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의학석사 학위논문

# **The effects of orthognathic surgery on speech in cleft lip and palate patients**

구순구개열 환자에서 악교정수술이  
언어에 미치는 영향

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서울대학교 대학원  
임상의과학과 석사과정  
유 안 나

A thesis of the Master of Science

구순구개열 환자에서 악교정수술이  
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**The effects of orthognathic surgery  
on speech in cleft lip and palate  
patients**

December, 2013

**The Department of Clinical Medical Sciences,  
Seoul National University  
College of Medicine  
Anna Yoo**

# The effects of orthognathic surgery on speech in cleft lip and palate patients

by  
Anna Yoo

A thesis submitted to the Department of Clinical Medical  
Sciences in partial fulfillment of the requirements for the  
Degree of Master of Science at Seoul National University  
College of Medicine

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Approved by Thesis Committee:

Professor Chairman\_\_\_\_\_

Professor\_\_\_\_\_

Professor\_\_\_\_\_

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논문 제목: The effects of orthognathic surgery on speech in cleft lip and palate patients

학위구분: 석사 ☒ · 박사 ☐

학 과: 임상의과학과

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저 작 자: 유 안 나 (인)

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서울대학교총장 귀하

# ABSTRACT

**Introduction:** The purpose of this study was to assess the effects of orthognathic surgery on speech in cleft lip and palate patients.

**Methods:** The samples consisted of 15 patients with cleft lip and palate had undergone two-jaw surgery. Speech evaluation, video fluoroscopy, the amount of maxilla advancement, age at surgery, and type of the cleft were assessed. Speech evaluation and video fluoroscopy were performed average 25 days before surgery, and average 13 months after surgery. The second postoperative evaluation was performed 6 months after the first evaluation in 3 patients. Speech intelligibility and hypernasality degree were graded each as five degrees. Velopharyngeal insufficiency(VPI) was evaluated as three degrees. The mean value of maxilla advancement amount was 6.9 millimeters.

**Results:** In preoperative speech evaluation, 11 patients(73.3%) appeared to have no hypernasality, 3 patient(20%) showed mild hypernasality, and 1 patient(6.7%) showed moderate hypernasality. In terms of speech intelligibility, 10 patients(66.7%) had grade 1, 4 patients(26.7%) had grade 2, and 1 patient (6.7%) showed grade 3 preoperatively. Comparing preoperative and postoperative evaluation, there was no alteration in speech intelligibility and hypernasality degree in 11 of 15 patients(73.3%).

Among 15 patients, 12 patients(80%) had both preoperative and

postoperative video fluoroscopy. Preoperatively, VPI was identified in 1 patient(8.3%) and mild VPI was identified in 7 patients(58.3%). After two-jaw surgery, three patients(25%) showed increased velopharyngeal gap and 1 patient (8.3%) showed newly developed VPI. Newly developed Passavant's ridge after the surgery was observed in four patients. All of three patients who had second postoperative evaluation showed no change in both speech evaluation and video fluoroscopy compared to the first postoperative assessment. However, in two patients, Passavant's ridge became more prominent at the second postoperative assessment than at the first postoperative assessment. There was no significant association between preoperative VPI findings and the occurrence of Passavant's ridge ( $p = .468$ ), and between amount of maxillary advancement and the occurrence of Passavant's ridge ( $p = .343$ ).

**Conclusions:** Although velopharyngeal gap could be increased after two-jaw surgery, speech intelligibility and hypernasality did not deteriorate accordingly. Newly developed Passavant's ridges and their progressive hypertrophy may act as a compensation mechanism.

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**Keywords:** Cleft lip and palate, Orthognathic surgery, Speech evaluation.

**Student number:** 2012-22711

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## INTRODUCTION

Maxillary hypoplasia is a common skeletal feature in patients with cleft lip and palate. This deformity is regarded as a result of a reduced growth potential and the effects of the surgical scarring.(1) These deformities have been corrected by orthognathic surgery.(2)

Orthognathic surgery can help the patients to have more aesthetic morphology, however, it has two sides to speech production. Patients with cleft lip and palate have abnormal development and anatomy of oral, pharyngeal, and palatal musculature.(3) These anatomical differences and surgical scarring of the palate contribute to speech problems. Orthognathic surgery has a potential benefit on speech in aspect of reestablishment of maxillomandibular relationships. On the other hand, maxillary advancement may deteriorate speech intelligibility and worsen velopharyngeal insufficiency.(4) Velopharyngeal insufficiency is defined as a structural defect of velum or pharyngeal wall, resulting in insufficient closure when speaking.(3) When maxilla is surgically advanced, the hard and soft palate are forced to advance as well, and this might compromise velopharyngeal closing.(1) Many clinical studies have reported the influence of orthognathic surgery on speech and velopharyngeal function(3-10), however, there is no established consensus on this issue. The main reason is due to highly variable nature of the patients, including severity and nature of preoperative occlusion.(6)

Mason et al(11) suggested that most patients without cleft have sufficient reservoir for velopharyngeal competency, so large amount of maxillary advancement more than 10 mm do not affect velopharyngeal function. In cleft lip and palate patients, the reservoir in length of soft palate is insufficient than in normal population because of postoperative scarring, and that makes higher risk of velopharyngeal incompetence. The deterioration of velopharyngeal function may also lead to nasal emission, articulatory errors and decreased speech intelligibility.(12-15)

The purpose of the present study was to evaluate the effects of orthognathic surgery on perceptual speech and velopharyngeal competency in cleft lip and palate patients. There exist various methods in assessing one's speech. In this study, speech assessment was performed by a qualified speech therapist using perceptual judgment of speech and velopharyngeal anatomy and function were evaluated by video fluoroscopy.

## PATIENTS AND METHODS

The current study was conducted on 20 patients with cleft lip and palate who had undergone orthognathic surgery at the Seoul National University Children's Hospital between 2010 and 2012 by a single surgeon (SW Kim). Five patients had undergone maxillary distraction before two-jaw surgery, while fifteen patients had undergone two-jaw surgery only. Gateno et al.(16) and Hussain(17) suggested that advancement of >6 mm of maxilla in operated cases of cleft palate require distraction for more stable results. In our institute, maxillary distraction was performed on patients who needed to advance maxilla more than 9 millimeters for correction of maxilla-mandibular discrepancy. For the consistency of subjects, the five patients who had undergone maxillary distraction were excluded. The amount of maxillary advancement ranged from 2.0-8.0 millimeters (mean, 6.9 millimeters). The movements of mandible were shown in Table 1.

To analyze the effects of orthognathic surgery, speech evaluation, video fluoroscopy result, the amount of maxilla advancement, age at surgery, and type of the cleft were assessed. Among 15 patients, 8 patients were male and 7 patients were female. Nine patients (60.0%) had unilateral cleft lip and palate and six patients (40.0%) had bilateral cleft lip and palate. Patient's mean age at the time of operation was 18.7 years.(range 17 years to 20 years)

**Table 1.**

Table 1. Relevant data about cleft lip and palate patients who undergone Two-jaw surgery \*

Patient	Sex	Age	Types of Cleft	Maxillary advance ment (mm)	Mandibular setback (mm)	Preoperative speech evaluation		First Postoperative speech evaluation		Second Postoperative speech evaluation		Preoperative video fluoroscopy	First Postoperative video fluoroscopy	Second Postoperative video fluoroscopy
						Hypernasality	Intelligibility grade	Hypernasality	Intelligibility grade	Hypernasality	Intelligibility grade			
1	F	18	BCLP	6	-3	none	1	mild	1	(-)	(-)	Mild VPI, P.ridge	No VPI, P.ridge	(-)
2	M	19	BCLP	8	-5	none	2	none	2	(-)	(-)	Mild VPI	Mild VPI, P.ridge	(-)
3	F	18	BCLP	7	-2	mild	1	moderate	1	(-)	(-)	No VPI	No VPI	(-)
4	M	18	UCLP	7	-4	none	2	none	3	none	3	Mild VPI	Mild VPI	Mild VPI
5	M	19	UCLP	7	-3	none	1	none	1	(-)	(-)	No VPI, P.ridge	No VPI, P.ridge	(-)
6	F	19	UCLP	8	4*CCW	none	2	none	2	(-)	(-)	No VPI	(-)	(-)
7	F	20	UCLP	7	+3	none	1	none	1	(-)	(-)	Mild VPI	Mild VPI, P.ridge	(-)
8	M	20	UCLP	8	2*CCW	none	1	none	2	none	2	Mild VPI	Increased gap P.ridge	Decreased gap P.ridge
9	F	18	BCLP	8	-2	mild	1	mild	1	(-)	(-)	VPI, P.ridge	(-)	(-)
10	F	19	UCLP	8	2*CCW	none	1	none	1	(-)	(-)	Mild VPI	Increased gap	(-)
11	M	17	BCLP	3.5	-10	none	2	none	2	(-)	(-)	VPI	VPI	(-)
12	M	19	UCLP	8	(-)	none	1	none	1	(-)	(-)	No VPI, P.ridge	Mild VPI, P.ridge	(-)
13	M	20	UCLP	2	-2	mild	1	mild	1	(-)	(-)	(-)	Mild VPI	(-)
14	F	19	BCLP	8	3.5*CCW	moderate	3	moderate	3	moderate	3	Mild VPI	Increased gap P.ridge	Decreased gap P.ridge
15	M	18	UCLP	8	-1	none	1	none	1	(-)	(-)	No VPI	No VPI	(-)

\* BCLP = bilateral cleft lip and palate; UCLP = unilateral cleft lip and palate; VPI = velopharyngeal insufficiency; P.ridge = passavant ridge; CCW = clockwise rotation.  
Speech intelligibility grade : Grade 1= normal for age and sex, Grade 2= mild difficulty in understanding, repetition not required; Grade 3= moderate difficulty, repetition required infrequently, Grade 4= marked difficulty, repetition required frequently; Grade 5= unintelligible even with repetition.  
Velopharyngeal insufficiency grade : No VPI = no velopharyngeal insufficiency, Mild VPI = velopharyngeal gap less than 5mm at lateral view of video fluoroscopy, VPI = velopharyngeal gap greater than or equal to 5mm at lateral view of video fluoroscopy.

Perceptual speech evaluation and video fluoroscopy were performed 1 day to 5 weeks (mean, 25 days) before surgery, and 4 months to 20 months (mean, 13 months) after surgery.

### Perceptual Speech Evaluation

Speech evaluation was assessed in all 15 patients by a qualified speech therapist affiliated with the Seoul National University Hospital. Hypernasality and speech intelligibility were assessed before and after surgery. Hypernasality degree was scored as 5 degrees; none, mild, moderate, severe, and profound. Intelligibility degree was scored as follows; Grade 1= normal for age and sex, Grade 2= mild difficulty in understanding, repetition not required; Grade 3= moderate difficulty, repetition required infrequently, Grade 4= marked difficulty, repetition required frequently; Grade 5= unintelligible even with repetition.

Patients with higher than grade 3 of postoperative speech intelligibility score and with deteriorated speech intelligibility grade had second postoperative evaluation after 6 months from first postoperative evaluation. Total three of fifteen patients had second postoperative assessment. During the period of six months between first postoperative evaluation and second postoperative evaluation, one patient got speech therapy and other two patients did not get speech therapy.

### Video fluoroscopy

The anatomical findings and movement patterns of the velopharyngeal mechanisms were evaluated via video fluoroscopy. Among 15 patients, 12 patients had both preoperative and postoperative video fluoroscopy results. The post-surgical changes were evaluated and recorded (Phillips DVI-II digital fluoroscopy system; model BH 5000; Andover, MA, USA). Velopharyngeal competency and palatopharyngeal structures including Passavant's ridge were evaluated at lateral view of video fluoroscopy. Velopharyngeal insufficiency grade was scored as 3 steps as follows; No VPI = no velopharyngeal insufficiency, Mild VPI = velopharyngeal gap less than 5mm at lateral view of video fluoroscopy, VPI = velopharyngeal gap greater than or equal to 5mm at lateral view of video fluoroscopy.

#### Statistical analysis

To analyze the association between the occurrence of Passavant's ridge and preoperative velopharyngeal status, linear by linear association method was used. In other statistical analysis, Mann-Whitney U test was used.

# RESULTS

## **Perceptual Speech Evaluation**

Among fifteen patients, eleven patients(73.3%) showed no hypernasality in preoperative assessment. Three patients showed mild degree, and one patient had moderate degree of hypernasality preoperatively. After surgery, two of fifteen patients (13.3%) had deteriorations in their hypernasality score. One patient without preoperative hypernasality showed mild degree of hypernasality after surgery. Another patient who showed mild degree of hypernasality in preoperative evaluation revealed to have moderate degree of hypernasality in postoperative assessment. Although these two patients had deteriorated score in their hypernasality degrees, their speech intelligibility score showed no change after the surgery. Thirteen of fifteen patients (86.7%) showed no change in hypernasality degree after orthognathic surgery.

In terms of preoperative intelligibility, 10 patients(66.7%) were assessed to show normal intelligibility for age and sex, 4 patients(26.7%) showed grade 2 (mild difficulty in understanding, repetition not required), 1 patient(6.7%) showed grade 3 (moderate difficulty, repetition required infrequently). After surgery, 2 patients (13.3%) showed some deterioration in speech intelligibility; one patient with preoperative grade 2 intelligibility was assessed to have



postoperative grade 3, the other patient who showed preoperatively grade 1 was shown to have grade 2 intelligibility postoperatively.

The relation between the amount of maxillary advancement and the change in speech evaluation was statistically evaluated. There was no significant association between the amount of maxillary advancement and postoperative change in hypernasality grade( $p=.229$ ). Also, there was no significant association between the amount of maxillary advancement and postoperative change in speech intelligibility grade( $p=.933$ ).

At the second postoperative evaluation, all three patients showed no change during six months. (Table 1)

### **Video fluoroscopy**

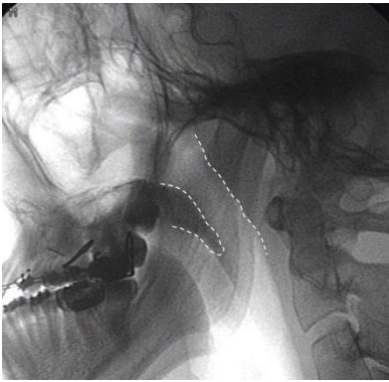
A total of 12 patients had both preoperative and postoperative video fluoroscopy results. At preoperative assessment, VPI was identified in 1 patient and mild VPI was identified in 7 patients. Four patients(33%) showed no VPI preoperatively. After two-jaw surgery, three patients who preoperatively had mild VPI showed increase in velopharyngeal gap and 1 patient showed newly developed velopharyngeal insufficiency. Among these 4 patients who showed post-surgical change in velopharyngeal competence, only one patient was found to have aggravated intelligibility grade. (Table 1)

Newly developed Passavant's ridge that was not observed before two-jaw surgery was identified in 4 patients.(33%)(Figure 1)

Three patients had second postoperative video fluoroscopy six months after first postoperative evaluation. Two of the three patients showed newly developed Passavant's ridge at first postoperative assessment, and these two patients were appeared to have decreased velopharyngeal gap with more prominent Passavant's ridge at second postoperative evaluation compared to the previous assessment. (Figure 2) The other patient who appeared not to develop Passavant's ridge at the first assessment had no change in velopharyngeal gap nor in pharyngeal musculature at the second postoperative assessment. (Figure 3)

Among the two patients who developed more prominent Passavant's ridge at second postoperative evaluation, one patient showed intelligibility grade 3 and moderate hypernasality in preoperative assessment, and these scores did not change at both first and second postoperative assessment. The other patient had no hypernasality in preoperative and first, second postoperative assessment, but the intelligibility grade worsened from preoperative grade 1 to postoperative grade 2, and maintained as grade 2 at second postoperative assessment.

(A)



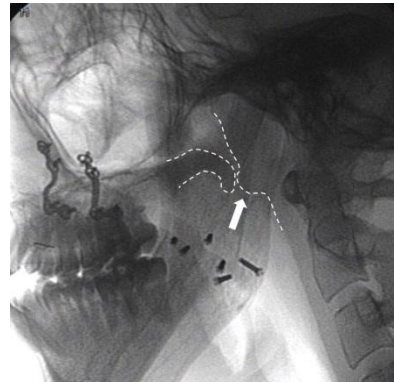
(B)



(C)

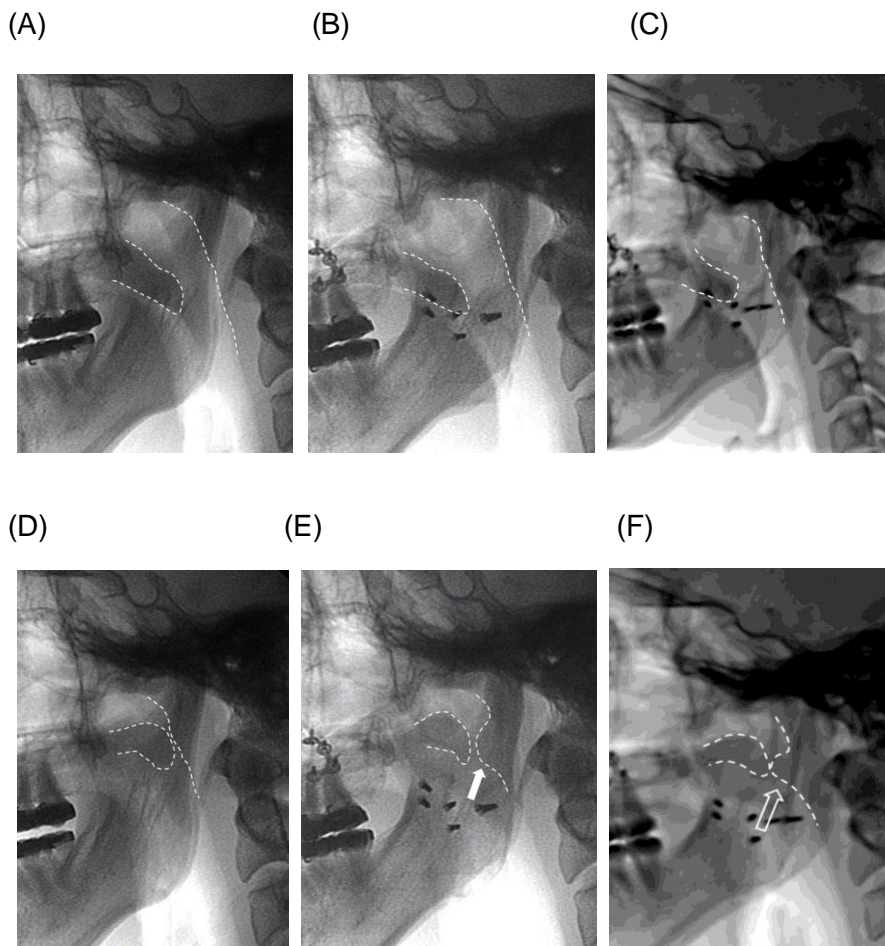


(D)



**Figure 1. Video fluoroscopy result of the patient with newly developed Passavant's ridge after two-jaw surgery.**

- (A) Preoperative resting gap.
- (B) Postoperative resting gap.
- (C) Preoperative velopharyngeal gap at speech. Passavant's ridge is absent.
- (D) Postoperative velopharyngeal gap at speech. Newly developed Passavant's ridge is observed. (white arrow)



**Figure 2. Video fluoroscopy result of the patient who showed more prominent Passavant's ridge at second postoperative assessment.**

(A) Preoperative resting gap. (B) First postoperative resting gap.

(C) Second postoperative resting gap.

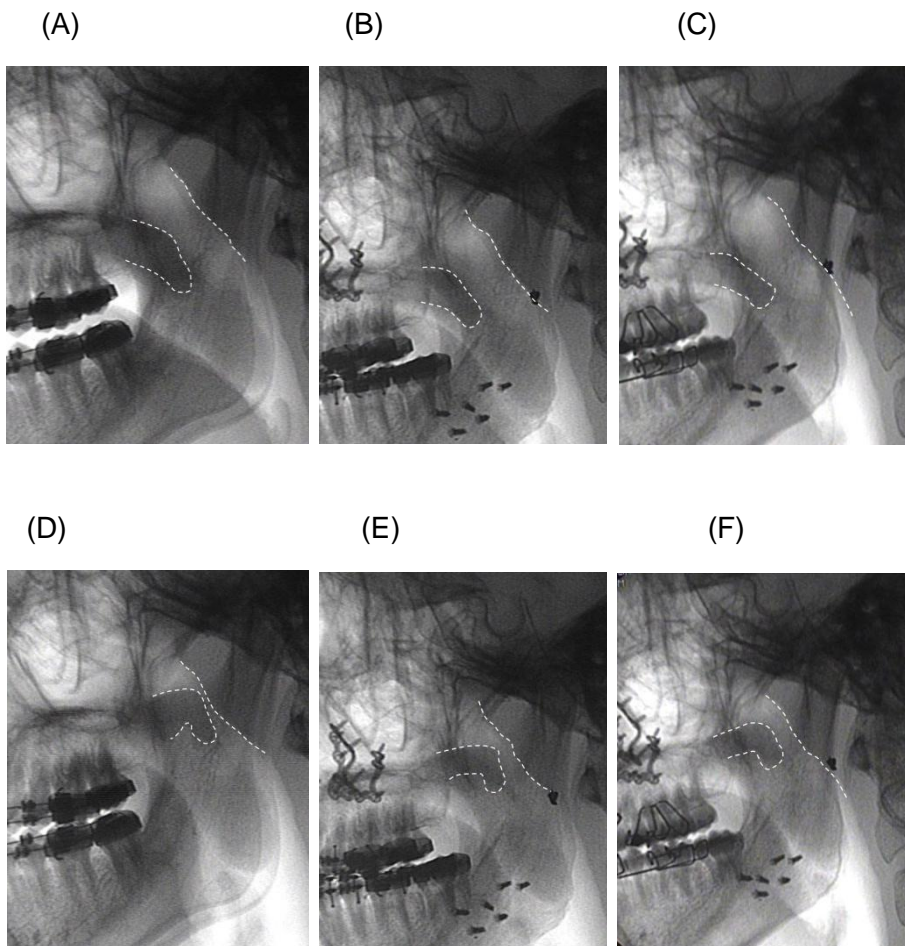
(D) Preoperative velopharyngeal gap at speech.

(E) First postoperative velopharyngeal gap at speech.

Passavant's ridge was newly developed. (white arrow)

(F) Second postoperative velopharyngeal gap at speech.

Passavant's ridge was more prominent compared to first postoperative assessment. (empty arrow)



**Figure 3. Video fluoroscopy result of the patient who did not develop Passavant's ridge with deteriorated speech result.**

(A) Preoperative resting gap. (B) First postoperative resting gap.

(C) Second postoperative resting gap.

(D) Preoperative velopharyngeal gap at speech.

(E) First postoperative velopharyngeal gap at speech.

Passavant's ridge was not developed. Velopharyngeal gap was increased compared to preoperative assessment.

(F) Second postoperative velopharyngeal gap at speech. Passavant's ridge was not developed since first postoperative assessment.

Though he showed more prominent Passavant's ridge and decreased velopharyngeal gap at the second postoperative evaluation, the intelligibility grade did not improve at the second postoperative evaluation compared to first postoperative evaluation.

To analyze the factors affecting in occurrence of Passavant's ridge, the effect of preoperative velopharyngeal status and the amount of maxillary advancement on the occurrence of Passavant's ridge were statistically evaluated using Mann-Whitney U test. There was no statistically significant association between the amount of maxillary advancement and the occurrence of Passavant's ridge( $p=.343$ ). No statistically significant association was found between the preoperative VPI grade and the occurrence of Passavant's ridge( $p=.468$ ).

## DISCUSSION

Since orthognathic surgery has been performed to correct maxillomandibular discrepancy in cleft lip and palate patients, several studies investigated the effects of maxillary advancement on speech. (3-10) Some articles reported both positive and negative impacts of orthognathic surgery on cleft palate patients.(3,4) Janulewicz et al.(3) suggested maxillary advancement can impair velopharyngeal function and speech scores, but may improve articulation defects and hyponasality. Trindade et al.(4) evaluated the impact of orthognathic surgery on acoustic nasalance, reported that orthognathic surgery increases internal nose size, therefore high nasalance can occur. They also suggested that this change may help improving nasal patency for breathing.(4)

Others suggested adverse effects of orthognathic surgery on speech. Niemeyer et al.(9)studied 42 subjects with cleft lip and palate patients submitted to maxillary advancement by analyzing perceptual speech analysis. They suggested that orthognathic surgery in individuals with cleft palate may interfere in resonance, or increase the degree of hypernasality.

Chanchareonsook et al.(10) reviewed 39 published articles, total 747 cases of cleft and noncleft patients, about the effects of cranio-maxillofacial osteotomies and distraction osteogenesis on speech and velopharyngeal status. As a result, many studies reported that surgery

had no impact on speech and velopharyngeal status, while some reported worsening especially in patients with preexisting velopharyngeal impairment. However, they did not clarify the method for outcome measurement. Chanchareonsook et al.(10) figured out methodological weakness that were noted in most studies; small sample size, subject mix, variations in surgical technique, validity of results, lack of direct observation, and timing of postoperative assessment.

We employed perceptual speech assessment and video fluoroscopy as evaluation methods. Perceptual speech evaluation utilizes clinical judgments by an experienced professional speech pathologist. Perceptual speech assessments include findings of preoperative and postoperative speech analysis, such as articulation errors transcribed by a speech-language pathologist, or evaluation of resonance of vowels and nasal consonants using a severity rating scale.(18) Articulation assessment was excluded in this article because we put more emphasis on the effects of the surgery on actual conversation than on phonological changes. As a direct evaluation method for velopharyngeal function, video fluoroscopy was used.

In this study, two of fifteen patients had deteriorated score in their hypernasality degrees after the surgery, but not enough to worsen their intelligibility score. In terms of speech intelligibility, 2 patients (13.3%) showed deterioration postoperatively. Although these two patients did not show any change in hypernasality degree, they had worsened



articulation errors enough to deteriorate the degree of intelligibility. Most patients (86.7%) maintained their preoperative speech intelligibility score. (Table 1)

Among the twelve patients who both had preoperative and postoperative video fluoroscopy, four patients showed increased velopharyngeal gap and none of the patients showed deteriorated hypernasality.(Table 1) In other words, hypernasality did not seem to have direct correlation with velopharyngeal patency. Theoretically, increased velopharyngeal gap may lead to hypernasality. In our investigation, it can be suggested that even if in cleft lip and palate patients, increase in the amount of velopharyngeal gap by orthognathic surgery is not enough to alter the hypernasality grade.

Moreover, we tried to figure out any factor which influences speech intelligibility by analyzing video fluoroscopy. Four patients are shown to develop Passavant's ridge after orthognathic surgery. Passavant's ridge was described as a cushion that projects forward in the pharynx, originating from the posterior and lateral walls of the nasopharynx by Passavant in 1869. He first stated that the ridge is an essential component of the normal speech mechanism.(19) Since then, there has been a controversy over the function of Passavant's ridge. Honjo et al.(20) disagreed to Passavant's opinion and suggested that the ridge has little importance in speech. Isberg et al.(21) studied 80 patients with hypernasality by using video fluoroscopy and nasopharyngoscopy. They identified an improvement of the sphincter

function associated with an enlargement of Passavant's ridge and also observed that the ridge could disappear if complete velopharyngeal closure was achieved, implying that Passavant's ridge is originated from compensatory mechanism.(21)

Among the three patients who had second postoperative assessment, two patients showed more prominent hypertrophic Passavant's ridge and decreased velopharyngeal gap than first postoperative video fluoroscopy assessment.(Figure 2) All of the two patients who had more prominent Passavant's ridge at second postoperative evaluation did not show any change in speech evaluation at second postoperative speech evaluation compared to first postoperative speech evaluation.

From these findings, we infer that Passavant's ridge may develop against worsened velopharyngeal insufficiency as a compensatory mechanism after maxillary advancement. However, development of Passavant's ridge may not be enough to improve the grade of VPI and the worsened speech intelligibility score after orthognathic surgery. Passavant's ridge may act to lessen the worsening effect in velopharyngeal insufficiency.

To analyze the reason why only some patients develop Passavant's ridge, we performed statistical analysis about the effect of the amount of maxillary advancement and preoperative velopharyngeal status on the occurrence of Passavant's ridge. In this study, four patients newly developed Passavant's ridge after orthognathic surgery. The mean value of the amount of maxillary advancement in these four patients

was 7.75 millimeters, and the average value in remnant eleven patients was 6.59 millimeters. However, there was no statistically significant association between the amount of maxillary advancement and the occurrence of Passavant's ridge. In aspect of preoperative velopharyngeal status, all the four patients showed mild velopharyngeal insufficiency preoperatively. In statistical analysis, no significant association was found between the preoperative VPI grade and the occurrence of Passavant's ridge. Although the amount of maxillary advancement and preoperative velopharyngeal status have been revealed to have no significant association with the occurrence of Passavant's ridge, further study is required in larger group.

Since patients with cleft lip and palate do not have enough reservoir in length of the soft palate, so the risk of velopharyngeal insufficiency after maxillary advancement surgery is higher than in normal patients. In this study, though velopharyngeal gap was increased after two-jaw surgery in some patients, speech intelligibility and hypernasality degree were not deteriorated accordingly and most patients showed no change in perceptual speech evaluation. Newly developed Passavant's ridges and their progressive hypertrophy may act as a compensation mechanism and may contribute to prevent worsening the grade of speech intelligibility.

## REFERENCES

1. Phillips JH, Klaiman P, Delorey R, MacDonald DB. Predictors of Velopharyngeal insufficiency in Cleft Palate Orthognathic Surgery. *Plast. Reconstr. Surg.* 2005 Mar;115(3):681-686.
2. Chua HD, Cheung LK. Soft tissue changes from maxillary distraction osteogenesis versus orthognathic surgery in patients with cleft lip and palate-a randomized controlled clinical trial.*J Oral Maxillofac Surg.* 2012 Jul;70(7):1648-58
3. Janulewicz J, Costello BJ, Buckley MJ, Ford MD, Close J, Gassner R. The Effects of Le Fort I osteotomies on Velopharyngeal and Speech functions in Cleft patients. *J Oral Maxillofac Surg* 2004;62:308-314.
4. Inge EKT, Renata PY, Roberto M S, Reinaldo M, Alceu ST. Effects of Orthognathic Surgery on Speech and Breathing of Subjects With Cleft Lip and Palate: Acoustic and Aerodynamic Assessment. *Cleft Palate-Craniofacial Journal* 2003;40: 54-64.
5. Dennis MR, Mary ET, Terri J, Leslie C, Joseph EVS. The effects of orthognathic surgery on speech production. *Am.J. Orthod.* 1986 Mar 89:237-241.

6. Ward EC, McAuliffe M, Holmes SK, Lynham A, Monsour F.  
Impact of malocclusion and orthognathic reconstruction surgery  
on resonance and articulatory function: an examination of  
variability in five cases. Br J Oral Maxillofac Surg.  
2002;40:410–417.
7. Jesper Ø, John J, Birte M. Factors of Importance for the  
Functional Outcome in Orthognathic Surgery Patients : A  
Prospective Study of 118 Patients. J Oral Maxillofac Surg  
2010;68:2221-2231.
8. Ruscello DM, Tekieli ME, Sickels JEV, Morgantown WV, San A.  
Speech production before and after orthognathic surgery: A  
review. Oral Surg. Oral Med. Oral Pathol. 1985;59:10-14.
9. Niemeyer TC, Gomes A de OC, Fukushiro AP, Genaro KF.  
Speech resonance in orthognathic surgery in subjects with cleft  
lip and palate. J Appl Oral Sci 2005;13(3):232-236.
10. Chanchareonsook N, Samman N, Whitehill TL. The Effect of  
Cranio-Maxillofacial Osteotomies and Distraction osteogenesis  
on Speech and Velopharyngeal Status: A Critical Review. Cleft  
Palate-Craniofacial Journal. 2006;43:477-487.
11. Mason R, Turvey TA, Warren DW. Speech considerations with  
maxillary advancement procedures. J Oral Surg.

1980;38(10):752-758.

12. Epker BN, Wolford LM. Middle-third facial osteotomies: their use in the correction of dentofacial and craniofacial deformities. *J Oral Surg.* 1976;34:324–342.
13. Jaques B, Herzog G, Muller A, Hohlfeld J, Pasche P. Indications for combined orthodontic and surgical (orthognathic) treatments of dentofacial deformities in cleft lip and palate patients and their impact on velopharyngeal function. *Pholia Phoniater Logop.* 1997;49:181–193.
14. Munro IR, Salyer KE. Orthognathic surgery for patients with cleft lip and palate. In: Bardach J, Morris HL, ed. *Multidisciplinary Management of Cleft Lip and Palate.* Philadelphia: WB Saunders. 1990;500–514.
15. Witzel MA, Vallino LD. Speech problems in patients with dentofacial or craniofacial deformities. In: Bell WH, ed. *Modern Practice in Orthognathic and Reconstructive Surgery.* Vol. 2. Philadelphia: WB Saunders; 1992:1687–1735.
16. Gateno J, Teichgraeber JF, Xia JJ. Three-Dimensional Surgical Planning for Maxillary and Midface Distraction Osteogenesis. *J Craniofac Surg.* 2003;14:833–839.

17. Hussain SA. External frame distraction osteogenesis of the midface in the cleft patient. Indian J Plast Surg. 2009;42:S168–173
18. O'Gara M, Wilson K. The effects of maxillofacial surgery on speech and velopharyngeal function. Clin Plast Surg. 2007 Jul;34(3):395-402.
19. Kaplan H. Anatomy and physiology of Speech, McGraw-Hill Book Company, Inc., New York, 1960:207
20. Honzo I, Kojima M, Kumazawa T. Role of Passavant's Ridge in Cleft Palate Speech. Arch. Oto-Rhino-Laryng. 1975;211.203-208.
21. Isberg AM, Henningsson GE. Intraindividual Change in the Occurrence of Passavant's Ridge due to Change in Velopharyngeal Sphincter Function : A Videofluoroscopic Study. Cleft Palate Journal 1990;27:253-257.

# 국문초록

**서론:** 본 연구의 목적은 구순구개열 환자에서 악교정수술이 언어에 미치는 영향을 연구하기 위함이다.

**방법:** 환자군은 양악수술을 시행받은 15 명의 구순구개열 환자로 구성되었다. 언어평가, 비디오투스검사, 상악 전진량, 수술 시 연령, 구순구개열 형을 분석하였다. 언어평가와 비디오투스검사는 술 전 평균 25 일에 시행하였고, 술 후 평균 13 개월째에 시행하였다. 두번째 술 후 평가는 첫번째 술 후 평가 6 개월 후에 3 명에서 시행하였다. 말의 명료도와 과비성성은 5 단계로 나누어 평가하였고, 입천장인두 기능부전은 3 단계로 나누어 평가하였다. 평균 상악 전진량은 6.9 밀리미터였다.

**결과:** 술 전 언어평가에서 11 명(73.3%)의 환자가 과비성성이 없었고, 3 명(20%)의 환자가 약한 과비성성을 보였으며, 1 명(6.7%)의 환자가 중간 정도의 과비성성을 보였다. 술 전 말의 명료도 측면에서 10 명(66.7%)의 환자가 1 단계명료도, 4 명(26.7%)의 환자가 2 단계명료도, 1 명(6.7%)의 환자가 3 단계의 명료도를 보였다. 술 전과 술 후 평가를 비교해 보았을 때, 15 명중 11 명(73.3%)에서 말의 명료도와 과비성성에 변화가 없었다. 15 명중에 12 명(80%)의 환자가 수술 전과 후에 비디오투스검사를 시행받았다. 이 중 술 전 입천장인두 기능부전은 1 명(8.3%)의 환자에서 나타났고 7 명(58.3%)의 환자에서 약



간의 입천장인두기능부전 소견을 보였다. 4 명(33.3%)의 환자는 입천장인두기능부전 소견이 없었다. 악교정수술 후 3 명(25%)의 환자에서 구개범인두의 틈이 증가한 소견을 보였고, 1 명(8.3%)의 환자에서 새롭게 입천장인두기능부전 소견이 나타났다. 새롭게 발달한 팻사반트 융선은 4 명의 환자에서 관찰되었다. 두번째 술 후 평가를 받은 3 명 모두 첫번째 술 후 평가와 비교하여 말의 명료도와 비디오투시 검사에서 차이가 없었다. 그러나 두 명의 환자에서 팻사반트 융선이 첫번째 평가 시보다 두번째 평가 시에 더 저명해진 소견을 보였다. 팻사반트 융선의 발달과 수술 전 입천장인두기능부전의 단계, 팻사반트 융선의 발달과 상악 전진량 사이에는 통계적으로 유의한 관계를 보이지 않았다.

**결론:** 악교정수술 후에 구개범인두의 틈은 증가할 수 있으나, 이는 말의 명료도나 과비성성에 영향을 미칠 정도는 아니다. 새롭게 발달한 팻사반트 융선과 점진적인 비대는 보상기전으로 작용할 가능성이 있다.

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주요어 : 구순구개열, 악교정수술, 언어평가

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