyngeal closure may demonstrate VPI following maxillary advancement, particularly if the advancement exceeds 10 mm. They also observed that patients with significant preoperative VPI became worse after surgery. Schwarz and Gruner (1976) reported increased hypernasality of various degrees following maxillary advancement for 26 of their 31 patients with cleft palate and for four of their nine patients without clefts. Witzel and Munro (1977) reported the case of a 16-year-old patient with a history of cleft palate (CLP) who developed hypernasality after maxillary advancement of 10 mm. A palatopharyngoplasty was done 6 months after the maxillary advancement in order to restore normal resonance. In an unpublished doctoral dissertation, Witzel (1981) studied 70 patients before and after Le Fort I maxillary osteotomy. Eleven of these patients (nine cleft and two noncleft)

showed deterioration in nasal resonance, nasal emission, and velopharyngeal closure.

Other investigators have reported no detrimental effect on maxillary advancement on resonance or velopharyngeal function. Jabaley and Edgerton (1969) presented the case report of an 18-year-old male without history of cleft palate who experienced "no gross change" in the velopharyngeal relationship following maxillary advancement. Speech was noted to be "in the normal range" after surgery. Bralley and Schoeny (1977) reported the case of a 19-year-old patient with a history of submucous cleft palate who experienced no change in nasality following maxillary advancement. Schendel et al (1979) studied 21 patients through speech evaluation, lateral cephalometric radiographs, and nasopharyngoscopy. They found no change in speech or velopharyngeal competence following maxillary advancement. Dalston and Vig (1984) studied the effects of various forms of orthognathic surgery on the speech of 40 patients. Based on speech evaluation and assessment of velopharyngeal port area, oronasal acoustic coupling, and nasal resistance, they concluded that maxillary repositioning does not have a significant effect on velopharyngeal function.

The purpose of our current study was to explore possible changes in articulation, velopharyngeal valving, and resonance following maxillary repositioning.

Methods

Subjects

All patients who underwent Le Fort I osteotomies by one oral surgeon (WHG) in 1985 and 1986 were considered for participation in this study. Patients were included in this study if they were in good general health and had no history of mental retardation, neurologic disorder, or sensorineural hearing loss as determined by medical records or interview. Sixteen subjects, ranging in age from 14 to 35 years (mean 22 years), agreed to participate in both pre- and postoperative testing following informed consent. Seven of the patients had cleft palate, and of these, several had some degree of preoperative hypernasality. Two of the CLP patients (#10 and #16) had pharyngeal flaps. One subject (#9) had a cleft lip and alveolus (CL) only but also had preoperative hypernasality. The remaining eight subjects had no clefts (NCLP) and no preoperative hypernasality. None of the patients had speech therapy between pre- and postoperative evaluations.

Surgical Procedures

All subjects had a Le Fort I osteotomy extending from the piriform aperture to the pterygoid plates at a level several millimeters above the apices of the teeth. In all cases surgical movement of the maxilla involved either advancement or intrusion for superior repositioning. In some cases the maxilla was moved in both directions. It was not necessary to release the pharyngeal flaps in the two patients noted above. The type of surgical procedure for each patient is shown in Table 1.

In three cases the skeletal deformity could not be corrected with a maxillary procedure alone, and therefore a mandibular sagittal split osteotomy was also necessary. The type and degree of jaw movements necessary in each case was determined by cephalometric x-ray analysis, model analysis, and model surgery. The amount of jaw movement was verified intraoperatively by pre- and postosteotomy measurement of the intrabony reference marks in the maxilla. After the maxillary osteotomy was done and the maxilla was fixed in position, a mandibular osteotomy was done when necessary. The mandible was fixed in a predetermined relationship with the maxilla using an interocclusal acrylic template that had been constructed on the models.

Evaluation Procedures

Each patient underwent a pre- and postoperative speech evaluation and multiview videofluoroscopic speech study. The preoperative evaluations were done the day before surgery. The postoperative evaluations were done 3 to 6 months after surgery. At that time all fixation wires had been removed, and swelling was no longer considered a significant factor.

Speech Evaluation: Articulation and Resonance

Articulation was tested using single words and sentences that were read by each patient from the Templin-Darley Test of Articulation (1969). A speech sound was considered in error if it was misarticulated in at least one word position in at least one word. Each speech sound was counted only once. The presence of nasal emission during the production of a speech sound was not considered an articulation error. The speech sounds in error were then recorded for each patient on the pre- and postoperative evaluations.

The presence of hypernasality and nasal emission was tested by having the patients read sentences containing a high incidence of plosive, fricative, and affricate sounds. The patients were then instructed to count from one to 10 and from 60 to 70. Finally, a 3-minute sample of conversational speech was elicited. Resonance was rated as hyponasal, normal, or hypernasal to a slight, mild, moderate, or severe degree. The presence of nasal emission was rated as either consistent on all pressure sensitive consonants, inconsistent, or absent.

Articulation, resonance, and nasal emission were judged at the time of examination by one of the authors (AWK). This allowed the examiner to take advantage of visual cues. All examinations were also taperecorded so that another author (LL) could independently rate articulation, resonance, and nasal emission to establish reliability. Both judges are speech pathologists who have had more than 10-years experience working in the area of cleft palate. All tape recordings were made with the patient speaking within 6 inches of the microphone. The ambient sound level in the examination room was measured on a Quest Electronics Model 215 sound level meter (C scale) and was found to be less than 30 dB SPL on two separate occasions.

To establish interjudge reliability, a comparison was made between each judge's ratings of all articulation measures for all patient's ratings. This comparison revealed agreement in all but one patient's rating. This disagreement was felt to be attributable to the lack of visual cues for the second rater. Using the Pearson Product-Moment Coefficient of Correlation, the correlation coefficient between the two judges' ratings of articulation was found to be +0.99

TABLE 1 Pertinent Data for All Patients

Group	Patient	Age (Years)	Sex	Occlusal Classification	Type of Maxillary Surgery	Amount and Direction of Movement		Mandibular Surgery
						Advancement (mm)	Intrusion (mm)	
Noncleft palate group	1	18	F	Class II, open bite	Le Fort I		5	
	2	32	F	Class II, open bite	Le Fort I		3	Yes
	3	19	F	Class II	Le Fort I	3	4	Yes
	4	15	F	Class II, open bite	3-piece Le Fort I with posterior midline split and transverse osteotomy through 1st bicuspid area	3	2.5	No
	5	32	F	Class II, open bite	Le Fort I	3	4	
	6	24	F	Class II, open bite	Le Fort I		3	No
	7	39	F	Class II, open bite	Le Fort I		5	Yes
	8	23	M	Class II, open bite	Le Fort I	4	5	No
Cleft lip	9	17		Class III	2-piece Le Fort I with midline split	5	2	No
Cleft lip/ palate	10	21	M	Class III	2-piece Le Fort I with midline split	4	2	No
	11	14	F	Class III	Le Fort I	4	2	No
	12	21	M	Class III	2-piece Le Fort I with midline split	7	2	No
	13	14	M	Class III	Le Fort I	5	2	No
	14	25	M	Class III	Le Fort I	14	2	No
	15	18	M	Class III	2-piece Le Fort with midline split	2	2	No
	16	18	M	Class II	2-piece Le Fort I	6	2	No

with df = 702, which is significant at the 0.001 level of confidence. In comparing the ratings of resonance and nasal emission, 100 percent agreement was obtained between the two judges.

Videofluoroscopic Studies

The videofluoroscopic speech studies were performed according to the procedures described by Skolnick (1969). Lateral and frontal projections were included in the examinations. Barium was instilled into the nasopharynx through the nose via a small soft catheter in order to coat the velum and pharyngeal walls for the frontal view. Two patients (#4 and #5) refused to allow the barium to be introduced into the nasopharynx. Therefore, only the lateral view was done on these patients. In both lateral and frontal views, the patients were instructed to repeat sentences containing a high incidence of pressure sensitive speech sounds with high vowels. Nasals were intermixed in order to evaluate rapid movement of the velopharyngeal structures. The speech sample included the following tests: "Suzy sees the sun in the sky," "Popeye plays baseball at the park," "I like Coca-Cola, but I don't like cheesecake," "pitipitpiti," and counting 60 through 66.

A rating scale was developed specifically for this study with numeric values assigned to each descriptive statement on the scale (Table 2). Psychophysical rating scales have been shown to provide good reliability in rating videofluoroscopic speech studies (McWilliams-Neely and Bradley, 1964). Prior to rating studies for this investigation, the examiners independently rated five videofluoroscopic speech evaluations of patients not included in the present investigation. Interjudge reliability was established using the Pearson Product-Moment Coefficient of Correlation. The correlation coefficient was found to be +0.93 with df = 33, which is significant at the 0.001 level of confidence. In evaluating the studies for this investigation, the examiners viewed each study together several times. Each rating was determined through consensus after discussion.

RESULTS

Articulation

Preoperatively, 11 of the 16 patients (six CLP, one CL, and four NCLP) demonstrated articulation errors. On the postoperative evaluation, seven of these 11 patients showed a decrease in the number of misarticulated speech sounds

TABLE 2 Rating Scale Used to Evaluate Velopharyngeal Function from Videofluorscopic Speech Studies

Measure	*Function*	*Rating*
Velopharyngeal contact	Total closure	−1
	Touch closure	−2
	Narrow opening	−3
	Moderate opening	−4
	Wide opening	−5
	No movement	−6
Velar thickness	Thick	−1
	Average	−2
	Thin	−3
Velar length	Long	−1
	Average	−2
	Short	−3
Velar height during closure in relation to hard palate	Well above	−1
	Slightly above	−2
	At the level	−3
	Slightly below	−4
	Well below	−5
Lateral wall movement	Total closure	−1
	Touch closure	−2
	Narrow opening	−3
	Moderate opening	−4
	Wide opening	−5
	No movement	−6
Lateral wall symmetry	Both walls move	−1
	Right greater than left	−2
	Left greater than right	−3
Passavant's ridge	Present	−1
	Absent	−2

(Table 3). None of the patients showed a deterioration in articulation after surgery.

Table 4 provides an analysis of the types of articulation errors noted on the pre- and postoperative evaluations. Sibilant sounds (i.e., s, z, sh, ch, j) were most frequently misarticulated preoperatively. These sounds require contact of the maxillary and mandibular incisors for correct production. Considerable improvement was noted in the production of these sounds postoperatively.

Resonance and Nasal Emission

Four patients showed a slight degree of change in nasality postoperatively (Table 5). Changes in resonance were noted

TABLE 3 Number of Speech Sound Errors on Pre- and Postoperative Articulation Tests for All Patients

Group	*Patient*	*Preoperative*	*Postoperative*	*Change*
Noncleft	1	5	2	−3
	2	0	0	0
	3	0	0	0
	4	0	0	0
	5	3	1	−2
	6	0	0	0
	7	6	0	−6
	8	5	0	−5
Cleft lip	9	6	6	0
Cleft lip/ palate	10	2	2	0
	11	3	3	0
	12	5	0	−5
	13	15	13	−2
	14	8	0	−8
	15	2	2	0
	16	0	0	0

TABLE 4 Number of Patients who Misarticulated Each Speech Sound on Pre- and Postoperative Evaluations and Number of Patients With Corrected Speech Sounds After Surgery

Speech Sound	*No. of Patients with Sound in Error*		*No. of Patients with Sound Corrected After Surgery**
	Preoperative	*Postoperative*	
p	3	2	1
b	3	2	1
t	2	1	1
d	2	1	1
k	1	1	0
g	1	1	0
m	2	1	1
n	2	0	2
ng	0	0	—
f	3	3	0
v	3	3	0
th	1	1	0
s	8	4	4
z	8	4	4
sh	7	2	5
ch	6	1	5
j	6	1	5
w	0	0	—
h	0	0	—
y	0	0	—
r	1	1	0
l	1	0	1

* Total speech sounds corrected for all patients = 31.

in two patients, both from the group without clefts. One patient (#5) changed from hyponasality to normal resonance following maxillary advancement and intrusion. The other patient (#7) changed from normal resonance to a slight degree of hypernasality followed maxillary intrusion only.

Two patients developed mild and inconsistent nasal emission following surgery. Both patients had preoperative hypernasal resonance that was unchanged after surgery. One of these patients (#9) had a history of cleft lip only, although preoperative videofluoroscopy indicated that he had a narrow velopharyngeal gap. The other patient (#10) had a history of CLP and also had a pharyngeal flap. Both underwent maxillary advancement.

TABLE 5 Pre- and Postoperative Ratings of Resonance and Nasal Emission for All Patients

Group	*Patient*	*Resonance (Preop/Postop)*	*Nasal Emission (Preop/Postop)*
Noncleft	1	1/1	0/0
	2	1/1	0/0
	3	1/1	0/0
	4	1/1	0/0
	5	0/1	0/0
	6	1/1	0/0
	7	1/2	0/0
	8	2/2	0/0
Cleft lip	9	4/4	0/1
Cleft lip/ palate	10	3/3	0/1
	11	1/1	0/0
	12	3/3	0/0
	13	3/3	1/1
	14	1/1	1/1
	15	1/1	0/0
	16	1/1	0/0

Velopharyngeal Function

Several changes in velopharyngeal function were noted after surgery on the videofluoroscopic speech studies (Fig. 1). Changes in velopharyngeal contact and velopharyngeal height were observed in half of the patients (Table 6). Nine patients (five CLP, one CL, and three NCLP) showed diminished velopharyngeal contact. In evaluating velar height in relation to the hard palate, eight patients (three CLP and five NCLP) showed an apparent decrease in velar height when comparing pre- and postoperative findings. Three patients (one CLP and two NCLP) showed a decrease in velar thickness. Four patients (one CLP, one CL, and two NCLP) showed an increase in velar length. An increase in lateral pharyngeal wall movement was noted in three patients (one CLP and two NCLP). No changes were noted in the symmetry of lateral pharyngeal wall movement or in the presence of a Passavant's ridge. A summary of the changes observed in each group is noted in Table 7.

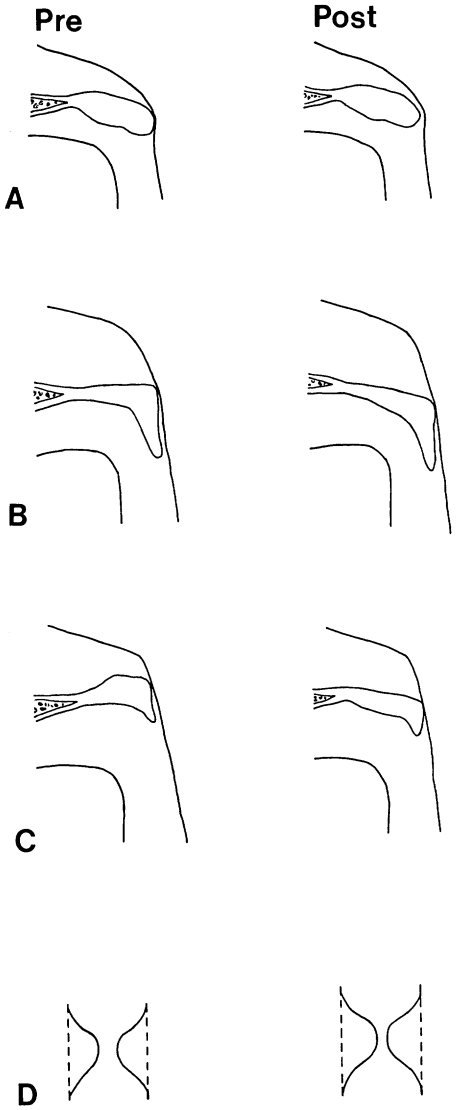

FIGURE 1 Tracings of pre- and postoperative videofluoroscopic speech studies. *A*, Lateral view for subject 16 demonstrates closure preoperatively. The velum is short and thick and raises to the level of the hard palate. Postoperatively, a narrow velopharyngeal gap is apparent. *B*, Touch closure of a normal velum (subject 3) occurs at the level of the hard palate preoperatively. Postoperatively, the level of velar elevation is below the plane of the hard palate. *C*, A short, thick velum (subject 2) makes touch closure slightly above the plane of the hard palate. Postoperatively, the velum stretches and raises to a level slightly below the hard palate. *D*, The frontal view in subject 3 shows a decreased distance between the lateral pharyngeal walls from the preoperative to postoperative studies.

In evaluating the videofluoroscopic studies of the four patients who showed changes in resonance or an increase in nasal emission, some observations were made that could be related to acoustic changes (Table 8). Two of the patients showed no changes in velopharyngeal function. Three of the patients (two NCLP and one CL) showed a decrease in velopharyngeal contact. One patient (#10) from the CLP group showed no observable change in velopharyngeal contact but still showed an increase in nasal emission. This patient had had a pharyngeal flap. The other patient (#16) with a pharyngeal flap in place showed no change in resonance or nasal emission postoperatively but demonstrated increased lateral pharyngeal wall movement on postoperative videofluoroscopy.

DISCUSSION

Le Fort I maxillary advancement is a commonplace procedure for correcting some malocclusions and for normalizing facial proportions. Our current investigation suggests that Le Fort I surgery may also have the added benefit of improving articulation in some cases. Seven of the 11 patients in this study with preoperative articulation errors showed an improvement in articulation postoperatively. Improvement was primarily noted in the production of sibilant sounds. Since these speech sounds are particularly dependent on articulation of the maxillary and mandibular incisors for production, they appear to be frequently affected by dental occlusal defects. The results of this study seem to indicate that, in some cases, correction of the occlusion alone may improve articulation and speech therapy is not needed. This is consistent with other reports (Schwarz and Gruner, 1976; Witzel et al, 1980; Ruscello et al, 1986).

Although concern has been expressed in the literature regarding the possibility that patients may develop or experience an increase in hypernasality following maxillary advancement (Schuchardt, 1954; Edgerton, 1969; Converse et al, 1974; Bralley and Schoeny, 1977; Witzel and Munro, 1977; Schendel et al, 1979), only four of 16 patients in this study showed a change in resonance or nasal emission postoperatively. One patient actually improved, with a change from hyponasal resonance to normal resonance. One patient changed from normal resonance to a slight degree of hypernasality. Two patients developed mild and inconsistent nasal emission, although both had preoperative hypernasality. None of these changes was felt to be clinically significant, and none of these changes was noticed by the patient. Other reports have documented similar findings. Therefore, based on this study and the work of others (Bralley and Schoeny, 1977; Schendel et al, 1979; Dalston and Vig, 1984). However, the small sample size should be considered when evaluating these results.

In comparing the patients with and without cleft palate, this study does not show an increased risk for postoperative hypernasality for patients with clefts. Again, this may be attributable to the limited number of subjects in each group.

TABLE 6 Pre- and Postoperative Ratings of Velopharyngeal Function Based on Videofluoroscopic Speech Studies

Patient	*Vp* Contact*	*Velar Thickness*	*Velar Length*	*Velar Height*	*LW Movement*	*LW Symm.*	*P Ridge*	*Total Changes*
1	2/2†	2/2	2/2	2/3	2/1	1/1	2/2	2
2	2/2	1/2	3/2	2/4	1/1	1/1	2/2	3
3	2/2	2/2	2/2	3/4	4/3	1/1	2/2	2
4	1/1	2/2	2/2	2/2	—/—	—/—	2/2	0
5	1/3	1/2	3/2	3/4	—/—	—/—	2/2	4
6	1/1	2/2	2/2	3/3	1/1	1/1	2/2	0
7	1/3	2/2	2/2	2/4	1/1	1/1	2/2	2
8	1/2	2/2	1/1	3/3	1/1	1/1	2/2	1
9	3/4	1/1	3/2	1/1	3/3	1/1	2/2	2
10	1/1	2/2	2/2	3/3	1/1	1/1	2/2	0
11	1/3	2/2	3/2	3/4	1/1	1/1	2/2	3
12	2/2	2/2	2/2	4/5	1/1	1/1	1/1	1
13	4/5	1/1	3/3	4/4	4/4	1/1	2/2	1
14	4/5	1/3	3/3	2/3	4/4	1/1	2/2	3
15	2/3	2/2	2/2	3/3	2/2	3/3	2/2	1
16	1/3	1/1	3/3	3/3	3/2	1/1	2/2	2
Total changes	9	3	4	8	3	0	0	

* Vp = velopharyngeal; LW = lateral wall; P = Passavant's.
† Preoperative rating/postoperative rating.

It may be assumed that patients who undergo maxillary advancement are at more risk for postoperative hypernasality than are those who undergo intrusion or other types of maxillary movement. However, the one patient in this study who developed a slight degree of hypernasality postoperatively had had maxillary intrusion alone. Therefore, any type of maxillary movement may potentially affect velopharyngeal valving to a slight degree.

One of the two patients who developed mild, inconsistent nasal emission postoperatively also had preoperative hypernasality and had a pharyngeal flap in place. The flap and lateral ports were not visualized on the videofluoroscopic studies, and no postoperative change in velopharyngeal function was noted on these studies. The use of nasopharyngoscopy or even other videofluoroscopic views may have been more useful in determining the effect of the maxillary movement on the velum, the pharyngeal flap, and the lateral ports.

If hypernasality is an infrequent occurrence following maxillary movement, it might be assumed that some changes occur in velopharyngeal function to compensate for the displacement of the maxilla. Evidence for compensatory changes was found on the postoperative videofluoroscopic speech studies, including velar lengthening and increased lateral pharyngeal wall movement.

Several patients in this study showed decreased velar thickness and increased velar length, which suggest velar stretch. The concept of velar stretch has been reported in the literature in other contexts. Changes in velar length and thickness from a resting to speaking position have been documented (Pruzansky and Mason, 1962; Bzoch, 1968; Simpson and Austin, 1972; Mourino and Weinberg, 1976; Simpson and Colton, 1980; Simpson and Chin, 1981). In addition, Schendel et al (1979) noted an increase in velar length following maxillary advancement as observed on still cephalometric radiographs. This current study provides evidence for velar stretch following maxillary movement based on several aspects of velopharyngeal function using multiview videofluoroscopy.

Increased lateral pharyngeal wall movement was observed in three patients in this study. Shprintzen et al (1980) found that lateral pharyngeal wall movement can increase following pharyngeal flap surgery. This current study suggests that lateral wall motion may also change following maxillary movement in some cases.

Eight patients showed decreased velar height relative to the hard palate on postoperative study. The apparent decrease in velar height is probably attributable to the superior movement of the maxilla during surgery. If this is the case, the maxilla is in a different position following surgery, but

TABLE 7 Changes in Velopharyngeal Function After a Le Fort I Osteotomy With Maxillary Movement

	Cleft Lip Group (n=1)	*Cleft Lip/Palate Group (n=7)*	*Noncleft Group (n=8)*	*Total (n=16)*
Decreased velopharyngeal contact	1	5	3	9
Decreased velar height in relation to hard palate	0	3	5	8
Decreased velar thickness	0	1	2	3
Increased velar length	1	1	2	4
Increased lateral pharyngeal wall movement*	0	1	2	3

* No change was noted in lateral pharyngeal wall symmetry or in the presence of a Passavant's ridge in any patient.

TABLE 8 Changes in Velopharyngeal Function Noted in Those Patients who Demonstrated Postoperative Changes in Resonance or Nasal Emission

		Changes in Velopharyngeal (VP) Function Noted Postoperatively	
Patient	*Group*	*VP Contact*	*Possible Compensatory Changes*
5	Noncleft	Decreased	Decreased velar thickness and increased length
7	Noncleft	Decreased	No change
9	Cleft lip	Decreased	Increased velar length
10	Cleft lip/palate	No change	No change

the velum and velopharyngeal contact remain relatively unchanged. Therefore, this apparent change may be of no clinical significance.

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Commentary

The effect of Le Fort I maxillary osteotomy on velopharyngeal function remains a controversial issue. The preceding study by Kummer and colleagues reported a deterioration in velopharyngeal function in two different patient groups who underwent maxillary intrusion with or without advancement. However, because the deterioration in velopharyngeal function was not clinically significant in their cases, Kummer et al have concluded that Le Fort I maxillary osteotomy has a negligible effect on velopharyngeal function in both cleft and noncleft cases. I disagree with their conclusions. Their study clearly demonstrates a deterioration in velopharyngeal closure in nine patients and increased velar and lateral pharyngeal wall movements in nine patients after surgery. The fact that the deterioration was not great enough to cause symptomatic hypernasality in their small sample of patients may be related to the extent of the surgery and/or the preoperative velopharyngeal competence of each patient in the study.

It is difficult to assess the extent of the surgery in this study. The authors reported the amount of advancement and intrusion of the maxilla measured at the time of surgery prior to fixation. However, they did not describe the exact location of the maxillary intrusion (i.e., anterior, posterior, or both). Skeletal repositioning of the maxilla is often not stable until 6 to 12 months after surgery (Posnick et al, 1988). Therefore, cephalometric measurements taken at these stages would be more descriptive of the surgical outcome.

At the Craniofacial Treatment and Research Centre at The Hospital for Sick Children, we have accumulated data on changes in articulation and velopharyngeal function after Le Fort I maxillary advancement since 1975 (Witzel and Munro, 1977; Witzel, 1981; Posnick et al, in press). Patients routinely have speech assessment and evaluation of velopharyngeal function with videofluoroscopy and/or nasopharyngoscopy before surgery and speech assessment and nasopharyngoscopy at 6 months, 1 year, and 2 years after surgery. At each evaluation, velopharyngeal function is

rated as adequate, borderline, or inadequate. Adequate is operationally defined as normal nasal resonance, normal nasal air emission, and adequate velopharyngeal closure during speech. Borderline is defined as normal nasal resonance or clinically insignificant hypernasality, inaudible nasal air emission (via mirror test), and borderline or marginal velopharyngeal closure during speech. These patients usually have small pinhole gaps in the velopharyngeal valve through which bubbles of barium or mucus are observed during videofluoroscopy, nasendoscopy, or both. Inadequate is defined as clinically significant hypernasal resonance, nasal air emission, and velopharyngeal insufficiency during speech.

Our findings in a sample of 41 patients without cleft palate who have had Le Fort I maxillary advancement and 50 patients with repaired cleft palate or cleft lip and palate indicate that patients without cleft palate have a very low risk for deterioration of velopharyngeal function. Patients with a repaired cleft palate who have adequate velopharyngeal function before surgery are also at low risk. However, 11 of 15 of our patients with clefts and a preoperative rating of "borderline" have acquired surgically induced symptomatic velopharyngeal insufficiency after Le Fort I advancement. Patients who were rated inadequate before surgery have remained so after surgery. We have found no statistical relationship between velopharyngeal function and the increase in pharyngeal depth after surgery. However, the preoperative competence of the velopharyngeal sphincter has been found to provide accurate predictions of the postoperative function in most cases (Witzel, 1981).

At The Hospital for Sick Children, the planning and treatment of patients undergoing orthognathic surgery have always emphasized the aesthetics of the face without ignoring the esthetics and function of dental occlusion. The patient with cleft palate or cleft lip and palate often responds differently to repositioning of the maxilla than does the patient without clefts because of scarring in the lip, palate, or both. These patients sometimes require more extensive movements of the maxilla, and this may increase the risk for changes in velopharyngeal function. The types of surgical requirements are also different. Patients with cleft palate only may undergo advancement of the total maxilla alone or in combination with a midline split. Patients with unilateral or bilateral cleft lip and palate generally undergo advancements with differential repositioning of the maxillary segments to close the cleft site completely (Dagys, 1989). The requirements for vertical changes in the maxilla will also vary according to the patient. Some require either intrusion, extrusion, or a combination of posterior intrusion and anterior extrusion. Therefore, the movement of the maxilla, particularly in the patient with a cleft, is often multidimensional. This makes it difficult to measure all aspects of movement and relate these to changes in velopharyngeal function.

In our series, the patients without clefts and patients with clefts with adequate preoperative velopharyngeal closure have had enough adaptability in the velopharyngeal muscles to maintain velopharyngeal closure after maxillary repositioning. However, most patients with clefts and preoperative borderline closure do not have this adaptability, and previous scarring in the palate may have a tethering effect that impedes muscular stretch and movement.

The name of a surgical procedure (i.e., Le Fort I) does not provide an accurate description of how an operation is performed. Surgeons do not perform the same "generic" operation in identical ways. The philosophies, treatments, and goals, as well as the surgical techniques, will vary from team to team and even among team members. The results from one center may not correspond to the results from another center. The experience of others is of immense value, but it is also important for organized cleft palate–craniofacial teams to assess carefully and scientifically the outcome of their particular treatment approaches, whether they may be primary palate surgery, lip surgery, or in this case maxillary repositioning.

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