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SPEECH CHARACTERISTICS OF CLEFT LIP AND PALATE PATIENTS AFTER ORTHOGNATHIC SURGERY

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ABSTRACT

INTRODUCTION: The velopharyngeal (VP) sphincter is ineffective in individuals with cleft lip and palate (CL/P), among other abnormalities in the speech-producing structures. Premaxilla protrusion, posterior crossbite, and maxillary hypoplasia are common symptoms in adult CL/P patients. Thus, orthognathic surgery is typically necessary, which could involve a segmental Le Fort I (SLF-1) osteotomy. The VP function may be impacted in different ways by this procedure.

OBJECTIVE: This study's objective was to assess SLF-1's impact on adult CL/P patients' speaking characteristics.

METHODOLOGY: Nine patients between the ages of 15 and 25 who had a history of CL/P, a maxillary skeletal deformity that needed to be corrected, and chronic alveolar defects were chosen. All patients had their speech evaluated prior to surgery and six months later. This included videofluoroscopy, nasoendoscopy, nasometry, and auditory perceptual evaluation. Maxillary advancement was 4.1 mm on average.

RESULTS: Except for three patients who developed hypernasal changes, postoperative findings for all parameters remained unchanged, according to nasometry results alone.

CONCLUSION: This shows that advancement through SLF-1 has no impact on the VP function, and that there may be other factors that have a compensatory effect.

KEYWORDS
Segmental, Le Fort I, cleft palate, velopharyngeal, speech, orthognathic

RUNNING TITLE: speech characteristics of cleft lib and palate patients after orthognathic surgery

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INTRODUCTION

Patients with cleft lip and palate (CL/P) appear with a variety of abnormalities in the structures responsible for producing speech. These include teeth that are extra, ectopic, or are positioned abnormally, preventing the mouth from closing or the tongue's tip from moving. The retruded maxilla with jaw malocclusion, which also prevents the mouth from closing, is another abnormality. A blocked nasal passageway can result in hyponasal speech, cul-de-sac resonance, or mixed resonance, whereas airway obstruction can also cause some speech problems.(1)

The ineffectiveness of the velopharyngeal sphincter in CL/P patients due to the dysrepaired muscle system and short length of the soft palate is another significant factor that can result in speech difficulties. The airflow in the oral cavity cannot be contained because the soft palate muscles cannot converge with the pharyngeal wall.(2) Instead, air enters the nasal cavity and produces noises through nasal emission or hypernasality (a sound leak) (a leak of airflow).

Twenty to thirty percent of people with cleft lip who have received treatment have this velopharyngeal insufficiency (VPI).(3-6)

The size of the gap in the velopharyngeal sphincter is associated with hypernasality and nasal air emission. Although nasal emission occurs in all velopharyngeal opening sizes, it is imperceptible in big gaps, because air passes through them without resistance. Nasal air emission leaves very little air in the oral cavity, which makes the sounds weak. In addition, the CL/P patient cannot talk in long sentences because they frequently need to breathe. A smaller velopharyngeal gap results in less hypernasality, more audible nasal air emission because of the greater air resistance, and slightly stronger consonants. Additionally, spoken words may be lengthier. The high nasal emission changes into

nasal turbulence, a loud bubbling sound, as the gap gets very tiny. This is because the air encounters more resistance, which causes the sound of the bubbling fluids to be audible.(1, 3, 7)

CL/P patients' premaxilla tends to protrude outward, the buccal segments' tend to collapse, with maxillary hypoplasia, thus adult CL/P patients frequently exhibit a posterior crossbite.(8) The maxilla and mandible are not aligned properly, which results in an abnormal maxillomandibular relation.(9) By performing orthognathic surgery using segmental Le Fort I (SLF-1) osteotomy or conventional osteotomy, this malrelation can be resolved. In 80% of CL/P patients, this critical step in cleft care and management is required.(10) However, some studies indicate that if a patient has a normal velopharyngeal mechanism prior to surgery, they become borderline VPI and may acquire VPI in 12.5% of cases following orthognathic surgery. On the other hand, patients who already had VPI prior to the surgery do not experience a worsening of the disease. Patients on the borderline could deteriorate.(11-14) According to other research, the maxillary advancement improves the position and relationship between the teeth and tongue, which improves speech output.(15, 16)

Maxillary advancement did not result in speech impairment, according to a review by Chanchareonsook et al.(15), in twelve studies. Contrarily, fifteen studies revealed that velopharyngeal incompetence increased following surgery, although in nine of those studies, this impairment only affected a tiny proportion of the participants. Additionally, five studies came to the conclusion that the development only had an impact on preoperative borderline patients.(15) The majority of the studies mentioned above and other studies looked at maxillary progress using the traditional Le Fort I osteotomy as a one-piece maxilla.(10, 14, 15, 17, 18) A single study looked at the effects of moving only the anterior maxilla, while few studies investigated the impact of the SLF-1.(19, 20)

The aim of this study was to evaluate the effect of SLF-1 on the speech properties of CL/P adult patients.

MATERIALS AND METHODS

This study was a prospective clinical trial that took place in the Cleft Care Center, Faculty of Dentistry, Ain Shams University and the Oral and Maxillofacial Surgery department, Faculty of Dentistry, Alexandria University. The research ethics committee in both faculties approved the study, and it was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki)(21) for experiments involving humans. Patients were selected to be between 15 and 25 years of age, who had history of CL/P with maxillary skeletal deformity requiring correction, with persistent alveolar defects. Thus, the maxilla is separated into two or three segments according to each case. Twelve CL/P patients fulfilled the study criteria, and after dropout exclusion, the study size was nine patients. The informed consent was obtained from patients and patients guardians as the sample include patients under the age of 18 years old.

Surgical Procedure

Patients were operated on under general anesthesia using endotracheal intubation. Standard maxillary vestibular incision was cut extending from one zygomatic buttress to the other, and passing along the alveolar cleft margins. Osteotomy was done from pyriform fossa above the roots of the teeth and into the maxillary sinus through the lateral, anterior, and medial maxillary walls. Nasal septum, if present, and pterygomaxillary fissures were separated and the maxilla downfractured as two or three segments. The maxillary segments were then ligated into a prefabricated resin occlusal splint. The segmental repositioning closes the cleft–dental gap, brings the alveolar ridges together, and approximates the labial and palatal mucosal soft tissues for oral-side fistula closure. Titanium miniplates were used to fixate the segments into the new position and incisions were sutured.

Speech Assessment

A phoniatrician doctor (speech and language pathologist) evaluated the patient to characterize velopharyngeal (VP) function. This was done according to the protocol of assessment used by the Phoniatric Unit, ENT Department, Faculty of Medicine, Ain Shams University hospitals, preoperatively and six-months postoperatively. This evaluation included:

I. Auditory perceptual assessment (APA) of the patient's speech and voice

This was used to analyze the acoustics of the VP mechanism to give an initial idea of its competency. The resonance of the speech was judged for hypernasal, hyponasal, cul-de-sac, or mixes of either. Speech was also examined for presence of nasal emission.

II. Clinical Diagnostic Aids

1. Documentation of APA by high field audio recording

In order to quantify results obtained by APA, nasometry was performed. A Nasometer II (KayPENTAX, Montvale, NJ) was used to indirectly demonstrate the nasalance of speech, described as the "ratio of nasal/total (nasal plus oral) acoustic energy converted to a percentage value". Therefore, it gives an idea about the amount of nasal acoustic energy and the relative percentage of nasality in a speech

sample.(22, 23) Nasalance was collected as a mean percentage for each syllabus, and placed on a 2-point nasalance scale, where nasalance greater than 30% represents "1" (i.e., hypernasality) and less than 30% represents "0" (i.e., no hypernasality). This scale is based on studies by Dalson et al(24) and Hardin et al(25). (17) (Figure 1)

Figure 1. Nasometric

2. Documentation and augmentation of visual assessment by nasopharyngeal videofibroscopy and videofluoroscopy

The goal of evaluation was to assess the shape, timing, amount of closure, and movement of the involved structures, achieved by nasoendoscopic assessment (nasopharyngoscopy).(26) A flexible endoscope (Kay Rhino-Laryngeal Stroboscope RLS 9100B, KayPentax, Lincoln Park, NJ; Olympus ENF type P-4, Olympus America Inc., Melville, NY) was introduced into and moved through the nose to reach the superior of the soft palate, and high-resolution video imaging was captured and recorded onto a connected monitor. The velopharyngeal sphincter boundaries were then examined from their nasal surface, the velum posterior border, left and right lateral pharyngeal walls, and the posterior pharyngeal wall, all in a single field. Nasopharyngoscopy allows the allocation of the VP gap and gives an estimate of its size. It also gives an idea on lateral wall movement and the effect of the adenoids on the VP function. Presence or absence of Passavant ridge can also be noted.(23, 27) A score from zero to three was given according to the closure of the VP sphincter; zero complete closure, one mild gap, two moderate gap, and three severe gap. Two scores were recorded for each patient, one for velar closure, and one for lateral closure.

As an additive evaluation, videofluoroscopy was performed. It was used to evaluate movement of the velopharyngeal structures from the lateral view and detect the deficiencies in velopharyngeal closure.(23) The lateral view represents a midsagittal plane through the VP portal that demonstrates the relationships between the velum and posterior pharyngeal wall. Videofluoroscopy possesses the advantage of being able to record the speech simultaneously with the roentgen imaging, thus providing valuable observation of both at the same time.(28) The use of nasopharyngoscopy with lateral view videofluoroscopy eliminates the need for multiplanar view videofluoroscopy.(29)

The patient-examining table of a typical radiographic system was moved into a vertical position, with fluoroscopic source kept perpendicular to the table. The patient was asked to stand in the gap between the examining table and the fluoroscopic screen with his/her right side adjacent to the table. The patient looked right in front of him with head in neutral position (plane of hard palate parallel to floor). It was important for the patient to focus on a person or object during the procedure to help him maintain a constant position. The patient was asked to repeat the speech protocol while the image obtained was video-recorded from the viewing screen to be used for later assessment. A score from zero to three was given according to the closure of the soft palate with the posterior pharyngeal wall; 0 complete contact, 1 mild gap, 2 moderate gap, and 3 severe gap. (Figure 2)

The speech protocol for each of the APA, nasometry, nasopharyngoscopy, and videofluoroscopy was provided by the Phoniatric Unit, ENT Department, Faculty of Medicine, Ain Shams University hospitals. Speech pathologists judging the APA, nasoendoscopy, and videofluorscopy were blinded to subject details before hearing and viewing the samples. This was only a descriptive study, due to the small sample size, with planned statistical analysis to be done with larger sample, in future research.

Figure 2. Videofluoroscopic assessment Left: Patient positioning Middle: Soft palate at rest Right: Soft Palate during function

RESULTS

Table 1 shows the descriptive data of subjects included in the study. There were 44% male subjects, with mean age of 18.6 years. About three-quarters of the patients had cleft lip and palate, while the rest had only cleft lip. All patients had variable degrees of maxillary retrusion requiring surgical correction, with the amounts of achieved surgical maxillary advancement recorded in Table 1. The average maxillary advancement was 4.1 mm, ranging between 2.3 and 8.3 mm.

The postoperative period was uneventful for most of the patients, with soft tissues wounds healing properly, postoperative edema decreasing after 5 – 7 days, and patients regaining their normal routines after about 2 weeks. In all patients with preoperative oronasal fistula, the fistulas were closed intraoperatively, and healed postoperatively. Only two patients had persistent oronasal fistula, and one patient experienced postoperative infection. The infection was treated medically and through debridement, leading to its resolution.

When comparing the preoperative and postoperative assessments (Table 2), three patients showed hypernasality in the nasometry measurement after the operation, that wasn't present before the operation. All the other patients had hypernasality before and after the operation. In the nasoendoscopic evaluation, all patients showed almost no change in their closure patterns before and after the operation. This was the same with the videofluoroscopic findings.

Table 1 Subject details

Subject	Age at operation (years)	Gender	Cleft type	Palatal Fistula	Planned Maxillary Advancement (mm)	Actual Maxillar Advancement (mm)
1	**21**	**F**	**BCLP**	**Yes**	**10**	**8.3 mm**
2	**18**	**M**	**BCLP**	**Yes**	**9**	**2.3 mm**
3	**16**	**M**	**BCLP**	**No**	**7**	**4.3 mm**
4	**19**	**M**	**BCLP**	**No**	**8**	**2.5 mm**
5	**21**	**F**	**UCLP**	**Yes**	**7**	**2.7 mm**
6	**20**	**F**	**UCL**	**No**	**5**	**4.3 mm**
7	**19**	**F**	**BCL**	**No**	**4**	**2.6 mm**
8	**16**	**F**	**BCLP**	**Yes**	**6**	**2.7 mm**
9	**17**	**M**	**BCL**	**No**	**7**	**7.6 mm**

Table 2 Speech assessment results

Subject	Nasalance of oral sentence Preoperative	Nasalance of oral sentence Postoperative	Nasopharyng-oscopy Preoperative	Nasopharyng-oscopy Postoperative	Videofluorscopy Preoperative	Videofluorscopy Postoperative
1	1	1	Velar 1-2 Lateral 1-2	Velar 1-2 Lateral 1-2	2	2-3
2	0	1	Velar 2 Lateral 2	Velar 2-3 Lateral 2-3	1-2	1-2
3	0	1	Velar 3 Lateral 3	Velar 2-3 Lateral 2-3	1-2	1-2
4	1	1	Velar 3 Lateral 3	Velar 3 Lateral 3	1-2	2
5	0	0	Velar 2 Lateral 0	Velar 2 Lateral 0	1	1
6	0	1	Velar 2 Lateral 2	Velar 2 Lateral 2	2	2
7	0	0	Velar 1-2 Lateral 1	Velar 1 Lateral 1	0	0
8	1	1	Velar 3 Lateral 2	Velar 3 Lateral 2	1	1
9	1	1	Velar 1 Lateral 1-2	Velar 1 Lateral 1-2	0	0

DISCUSSION

The purpose of this research was to determine the impact of segmental Le Fort I maxillary advancement on the speech characteristics of people with cleft lip and palate. Nasometry, nasoendoscopy, and videofluoroscopy were used to assess these traits before and after surgery.

Nasometry revealed surgical hypernasality in 33% of the patients. Meanwhile, the other indicators showed no differences between preoperative and postoperative speech characters, even in patients with nasometry changes. Perceptual speech evaluation revealed no changes in the heard speech of the cases. This suggests that the maxillary advancements achieved in our study had no negative impact on the individual's speech. This was consistent with the results of Phillips(20), who found even greater maxillary advancements ranging from 5 to 17 mm, with an average of 10.7 mm. Many investigations found that conventional maxillary advancements had no effect on velopharyngeal characteristics.(30) Others discovered that maxillary surgery can affect VP function.(31) In our study, patients with only nasometry changes having borderline values shifted slightly to the hypernasal side after the operation, with no visible changes in nasoendoscopy or videofluoroscopy. As a result, there was no change in their observed speech.

These results are backed up by the fact that maxillary advancements in non-cleft patients do not increase the risk of velopharyngeal insufficiency. This could imply that the predicting element is palatal shape and function rather than maxillary advancement.(30, 32) Kummer et al(33) discovered that velar structures adjust for maxillary advancement through velar lengthening and increased lateral pharyngeal wall movement. This may be more noticeable in segmental rather than conventional surgeries, as segments may allow for greater multidirectional stretch of the tissues, a point that will require further study in the future. McComb et al.(27) also discovered that soft palate length and palatal scarring are accurate indicators of postoperative VP insufficiency.

The small number of included subjects is a limitation of this study, necessitating more extensive investigation. Another limitation is that all subjects did not have extensive maxillary advancement, which could be attributed to the palatal scarring observed in the majority of them, preventing extensive advancement. Small amounts of advancement were suggested to have no impact on VP function, with a cut-off point of 10 mm recommended. Others have claimed that there is no link between progress and VP changes.(17, 27, 34) However, our research demonstrated that small amounts of progress were safe from the perspective of the VP.

CONCLUSIONS

This study showed that SLF-1 had no effect on VF function, however, this needs to be verified more due to the limited number of patients included. Further study is needed to identify the morphological changes in the soft palate that compensate for the advancement, as well as the effect of large amounts of advancement.

Declaration of Interest

Authors confirm that they have no competing interests, whether financial or any other interest.

Author Contribution

MSH methodology, formal analysis, investigation, writing original draft; **RE** investigation, review/editing, supervision; **MHB** methodology, formal analysis, review/editing; **RMG** methodology, investigation, review/editing; **ME** conceptualization, methodology, supervision; **AMS** review/editing, supervision

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