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Articulation Training for Velopharyngeal Function Reinforcement

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Speech therapy for articulation disorder secondary to velopharyngeal incompetence had generally been instituted after attaining sufficient velopharyngeal function either by surgery or prosthetic treatment. This therapeutic policy seems to require some amendment now.

Recent advancement in fluorovideoscopy and fiberscopy permitted direct visualization of the dynamic velopharyngeal function. Through observation of these video-taped data, we found that some cases of slight velopharyngeal incompetence could be improved solely by speech therapy in terms of velopharyngeal function as well as articulation.[6]

We also found that transient velopharyngeal closure could be elicited by tentative articulation therapy even in some of the obvious velopharyngeal incompetent cases. These cases have improved velopharyngeal function as well as articulation after further intensive speech therapies.

This report deals with five cases which illustrate how velopharyngeal function has been improved by speech therapy.

SUBJECTS

They consist of 2 cleft lip and palate, 1 cleft palate, 1 submucous cleft palate, and 1 congenital velopharyngeal incompetence. The age ranges from 4 to 18 years at the first visit (Table 1).

METHODS

Velopharyngeal function was assessed by utilizing fiberscopy and fluorovideoscopy, and recorded on video-tape.

Fluorovideoscopy

The patients were laid supinely on the bed. Barium sulfate, about 10 cc, was

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Table 1. Subject

Case No.	Type of Cleft	age
1	CLCP	4 y
2	CVPI	4 y
3	SMCP	5 y
4	CLCP	9 y
5	CP	18 y

CLCP: Cleft lip & palate
CP: Cleft palate
SMCP: Submucous Cleft palate
CVPI: Congenital velopharyngeal incompetence

instilled into the oral cavity and through the nostril into the naso-pharynx. The articulatory movements during speech were observed in both lateral and antero-posterior projections, using a U-arm type X-ray apparatus (PHILIPS OPTMUS M200). Simultaneous recording of the fluorovideoscopic image and speech sound was made with a videocassette recorder (NATIONAL NV-9200).
This examination was done only once at the first visit.

Nasopharyngofiberscopy

After anesthetizing the nasal mucosa with 4% Xylocaine, a fiberscope was inserted into the nasal cavity for visualization of the velopharyngeal port: the velum, and lateral and posterior pharyngeal wall during speech production. Most frequently we used a flexible end-view type fiberscope (OLYMPUS ENF, TYPE P). The fiberscopic image was recorded on a videocassette recorder (SONY VO-2960) through a video camera (SONY DXC-1850). This examination was done at the first visit and the successive sessions of articulation therapy.

Assessment

Two speech therapists and two doctors examined the recorded video-tape with the focus on the following four points.

1) Clinical assessment of articulation and velopharyngeal function.
2) Search for clue consonants for velopharyngeal closure.
3) Analysis of dynamic velopharyngeal closure.
4) Process of improvement in articulation and velopharyngeal closure.

Test words for fiberscopic and lateral fluorovideoscopic examinations consist of

1) Japanese vowels, [ɯ], [o], [a], [e], [i]
2) C-V syllables with plosives and fricatives, [pɯ], [ka], [ta], [ɕi]
3) Words containing plosive or fricative sound, [koto], [ɕika], [tatami], [popɯɾa]
4) A short sentence, [jabɯ no nakakaʃa ɯsagi ga pjokon to detekjimaɕita]

In addition to these samples, tentative articulation therapy was done at the first visit, using whispered sounds of [pɯ] [ka] [ta] [ɕi] and [sɯ].

note: [ɕ] represents the consonant sounds of Japanese C-V syllable sha, shu, sho, shi, Usually, [ʃ] is used instead of [ɕ].

During frontal fluorovideoscopic examination, only vowel [a] is pronounced. Three of the subjects had tentative speech therapy on the whispered [pɯ] and [çi].

For [p] sound, the patient was asked to keep expiratory air within a mouth, flip the lips and make the plosive emission of air to produce [þΦΦΦ···], which leeded toa Japonese C-Vsyllable [pw]. For [k] sound, a whispered [ga] leaded to [ka]. For [t] sound a whispered [da] leaded to [ta].

[ç] sound was induced by imitation of a whispered [çi] or a whispered [çi] leaded to whispered [çi]. For production of [s], the patient was asked to protrude the tongue tip between the lips and produce a whispered [ɬɯ] which leaded to whispered [sɯ].

RESULTS

1) Articulation and Velopharyngeal Function at the First Visit

According to the auditory impression, all the subjects were judged nasal of their speech. They all demonstrated faulty articulations for both plosives and fricatives such as omission of the consonants, glottal stop, and laryngeal fricative. These faulty articulations do not require raising of the intraoral pressure (Table 2).

Velopharyngeal closing behavior at the first visit is illustrated on the case 4. The fluorovideoscopic lateral view shows an obvious gap between the velum and the posterior pharyngeal wall at the time of [pɯ] production, even though the velum elevates in a 'knee' shape as compared with that of rest time (Figure 1). Velopharyngeal incompetence was also observed at the time of other test words productions.

The other four subjects were also auditorily judged to have velopharyngeal incompetence at the initial examination (Figure 2). The fiberscopic examination substantiated the judgement. Although slight movement was recognized in the velum and posterior pharyngeal wall, the velopharyngeal port remained unclosed.

Table 2. Articulation and hypernasality at initial examination

Case No.	plosive			fricative		hypernasality
	p	t	k	s	ç	
1	dis	om	om	om	om	+
2	om	om	om	om	om	+
3	dis	om	om	om	om	+
4	gl.s.	gl.s.	gl.s.	l.fr.	l.fr.	+
5	wk	wk	wk	wk	wk	+

dis: distortion
om: omission
gl.s.: glottal stop
l.fr.: laryngeal fricative
wk: weakness

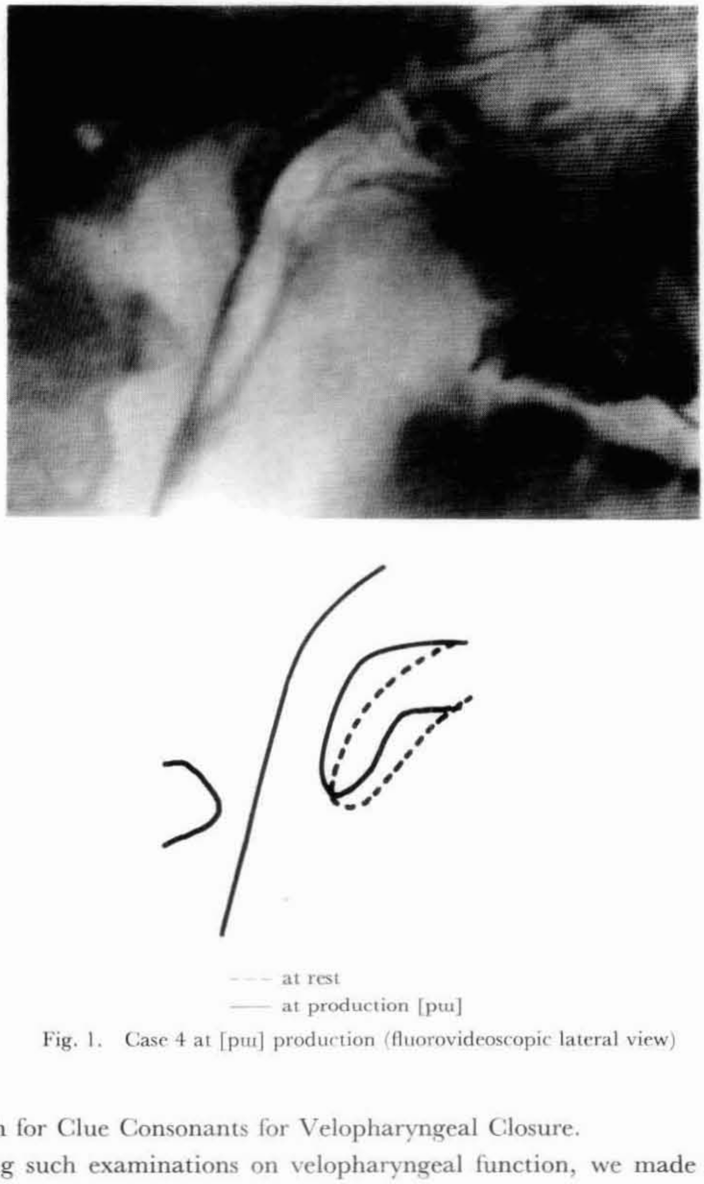


Fig. 1. Case 4 at [pɯ] production (fluorovideoscopic lateral view)

2) Search for Clue Consonants for Velopharyngeal Closure.

During such examinations on velopharyngeal function, we made a tentative articulation therapy and searched for such clue consonants as inducer of velopharyngeal closing behavior (Table 3).

For consonant [p], a whispered [pɯ] was exercised as a guide to velopharyngeal closure in all of the subjects. As to the consonant [ç], four subjects were instructed to produce whispered [çi]. Three of them showed sufficient velopharyngeal closure, but the other one subject could not close the velopharyngeal port, though improved to some extent.

The older two subjects were instructed to produce [k], [t] and [s]. One showed velopharyngeal closure for all these consonants, while the other remained velopharyngeal incompetent, though improved.

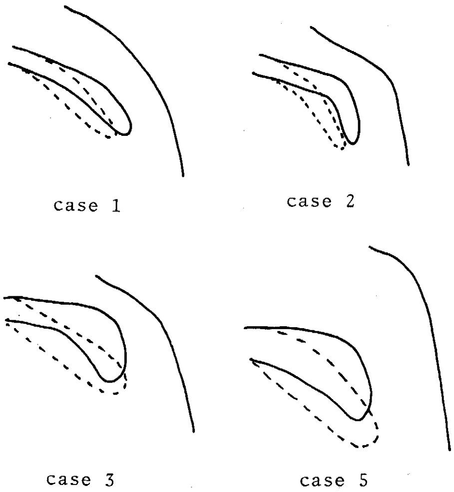


Fig. 2. Velar movements at the initial examination (the trace of fluorovideoscopic lateral view)

When sufficient velopharyngeal closure was attained, articulatory movement for whispered [pɯ], [ka], [ta], [çi] and [sɯ] also turned out normal.

3) Analysis of Velopharyngeal Closing Behavior

Velopharyngeal closing behavior, which was induced by articulation training, was analyzed on Case 4. On the fluorovideoscopic lateral view, emergence of Passavant's ridge can be identified on the posterior pharyngeal wall, touching the elevated velum on producing a whispered [pɯ]. As shown in the trace, the velum elevates up to the level almost the same as that for glottal stop production which is usually produced for [pɯ] in this case (Figure 3).

As shown by the fluorovideoscopic frontal view, the lateral walls move inward during whispered [pɯ] production at the level lower than that for vowel [a] to make contact with each other on the mid-line. This contact level for whispered [pɯ] is found to correspond to the upper edge of the contact surface which the bilateral walls make on swallowing (Figure 4).

Fiberscopic examination revealed that, at the time of whispered [çi] trial,

Table 3. Velopharyngeal response to the tentative articulation training

case No.	p	t	k	ç	s
1	◎			◎	
2	◎				
3	◎			◎	
4	◎	◎	◎	◎	◎
5	◎	○	○	○	○

◎: almost complete closure
○: improved but incomplete closure

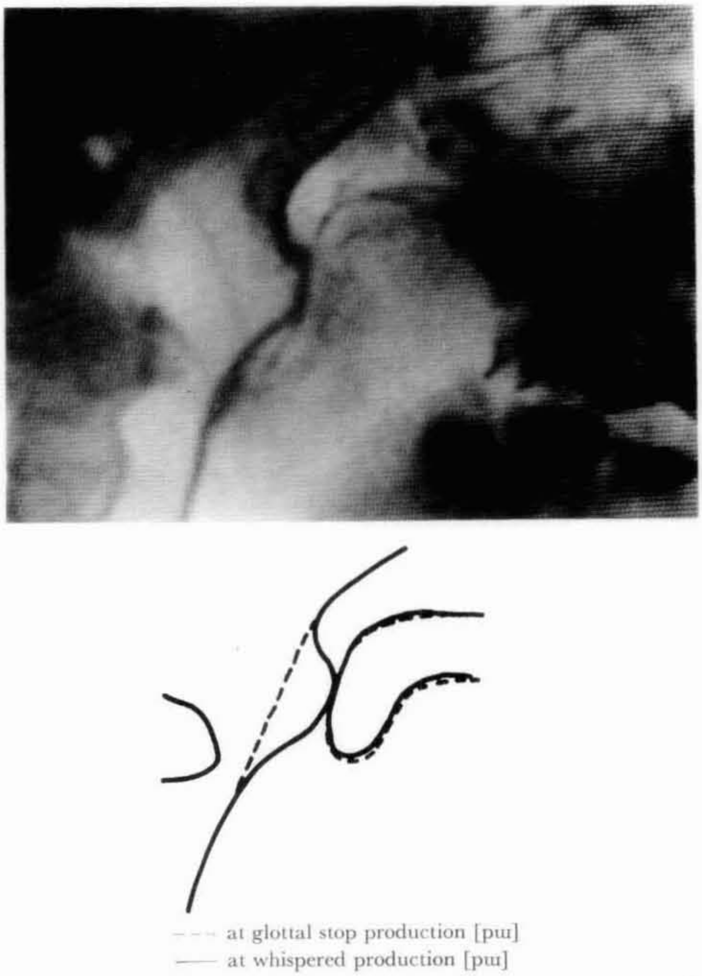


Fig. 3. Case 4 at whispered [pɯ] production (fluorovideoscopic lateral view)

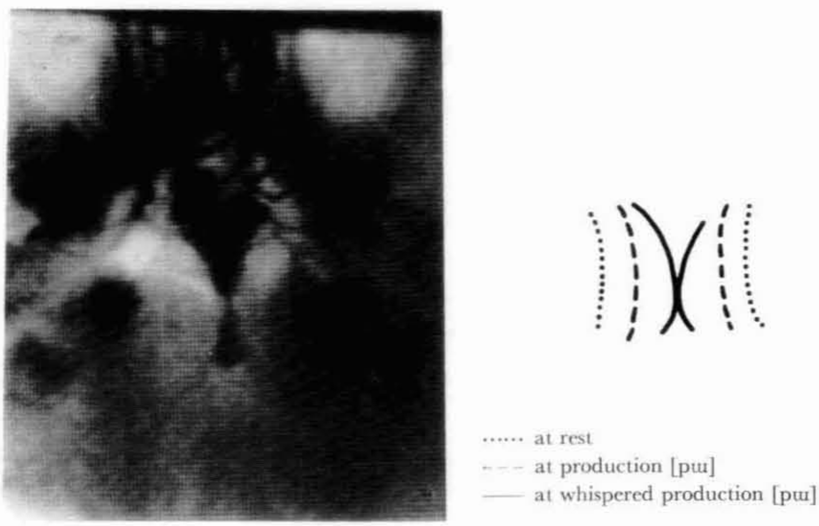
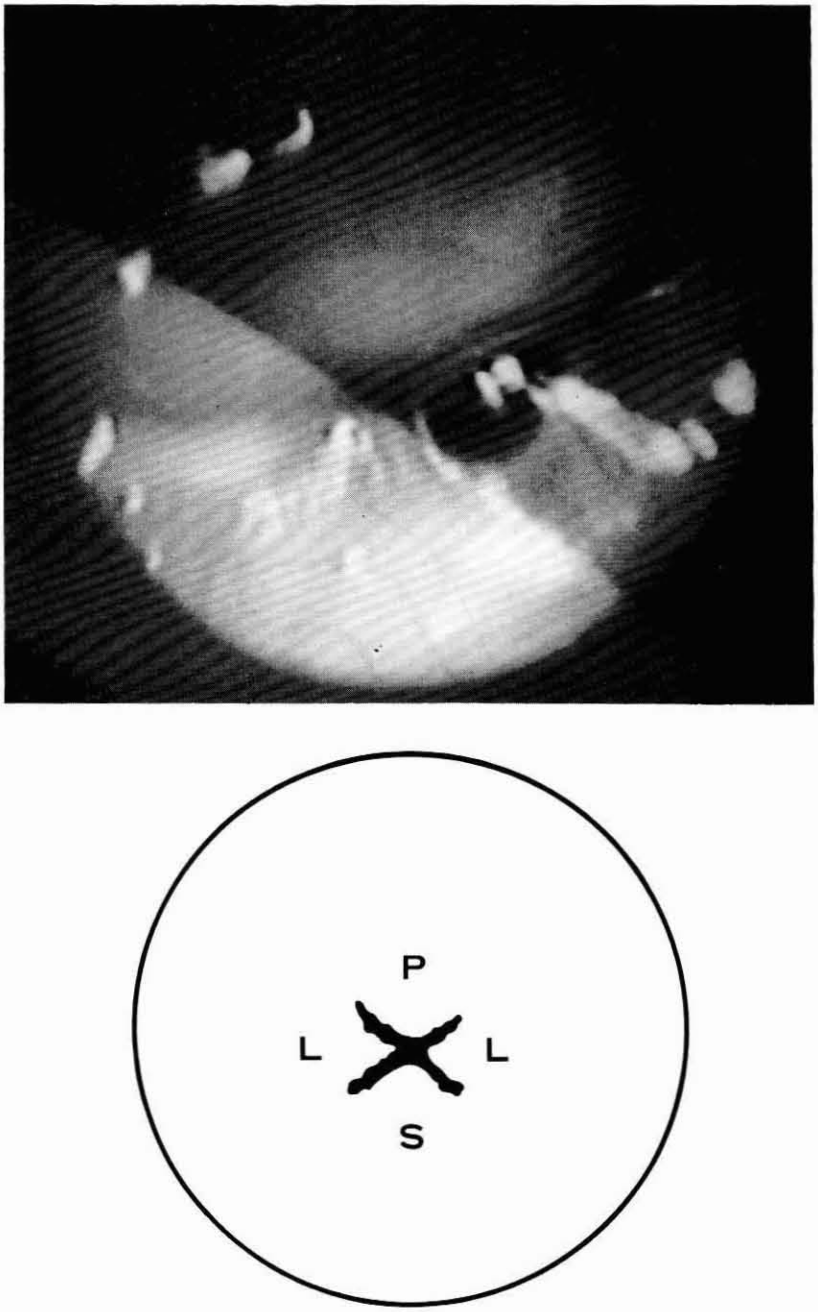


Fig. 4. Case 4 at whispered [pɯ] production (fluorovideoscopic frontal view)



P: Passavant's ridge
L: lateral wall
S: soft palate

Fig. 5. Case 4 at whispered [çi] production (fiberscopic image of velopharyngeal port)

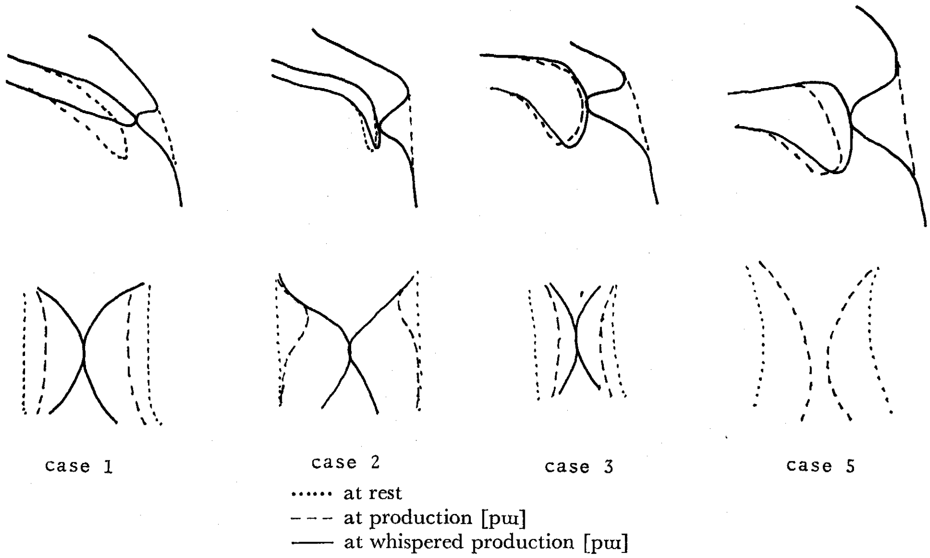


Fig. 6. Velopharyngeal responses to the initial articulation training (the trace of fluorovideoscopic lateral and frontal view)

Passavant's ridge emerged in the posterior pharyngeal wall, and the bilateral walls met to contact each other on the mid-line, simultaneously with elevation of the velum. Thus, the velopharyngeal port constricts in a centripetal coneshaped movement, resulting in closure (Figure 5).

On both fluorovideoscopic and fiberscopic examinations at the first visit, the other 4 subjects exhibited the same velopharyngeal closing gesture as case No. 4 at the time of whispered sound production (Figure 6).

4) Process of Improvement in Articulation and Velopharyngeal Closure.

Those who showed temporal velopharyngeal closure by tentative articulation therapy were placed on a regular speech therapy. When they achieved correct production of plosives and fricatives, their velopharyngeal function was improved for each corrected sound.

The closing pattern was essentially identical to that on the initial examination with whispered sounds, that was the concerted sphincteric movement among the velum, lateral walls, and Passavant's ridge.

Discussion

1) Improvement of Articulation and Velopharyngeal Function

Besides surgical or dental prosthetic treatment, many less aggressive attempts have been made to improve velopharyngeal function. E. Scheneider et al.[2] reported that 80% of the speech pathologists concerned considered speech therapy as the treatment of choice for velopharyngeal incompetence. However, few researches have been done to assess the effect of articulation therapy on velopharyngeal function.[1]

R. L. Shelton et al.[3] investigated the influence of articulation therapy on velopharyngeal closure mobility, utilizing fluorovideoscopy. From 17 subjects with slight velopharyngeal incompetence and articulation disorder, 8 subjects were randomly selected for articulation therapy, and were compared with the control group (9 subjects) without articulation therapy. They concluded that articulation therapy had no influence on velopharyngeal function.

In our previous paper on laryngeal fricative,[4] however, we have demonstrated that speech therapy for laryngeal fricative yielded velopharyngeal competence as the faulty articulation was being corrected.

On the basis of cineradiographical examination on the subjects with velopharyngeal incompetence and faulty articulation such as alternating oral and glottal stop, Henningsson studied velopharyngeal closing movement for the oral stop in comparison with that for the glottal stop. The velopharyngeal function was incompetent for the glottal stop, while it was competent for the oral stop. This report is indicative of velopharyngeal function being variable with articulation manner.

Our 5 subjects had faulty articulations in plosives and fricatives, such as the omission or glottal stop, all accompanied with velopharyngeal incompetence at the time of these defective sounds production. Our tentative articulation therapy with whispered sound, however, demonstrated that velopharyngeal function improved dramatically at the time when the normal articulatory movement was temporally attained. This improved velopharyngeal function was perpetuated at the time of correct production of other plosives and fricatives which were achieved by successive speech therapy.

Our cases substantiate that those with so called functional velopharyngeal incompetence, accompanied with faulty articulation, may attain sufficient velopharyngeal function as they achieve correct articulation. It is of great interest to note that the patients attained velopharyngeal competence, not necessarily gradually, but simultaneously with articulatory correction, led by speech therapy.

Thus, the patients with faulty articulation at the first visit are first instructed or trained, so that at least one consonant-vowel syllable can be produced correctly. If sufficient velopharyngeal function is found during these therapeutic articulation trials, a possibility is suggested that the velopharyngeal incompetence and faulty articulation as well may be corrected by further regular speech therapy.

The plosives or fricatives which require high intraoral pressure for production, such as [p] or [ç], are usually used for sorting out the candidates for the speech therapy for velopharyngeal incompetence. The above examples [p] and [ç] are rather easy to learn the pronunciation even for young children.

Faulty production of the plosives or fricatives can be corrected most easily with whispered sounds used as a guide. In other words, we teach the place and the manner of articulation using whispered sounds instead of voiced ones, then lead to Japanese C-V syllables. As understood from the transcription [pΦΦ] and [ççç] for the whispered [pɯ] and [çi], portions of consonant sound are prolonged in whispered sounds. In order to produce these sounds, one has to build good oral air pressure and lead the air stream forward from the point of articulation. It should be noted that the whispered sounds do not mean devoicing of the vowels which follow the defective consonants. In articulation therapy with whispered sounds, we intend to teach correct place and manner of articulation of the consonants, such as [p], [k], [t] and [ç].

By such articulation therapy, the subject attained correct articulation and good velopharyngeal function at the same time. But it is not clear how these changes occurred. It is reported[7] that the oral air flow rate for whispering is twice as high as non-whispered speech. This increased air flow may partly be responsible for the increased intraoral air pressure for whispered sounds, but further research is required.

2) Change in Velopharyngeal Movement

Velopharyngeal function of the five subjects was all judged to be obviously incompetent by fluorovideoscopic and fiberscopic examination. However, prompt improvement in velopharyngeal function and articulation as well was noted during the tentative articulation therapy with whispered [pɯ] and [çi].

The pattern of velopharyngeal closure at this moment was that the velum, lateral wall, and Passavant's ridge all come into contact each other like a sphincter. During tentative articulation training with [p] and [ç], the subject ②, ③ and ④ exhibited the same velar elevation as that at the defective sound production, even when he aquired correct production of [pɯ]. The subject ① and ⑤ exhibited slightly improved velar mobility, but there was still a distinct gap between the elevated velum and the posterior pharyngeal wall, which was filled though by emergence of Passavant's ridge on plosive or fricative production. The lateral pharyngeal walls were also found to meet on the mid-line on fluorovideoscopic frontal view. In other words, the change in mobility of the lateral walls and Passavant's ridge is said to be greater than that of the velum. As illustrated above, Passavant's ridge played an important role in velopharyngeal closure in those cases. Few researches have been done on the role of Passavant's ridge in velopharyngeal closure during speech. This type of research is currently in progress at our clinic.

The level of velopharyngeal closure where the above 3 structural components come into contact is featured by the following findings,

1) The contact portion between Passavant's ridge and velum is lower than velopharyngeal closing point in normal subjects.

2) The contact portion of the bilateral pharyngeal walls corresponds to the upper edge of the contact surface which the bilateral walls make during swallowing.

3) Nasopharyngofiberscopic image shows that velum, lateral pharyngeal walls, and Passavant's ridge make contact with each other at one point.

As above mentioned, both Passavant's ridge and lateral pharyngeal walls make maximum movement on the same level. The level of the velopharyngeal closure in these cases is slightly lower than that in the normal subjects.

Three dimentional assessment was made on velopharyngeal function by utilizing fluorovideoscopy and fiberscopy.

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