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Nasoendoscopy : Clinical Implications

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Abstract : The purpose of this study is to discuss the clinical use of nasoendoscopy examination of the velopharyngeal closure in patients with nasal speech and to describe the clinical implications of this technique. Three different patients with hypernasal speech, one with cleft palate, one with hearing loss and one with mental retardation, were studied velopharyngeal incompetence through direct assessment of the velopharyngeal closure by nasoendoscopy. An Olympus Nasoendoscope model ENFP3 was used and the Siriraj Speech Stimuli Resonation Test (Manochiopinig & Chuangsuwanich 2001) was used as a standard speech sample. After an explanation and informed consent, 10% xylocaine was sprayed into the nostril for topical anaesthesia. The first author performed the nasoendoscopy, meanwhile the second author stimulated the speech sample and velopharyngeal function. The same procedure and condition was conducted to each subject in an operating room. Excursion of the soft palate and pharyngeal wall, completeness, asymmetrical, leakage, adequacy, patterns of closure were observed during speech production. Descriptive analysis was used. The results indicate that intelligible speech production depends on a normal velopharyngeal closure mechanism. Abnormal coupling of the oral and nasal cavities of these patients are characterized by hypernasality, nasal emission, imprecise speech production and decrease speech intensity. These typical signs of velopharyngeal insufficiency could be due to either structural defect (cleft palate), physiological dysfunction (hearing loss) or mental status (mental retardation). Nasoendoscopy provides a direct approach to visualize the velopharyngeal closure. This technique helps clinicians to distinguish between those patients with nasal speech who appear to have the physiological potential for satisfactory velopharyngeal closure from those who do not. This distinction is clinically important because of the marked difference in the treatment. Furthermore, in patients considered for a pharyngeal flap operation, pre-operative evaluation of the closure is vital. In conclusion, hypernasal speech alone is not a sign of velopharyngeal insufficiency from structural defect. Thus, a diagnosis is suggested to be made by the cranio-maxillo-facial team after complete evaluation. In addition, nasoendoscopy has been valuable in distinguishing different groups of patient as well as planning for treatment.

เรื่องย่อ : การใช้ Nasoendoscope ทางคลินิก

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ผู้รายงานได้ทำการศึกษาการใช้ nasoendoscopy และการประยุกต์ใช้วิธีนี้ในงานบริการทางคลินิกเพื่อการตรวจวินิจฉัยลักษณะการทำงานของเพดานอ่อนและผนังลำคอในการเปิด-ปิดช่องคอหอยและพูดของผู้ประสบ 3 รายที่เสียงพูดขึ้นจมูกมากเกินไปภายหลังได้รับการผ่าตัดแก้ไขเพดานโหว่ ทุกรายมีปัญหาอื่นร่วมด้วย คือ 1 รายมีรูรั่วทะลุที่เพดานแข็ง 1 รายมีการได้ยินเสียงก้องในหู และ 1 รายมีปัญหาปัญญาอ่อน การประเมินความบกพร่องในการทำงานของอวัยวะบริเวณช่องคอ ทำโดยการส่องกล้องผ่านรูจมูกเพื่อศึกษาการทำงานเคลื่อนไหวในขณะพูด เครื่องมือที่ใช้ส่องคือ nasoendoscope ของบริษัท Olympus รุ่น ENF3 และใช้แบบทดสอบความก้องกังวานของเสียงพูดศิริราช (ศรีวิมล มโนเชี่ยวพินิจ และ อภิรักษ์ ช่วงสุวนิช 2544) ในการกระตุ้นตัวอย่างเสียงที่ต้องการและศึกษาการทำงานของอวัยวะบริเวณช่องคอด้วยวิธีมาตรฐาน หัตถกรรมเริ่มภายหลังการให้ข้อมูลคำอธิบายรายละเอียดเกี่ยวกับหัตถกรรมและเมื่อผู้ป่วยเซ็นชื่อลงในยินยอมรับการทำหัตถกรรม ผู้ป่วยได้รับยาระงับความรู้สึกเฉพาะที่โดยการพ่นยา xylocaine ที่มีความเข้มข้นร้อยละ 10 เข้าทางรูจมูกและช่องปาก นักจิตบำบัดกระตุ้นให้ผู้ป่วยพูดในขณะที่ศัลยแพทย์ส่องกล้องเข้าทางรูจมูกข้างที่ใหญ่และกว้างกว่าเพื่อตรวจและบันทึกข้อมูลการทำงานของอวัยวะดังกล่าว ทำหัตถกรรมด้วยมาตรฐานเดียวกันกับผู้ป่วยทุกรายในห้องผ่าตัดใหญ่ โรงพยาบาลศิริราช ตรวจสังเกตการเปิด-ปิดของเพดานอ่อนและผนังลำคอ ความสมดุลย์ในการทำงานของอวัยวะทั้งซ้าย-ขวา ความสมบูรณ์เพียงพอของการปิด ลักษณะรูปแบบการปิด รูรั่วขณะปิดและช่องว่างที่เกิดจากการปิดที่ไม่สนิท วิเคราะห์ข้อมูลด้วยวิธีการวิเคราะห์ทางสถิติเชิงพรรณนา ผลการศึกษาพบว่าการพูดที่ดีมีคุณภาพของเสียงพูดที่ไม่ขึ้นจมูกมากหรือน้อยเกินไปนั้นสัมพันธ์โดยตรงกับกลไกการเปิด-ปิดช่องคอของอวัยวะบริเวณช่องคอ การปิดช่องคอที่บกพร่องมีผลทำให้เกิดความผิดปกติของเสียงพูด คือ เสียงพูดขึ้นจมูกมากกว่าปกติมีลมรั่วออกทางจมูกขณะออกเสียงพูด พูดไม่ชัดและความดังของเสียงลดลง ความผิดปกตินี้มีสาเหตุได้จากความบกพร่องทางด้านโครงสร้าง คือ รูรั่วทะลุที่เพดานปากหรือ จากความบกพร่องทางด้านสรีรวิทยา คือ สูญเสียการได้ยินหรือจากสาเหตุทางจิตภาวะทางสมอง คือปัญญาอ่อน การตรวจ nasoendoscopy เป็นวิธีการตรวจที่ทำให้เห็นการทำงานเปิด-ปิดของช่องคอโดยตรง ช่วยให้สามารถแยกผู้ป่วยที่มีเสียงพูดขึ้นจมูกมากเกินไปว่ารายใดมีโครงสร้างที่เอื้ออำนวยให้มีศักยภาพของปิดช่องคอจากรายที่โครงสร้างผิดปกติทำให้ไม่มีศักยภาพในการทำงาน ซึ่งเป็นสิ่งสำคัญในการดูแล วางแผนการรักษาผู้ป่วยเป็นอย่างมาก เพราะสาเหตุที่แตกต่างกันย่อมต้องการรักษาที่ต่างกันโดยเฉพาะอย่างยิ่งรายที่ต้องได้รับการผ่าตัด โดยสรุปลักษณะเสียงขึ้นจมูกไม่ใช่จากการแสดงของความบกพร่องของโครงสร้างแต่เพียงอย่างเดียวแต่อาจร่วมกับการเรียนรู้ได้ ดังนั้นนอกจากการศึกษาครั้งนี้คือการวินิจฉัยแยกโรคและการวางแผนการดูแลรักษาที่สมบูรณ์ควรทำโดยกลุ่มที่มงาน cranio-maxillo-facial และวิธี nasoendoscopy มีประโยชน์อย่างมากทั้งต่อการวินิจฉัยแยกโรคและวางแผนการรักษา

Key words : nasoendoscopy, velopharyngeal insufficiency, cleft palate, nasality evaluation

INTRODUCTION

Care for patients after surgery of cleft palate repair is a significant challenge to the Cranio-Maxillo-Facial Team. Generally surgery takes the form of pharyngeal flap surgery and/or palatal lengthening surgery, which is aimed at improving the ability of the velopharyngeal closure to function normally. Although the surgery is successful, a further period of therapy is probably needed to correct speech habits in some cases. Approximately 5% - 38% of the cases with repaired cleft palate have velopharyngeal dysfunction[1,2]. There are two groups of procedures for assessing velopharyngeal function: indirect and direct[3-13]. Indirect procedures provide information about velopharyngeal function, whereas direct procedures enable the clinician to visualize the structures involved in velopharyngeal closure. Most of the indirect procedures, particularly non-instrumental tools for screening velopharyngeal closure, are inexpensive and easy to use. The available indirect procedures are perceptual judgments[3,16], acoustic analysis[6,8,11,17] and pressure-flow assessment[3,12,18-22]. Nasoendoscopy[2,23-25], multi-view cine / video fluoroscopy[7,26-27], ultrasound[28-30], computed tomography (CT)[31-32], and magnetic resonance imaging (MRI) have been utilized to assess velopharyngeal function directly. Among these, two gold standard procedures for instrumental assessment of velopharyngeal function are nasoendoscopy and videofluoroscopy[24,26-27,33]. Both procedures are widely accepted as state-of-the art techniques for the direct visual assessment of the velopharyngeal movement[5,24,26,34-35].

Multi-view videofluoroscopy provides the visualized motion picture x-ray of the velopharyngeal valve. It is a sophisticated way of looking at the movement of the soft palate and pharyngeal walls during speech and is used when palatal problems are suspected. Most of the hospitals in Thailand, this multi-view videofluoroscopy for assessing velopharyngeal function is not available because of the high cost. Although it is a painless procedure, the x-ray mechanism needed for adequate viewing may be frightening for some young children. In addition, it is difficult to obtain the accurate actual sites of velopharyngeal closure and interpret certain views[35]. They still do not have a standard uniformity for the measurement and reporting of the observations[26]. Therefore, this procedure requires skillful expert to operate and interpret the results.

The nasoendoscopy was described in an attempt to assess velopharyngeal function in the late 1960's[21]. Nasoendoscope is a thin fiberoptic rod with a diameter of 2-4 millimeters. To perform the assessment, this tube is passed through the nostril into the nasal cavity, after the nose has been anesthetized with local anesthetic. The procedure gives a direct superior view of the velopharyngeal valve and allows the physician to directly visualize the structures in the dynamic state. More specifically, it provides information on the anatomy and function of the velopharyngeal valve, pattern and closure of the valve during speech, relative size and location of velopharyngeal gaps, and consistency of movements. Furthermore, movement of the specific components, function of the dorsum of the posterior tongue during speech, and anatomy and function of the laryngeal structures are also reviewed. Three types of endoscopes are available: side-viewing rigid, side-viewing flexible, and end-viewing flexible. Most physicians prefer end-view flexible scopes because all aspects of the velopharyngeal tube, including the larynx in the patients with large adenoids, may be examined. The whole motion is not only viewed directly during speech but it also may be videotape recorded. It has supplanted acoustic and nasal emission techniques as the primary adjunctive assessment measures. One of the main clinical applications of the nasoendoscopy is to investigate velopharyngeal inadequacy condition. The obtained information assists with decisions about the management and treatment such as form of surgery. This procedure generally does not hurt, but it can be uncomfortable and it may be poorly tolerated in some children less than 10 years old. It is accounted for one of the gold standards for visualization. Beside the similar benefit of the two gold standard procedures (videoflouro-scopy and nasoendoscopy) in assessing velopharyn-geal insufficiency, nasoendoscopy appears to be more available in Thailand than the other method due to some reasons such as its lower unit cost.

Velopharyngeal insufficiency is defined as an inability to separate the oropharynx from the nasopharynx. Velopharyngeal insufficiency condition[1,5,7,7] refers to any type of abnormal velopharyngeal function within a broad group of inadequacy closures either from structural, neurogenic, poor habit or functional origin causes. Dysfunction occurs in the surrounding structures of the velopharyngeal port (i.e., soft palate, posterior pharyngeal wall and lateral pharyngeal wall). The soft palate in particular cannot extend enough to seal the nasal cavity from the mouth during speech. Therefore, the patient has abnormal speech[9,19] such as hypernasal resonance[10,25], nasal emission[14,16,35-42]. Affected patients tend to compensate for the loss of velopharyngeal port closures by positioning the tongue posteriorly in the oropharynx. This results in a loss of tongue-to-alveolar contact causing omission of alveolar consonant production. As a results they have imprecise speech[10,12,16], nasal substitutions[14,15], compensatory articulation[10,12,42], sibilant distortion (i.e., cannot form fricative sound such as /s/), increase risk for disorders of phonation[9,38], decrease speech loudness[9,41] and short phrase[16,41]. These are common defects found in cleft palate patients[3]. However, these speech disorders are also found in other patients including those with hearing loss and mental retardation.

In the cleft palate patients, occasionally the palate after surgery may be too short or may not move very well from the previous habitual speech behaviours. When this happens, air can escape into the nose when the patient is speaking. A slight snorting noise on certain sounds could be heard or it may make all speech sound nasal. This is an indication for re-evaluation velopharyngeal function.

Generally, patients with cleft lip and palate have intelligence quotients that fall within the average range[5,13,41-42]. The risk for deficits in intelligence is increased in those with cleft palate only, especially when other congenital anomalies are present. Cognitive impairment can range from a specific language or learning disable to severe mental retardation. Consequently, they have poor speech production in relation to their mental capacities as well as structural defects. Articulation defects and resonation speech disorders (inconsistency hypernasality or hyponasality speech) are common problems in such cases.

Another example of the patients who tend to have hypernasal speech and articulation disorders are the ones with hearing impairment. Hearing loss is another common defect that co-exist with cleft palate conditions[41-45]. Patients with cleft palate have an increased incidence of middle ear disease and they may also compromisé hearing. Consequently, they have abnormal speech defects.

Since nasal speech and many other speech defects mentioned above could be found in different velopharyngeal insufficiency conditions, differential diagnosis is very important for the proper management. Usually a gold standard of assessment will be selected for differential diagnosis of the velopharyn-geal function and planning the treatment. Oftenly nasoendoscopy is applicable most of the time for many reasons.

The purpose of this study is to discuss the clinical value of nasoendoscopy examination in the management of the velopharyngeal insufficiency found in 3 different patients with nasal speech and to describe clinical implications of this technique.

MATERIALS AND METHODS

Subject

The velopharyngeal function of three postoperative cleft palate patients with hypernasal speech were included in this study. The first case was a 12 years old girl who has an oro-nasal fistula about 0.5 centimeters in diameter. The second case was a 14 years old boy who has bilateral sensory-neural hearing loss at a level of 55 dB. The third case was a 10 years old girl who has mental retardation with an IQ of 69. All were consulted by plastic surgeon for further management regarding to their velopharyngeal inadequacy resulting hypernasal speech problem. All their demographic and medical data are shown in Table 1.

Material

1. Standardized speech Test

Three standardized speech tests were used to elicit speech sample and/or evaluate speech of each subjects. These three tests were:

1.1 The Thai Articulation Test[33] for articulation test.

Table 1. Subject demographic and medical data

Number	Age (year)	Gender	Cleft Type	Primary Operation	Secondary Operation	Complication
1	12	Female	Incomplete Cleft Palate	Palatoplasty	Closure Fistular	Oro-nasal fistula (diameter 0.5 centrimeters)
2	14	Male	Incomplete Cleft Palate	Palatoplasty	None	Bilateral sensorineural hearing loss (55 dB)
3	10	Female	Incomplete Cleft Palate	Palatoplasty	None	Mental Retardation (IQ = 69)

1.2 The Thai Nasal Test[44,45] for pressure-flow assessment or resonation test by using Nasometer.

1.3 The Siriraj Speech Stimuli Resonation Test (Manochiopinig and Chuangsuwanich, 2001) (Appendix A) for nasoendoscopy.

2 Instruments

Two instruments, the Nasometer and a flexible fiberoptic nasopharyngoscopy, were selected for this study. These instruments were used for different purposes.

2.1 The Nasometer

Nasometer (model 6200) was used to assess resonation quality of the subject's speech. The Thai Nasal Test[44] was selected to use as a speech stimuli test for this acoustic assessment. Degree of nasality was justified based on the obtained nasalance score of each subject. Score that was higher or lower than the mean ± 1 S.D. of the normal population[45] was justified as hypernasality or hyponasality speech, respectively. The mean nasalance scores of normal subject in responding to the nasal sounds, oral sounds and oral-nasal sounds are 63.29%, 13.63% and 39.43%, respectively[45].

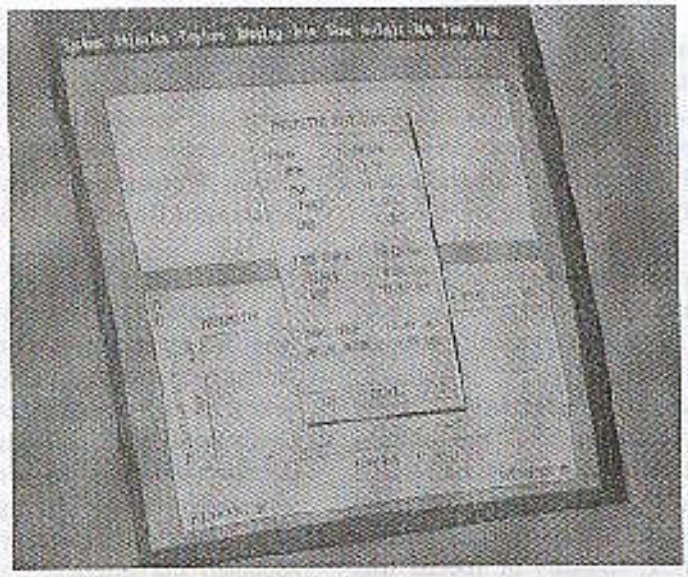


Figure 1. The monitor of Nasometer model 6200 displays the acoustic signals and the data analysis of the speech sample.

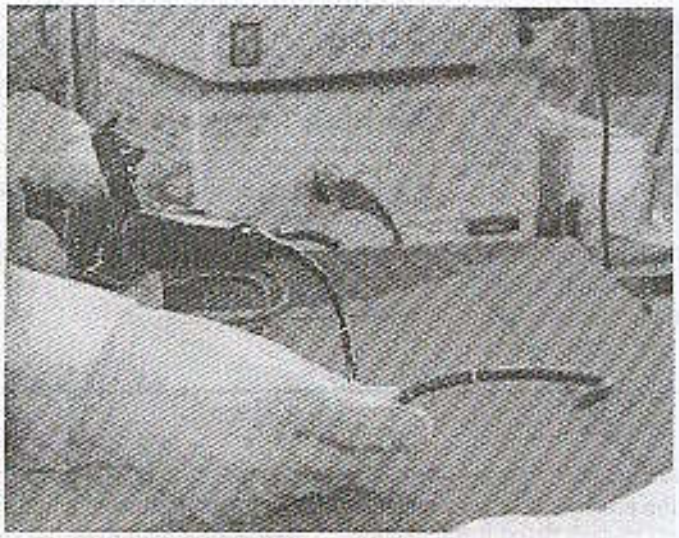


Figure 2. The fiberoptic, Olympus nasoendoscope model ENFP3, used in this study.

2.2 Nasoendoscope

For the nasoendoscopy, a flexible fiberoptic nasopharyngoscopy (an Olympus Nasoendoscope model ENFP3) (3.7 millimeters in diameter including the sheaf) was used. The Siriraj Speech Stimuli Resonation Test (Appendix A) was selected as a standard speech test for this procedure.

Procedure

The assessment was composed of two procedures: traditional speech assessment and velopharyngeal functional assessment. For the speech assessment, three components of speech characteristics were evaluated: preceptual evaluation (i.e., articulation test), clinical screening of the velopharyngeal function (i.e., resonation test) and oral examination (i.e., nasal emission test). This was followed by instrumental assessments (i.e., nasometer and nasoendoscope) for velopharyngeal functional assessment.

For the first step, a resonation test was carried on. Each patient's nasality speech quality was assessed by using the Nasometer model 6200. This procedure was performed by the second author at the speech - language clinic, Siriraj Hospital during February to May 2002. Nasality of speech was justified based on the nasalance score obtained. All these three cases were confirmed as having hypernasal speech with the nasalance scores of each patient higher than the normal population mean score plus 1 S.D. (Table 2)

The second step was to perform nasoendoscopy in the purpose of examining velopharyngeal closure. After an explanation and informed consent, the endoscopy procedure was started by applying lubricant gel on the tube and spraying 10% xylocaine into a nostril for topical anaesthsia. The first author performed the nasoendoscopy, meanwhile the second author stimulated the speech sample. This procedure was performed for each subject under the same conditions in an operating room, Siriraj Hospital during the same period with the traditional speech assessment. This procedure was videotape recorded.

Data analysis

Descriptive analysis was applied to data from the speech assessment and nasoendoscopy. Articulation speech characteristics, nasality, compensatory speech characteristic, nasal emission and nasalance scores of each patient were recorded. During nasoendoscopy, the excursion of the soft palate and pharyngeal wall during speech production was observed. Movement, symmetrical, leakage, adequacy and pattern of closure as well as gap of the velopharyngeal valve were all videotaped recorded. The authors reviewed the videotaped examination

results together and recorded their judgments of the anatomy and function on a standard form.

RESULT

1. Speech characteristics

All subjects had articulation disorders as shown in Table 2.

Table 2. Three speech aspects of cleft palate patients who had different complications.

Condition of Cleft palate patient	Articulation disorders			Resonation disorders			Nasal emission
	Substitution	Omission	Distortion	Nasal sounds	Oral sounds	Mixed sounds	
Oro-nasal	Mild degree of plosive fricative & affricate sounds (e.g., /p/, /s/, /c/)	No	No	Hypernasal (nasalance score = 84.36%)	Hypernasal (nasalance score = 45.20%)	Hypernasal (nasalance score = 56.33%)	No
Hearing loss	No	No	Yes only /s/ sound & Inconsistency	Hypernasal (nasalance score = 75.77%) consistency	Hypernasal (nasalance score = 30.14%) consistency	Hypernasal (nasalance score = 45.24%) consistency	Yes only /s/ sound
Mental retardation	All sounds consistency	All sounds consistency	All sounds consistency	Hypernasal (nasalance score = 70.11%)	Hypernasal (nasalance score = 27.65%)	Hypernasal (nasalance score = 44.13%)	Yes /s/ and /C/ sounds

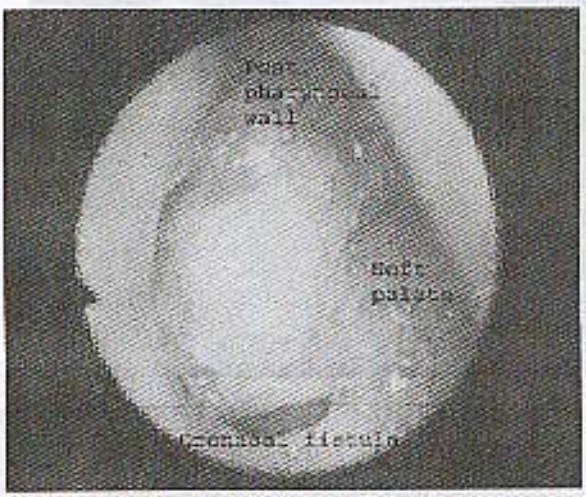


Figure 3. A gap in the right of the velopharyngeal closure of the cleft palate patient with oro-nasal fistula of the posterior part of the soft palate. Saliva was pumped out through the oro-nasal fistula during speech.

2. Velopharyngeal Functions

Each subject demonstrated different velopharyngeal function as shown in Table 3. Velopharyngeal closures of each case seen through the nasoendoscopy were reviewed as the following figures.

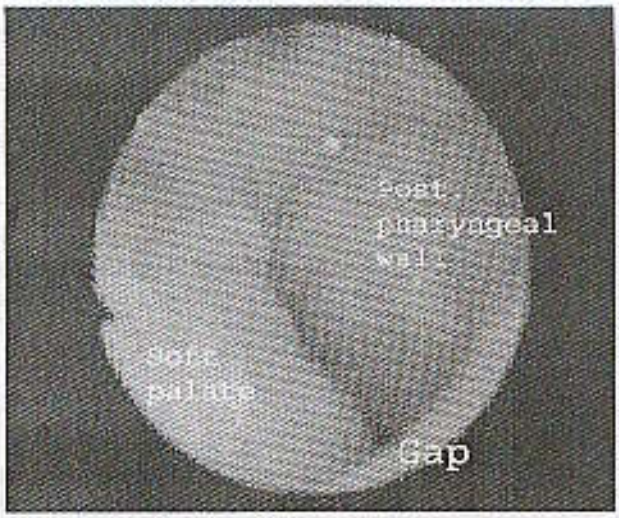


Figure 4. A gap at the right side of the velopharyngeal closure of the cleft palate patient with hearing loss.

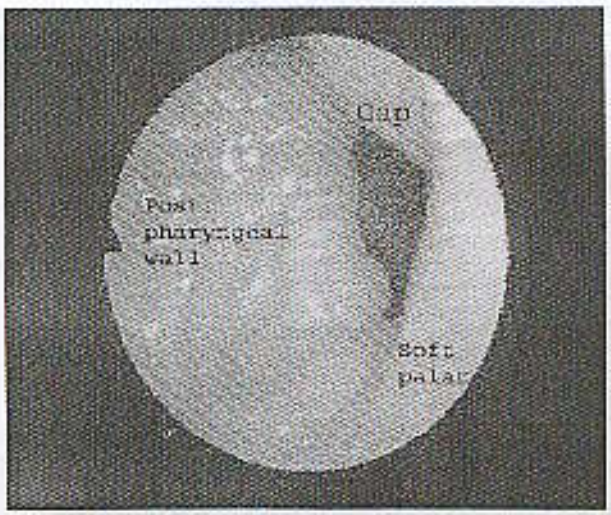


Figure 5. Velopharyngeal closure of the cleft palate patient with mental retardation during speech.

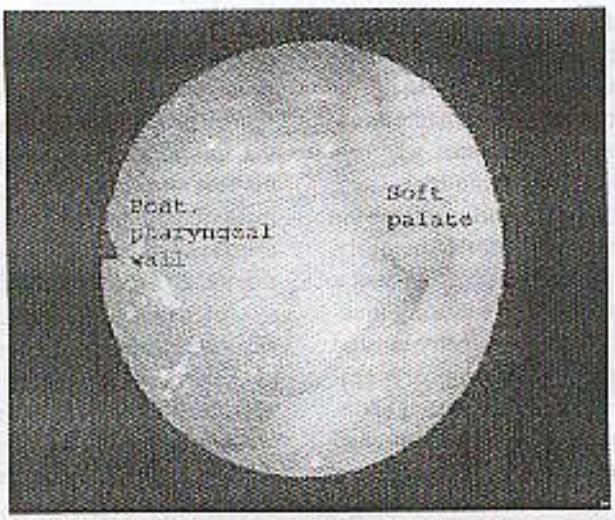


Figure 6. Velopharyngeal closure of the cleft palate patient with mental retardation during spontaneous swallowing.

Table 3. Velopharyngeal closures of the three cleft palate subjects seen through the nasoendoscopy.

Condition of cleft palate patient	Velopharyngeal closure			Gap	Fistula
	Closure Pattern	Completeness	Symmetrical/ Adequacy		
Oro-nasal fistula	Circular	Loose complete	Symmetry	-	Yes (0.5 cm. in diameter)
Hearing loss	Coronal	Inconsistency during phonation, Normal during swallowing	Left side moves more than right side	Yes (Right side of the velopharyngeal port) Inconsistency	No
Mental retardation	Mixed type (Circular with concave at the middle of the velum)	Inconsistency during phonation, Normal during swallowing	Inconsistency Poor contact in the middle of the velum	Yes (Central of the velopharyngeal port)	No

All cases demonstrated backward and upward motions of the velum (soft palate) with different degrees. Patterns of the closure were also difference. The first case with oro-nasal fistula had a circular closure pattern. Although the contact was in a loose manner, the movement was symmetry. There was air escape during phonation significantly as the saliva was pumped up through the fistula obviously. The second case with hearing loss demonstrated a coronal pattern with an inconsistently closing manner. More specifically, there was asymmetry closure with the gap on the right side of the velopharyngeal port during phonation, but closed tightly during spontaneous swallowing action. The third case who had low intelligence also demonstrated an inconsistency closure regardless of the speech sounds. Although there is a concavity at the middle of the velum that cause a big gap in the center of the valve during speaking, this patient was able to close more completely sometimes and in some situation such as during swallowing the saliva spontaneously.

Abnormal coupling of the oral and nasal cavities in these patients was characterized by hypernasality, nasal emission, and imprecise speech production (Table 2, 3 and Figures 3 - 6). During the nasoendoscopy, it was found that typical signs of velopharyngeal incompetence were due either to a structural defect (oro-nasal fistula), physiological dysfunction (hearing loss), or the patient's mental capacity (mental retardation). These results confirm that intelligible speech production depends on effectiveness of speech mechanism. Clear speech production requires adequate hearing, intellectual potential, the appropriate environmental stimulation and competency of speech related structures (a normal velopharyngeal closure mechanism). Consequently, obtained information from nasoendoscopy in conjunction with traditional articulation and resonation speech assessments were applied to both assessment and treatment planning.

Management for the velopharyngeal insufficiency

Careful, detailed assessment of velopharyngeal function combining clinical speech assessment with visualized techniques greatly increases the likelihood of selecting appropriate, efficient, and effective management and treatment for each patient as described as the followings.

Views from the nasoendoscopy of the first case, a post-operated cleft palate patient with an oro-nasal fistula (Figure 3), show clearly that hypernasal speech was caused by a fistula in the posterior part of the soft palate rather than an incomplete closure of the velopharyngeal valve. The lesion of the fistula is most often in the anterior palate. Few of these, however, are symptomatic. Fistula in the middle or posterior palate are much less frequent but are more often symptomatic. Without information from the nasoendoscopy, physicians might be expected that the hypernasality was the results of the velopharyngeal insufficiency and oro-nasal fistula. Therefore, an improper treatment for this case such as performing secondary operation around the velopharyngeal structures and closing the oro-nasal fistula might be arranged due to the misunderstanding. A proper management for this case should be any surgical procedure in repairing only the fistula because the patients had no valve problem. Because the velopharyngeal closure was intact and the patient had a moderate speech defects. In this case, such speech defects were placement and manner errors due to the inability to build up oral pressure for the plosive sounds and fricative sounds. By palatal exercises and intensive speech training for articulation defects post repairing the fistula, these speech problems can be corrected and better speech production could be achieved. Therefore, no secondary operative procedure was performed around the velopharyngeal structures, except for closing the fistula. On the other hand, speech training was recommended for this case.

The second case had velopharyngeal incompetence with hearing loss. Hypernasality speech was inconsistency and the view did not showed the closure clearly at the beginning of the procedure. To verify the findings, the scope was alternated until a better view of the closure was obtained. Finally a gap was found in the right side of the velopharyngeal valve (Figure 4). In relation to the nasalance score, the patient had marked hypernasal speech for the nasal sounds, but slightly hypernasality for the oral sounds and continuous mixed speech. The patient demonstrated some loose contact and closure of the velopharyngeal valve in pronunciation of some oral sounds (e.g., /kh/ sound in the words /khuon - po/ which means "father"). In addition, the patient also

demonstrated a complete closure during automatic action (i.e., swallowing). All these findings indicate that the patients had some potential in closing the velopahryngeal valve. Therefore, the preferred treatment for this case was intensive speech therapy after fixing the patient with hearing aid. Surgical management will be re-considered if the symptom of hypernasality persist after 6 months of intensive speech training.

The third case had a post-operated cleft palate with mental retardation. The nasoendoscopy showed inconsistent velopharyngeal closure during speech production (Figures 5 & 6). Obviously there was a structural defect in the middle of the velum (a concave) that caused the gap. However, it was surprising that this patient was able to close the valve completely sometimes and in a different condition, particularly during spontaneous swallowing. In relation to the acoustic speech assessment by using nasometer, it was found that the patient had high nasalance scores above means for all speech sounds. Furthermore, delayed speech-language development was also found due to the low intelligence. Therefore, surgical management was not necessary, but rather a speech and language intervention as well as special education were strongly recommended. Palatal exercises to improve the effeciency of the velopharyngeal closure was also assigned. For this case, feedback in auditory, visual and tactile modalities were applied to build up self awareness and to facilitate learning behaviours.

DISCUSSION

The function of velopharyngeal valve is to produce oral pressure[46-48]. For assessing the valve, firstly the clinician should listen for the oral pressure consonants such as /p/, /b/, /d/ and /s/[49]. The presence of these sounds usually suggests of some degree of velopharyngeal competence whereas the lack of these sounds may imply a velopharyngeal insufficiency[5,48,49]. The next step of the assessment should be followed by listening for hypernasality, nasal escape and compensatory articulation[5,8]. For this study, it was found that the patients demonstrated some compensatory speech defects. These are very common problems for patients with cleft palate. Generally there are at least one third of the post operative cleft palate cases need professional help with their articulation problems. They tend to use back sounds like /k/ for the more front sounds of /t/ and /d/ occasionally, and the sounds that seem to be more difficult for them are /s/ and /z/ [8,49-51].

For some patient with mild degree of velopharyngeal insufficiency, a small amount of air leak may not effect speech. For examples, the patient with hearing loss and the one with mental retardation had nasal air leak and a lack velopharyngeal closure during producing fricative sound (i.e., /s/ sound) and/or affricate sounds (e.g., /C/ sound). They have adequate oral pressure sound production for sometimes. This small degree of hypernaslity can sometimes be managed by increasing articulation effort and improving articulation. Therefore, goals of speech therapy for hypernaslity are to establish correct articulatory placements and manners, and to maxzimize oral-pharyngeal articulatory function[45,49]. Options for such technique include palatal training[52-54], palatal appliance[55-58], posterior pharyngeal wall augmentation[59-61], and further surgical correction[45,62]. Furthermore, treatment should also aim to increase the patient's ability to distinguish between the clear speech and nasal speech. This is done by the patient's listening, seeing and feeling correct speech patterns under the supervision of the speech therapist[45]. Some semi-direct methods such as sucking, swallowing and gagging should also be applied[51]. Although oro-facial exercises effects might last as long as therapy continued and only a poor carry-over to speech could be expected[54], the exercises are still recommended by the authors as an attempt to induce the patient's self awareness and to facilitate the mobility and strength of the structures.

With early intervention these speech problems can be overcome and majority of cleft palate patients, particularly children, will eventually have normal speech. The therapy for sound errors follows the same principles for all patients with speech problems. Initially, the patient should learn to make the sound accurately, and then by progressive steps to use in words, phrases and sentences. To adopt and master a new habitual behaviours is not always an easy or rapid process. It takes time and a lot of effort. As is the case with bad habits, changes require con-

text practice, self motivation and family support. In addition, consistency practice and home program could re-enforce the maturation of the new speaking patterns. Parents can create a good model for the child to imitate by using simple, clear and precise speech. Generally, a language rich environment will encourage and speed up the child's speech and language skills.

For this study, all patients enrolled for 6 months of intensive speech therapy that started one week after the diagnosis confirming the velopharyngeal insufficiency. Each patient enrolled a 2-time/week speech therapy. Education and training course for parents was also held for carrying the home program. The authors believe that some cases can achieve an improvement in speech without having to undergo an operation and some cases may achieve good palate function alongside an improvement in articulation skills. Unless hypernasality does not resolve in 6 months or functional concern arise, formal re-evaluation or physical management such as secondary surgery may be warranted.

For the cleft palate with oro-nasal fistula, closing the fistula by surgical approach was necessary. Therefore, a detailed assessment will be carried out 6 to 8 weeks post-operatively. Since the patient already had some good speech and language skills, therefore, some target sounds during speech correction was needed. The other two who have poor articulatory skills, require therapy to help them to learn to use their improved palatal musculature and to overcome "bad habits" in their speech patterns.

Suggestion

There are many issues regarding to the obtained information from the nasoendoscopy that could mislead or cause misunderstanding. For example, sometimes the gap was not clearly seen or underestimated, or there were difficulties in inserting the tube due to abnormal structures, or an unclear view due to excess salivation. Thus, cautions should be concerned. Simple ways to solve the defects are skillfulness of the one who operates the nasoendoscope, a proper instrument, and a clinical practical guideline. In addition, a good rapport between the subject and the clinician also contributes to the successfulness of the investigation. An inform consent and warm friendly atmosphere are the way to achieve the good co-operation. Sometimes, existed language, articulation and voice problems may not be satisfactory for other reasons. One of these could be some degree of hearing impairment, which is more common in patients with the cleft condition. It is, therefore, important to have the child/patient's hearing checked regularly, especially after middle ear infection.

Clinical Implications

Velopharyngeal insufficiency is an important clinical situation that affects speech and is seen primarily after cleft palate repair. Direct method, particularly the nasoendoscopy, has been use to assess the velopharyngeal function. It is effective in evaluating patients with velopharyngeal insufficiency. There are some advantages of the procedure. Mainly, this procedure provides dynamic visualization of the area. Soft palate, posterior and lateral pharyngeal walls and their relation to each other are visualized clearly at rest, during phonation and spontaneous swallowing. The motion, pattern, symmetrical of the closure as well as the gap could be seen and evaluated without difficulty.

After repairing cleft palate, some patients were consulted for hypernasality speech defects. Thus, velopharyngeal functions were re-assessed through nasoendoscope. The findings showed that patients had some degree of motion of the soft palate, ranging from no movement of the posterior pharyngeal wall to maximum movement of the lateral pharyngeal wall and velum. Generally, structural defect such as fistula or shortness and the restricted movement of the soft palate could be the main problem in post-operated cases. Some patient had a slight touch to the posterior pharyngeal wall and upward movement to the level of the hard palate. Movement of the velum of the patients appeared to be better than lateral wall movement. In this study only 1 case had full closure of the velopharyngeal sphincter during phonation. Others demonstrated an inconsistently closure and manner. A secondary operation was conducted only for the case with oro-nasal fistula in an attempt to correct the structural defect. These results indicate that nasoendoscopy could distinguish between those patients with nasal speech who appear to have the

potential for adequate velopharyngeal closure from those who do not. In addition, it also revealed that the nasal speech was a result from either poor habit or physical limitations.

There are some disadvantages of nasoendoscopy. Although the velopharyngeal sphincter and related structures can be seen in direct view, it does not provide information regarding sagittal movement and quantitative measures in this direction cannot be made. Furthermore, placement of the endoscope, angle of the view, and distortion of the picture can affect the results. It is an invasive procedures as the procedure will allow direct and continuous visualization of the velopharynx only during the speech. Therefore, it can be difficult to perform nasoendoscopy, especially in uncooperative and young patients. In addition, such procedure typically requires a medical environment and is performed in an operating room which could be frightening to some patients. However, many concerns can be overcome with a good inform consent and explanation as suggested above.

In conclusion, we would like to say that among many investigation techniques available, nasoendoscopy is one of the most valuable procedures in the evaluation of the velopharyngeal function in patients with nasal speech. Although the procedure has been used rarely in the diagnosis of velopharyngeal function in Thailand, its clinical value in assessment of velopharyngeal closure in this study was proved with satisfactory results. In addition, the flexible fiberoptic nasoendoscope can be successfully used in children older than 10 years old. Though it might be argued that this procedure is bothersome and/or expensive to be widely applied, especially within the confines of a speech pathology clinic. One must consider if the obtained information from the traditional indirect procedures is in sufficient for the recommendation of the treatment.

REFERENCES

1. Witt PD, D'Antonio LL. Velopharyngeal insufficiency and secondary palatal management: a new look at an old problem. Clin Plas Surg 1993; **20**: 707-21.
2. Dalston RM, Warren DW. The diagnosis of velopharyngeal inadequacy. Clin Plas Surg 1985; 12: 685-95.
3. Schwartz MF. Developing a direct objective measure of velopharyngeal inadequacy. Clin Plas Surg 1975; 2: 305-8.
4. Cisle C, Ball M. Instrumentation in speech-language pathology. San Diego, College Hill Press, 1984.
5. Van Demark D, Bzoch KR, Dorty D, et al. Method of assessing speech in relation to velopharyngeal function. J Cleft Palate 1985; 22: 281-85.
6. Dalston RW, Warren DW. The diagnosis velopharyngeal inadequacy. Clin Plas Surg 1985; 12: 685-95.
7. Barr LL, Hayden CK Jr, Hill LC, Swischuk LE. Radiographic evaluation of velopharyngeal incompetence in childhood. AJR 1989; 153: 823-24.
8. Fletcher SG, Adams LE, McCutcheon MJ. Cleft palate speech assessment through oral nasal acoustic measures. In : Bzoch KR, ed. Communication Disorders Related to Cleft Lip and Palate. Boston : College Hill Press, 1989: 246-57.
9. McWilliams BJ, Morris HL, Shelton RL. Cleft palate speech. Toronto : Decker, 1990.
10. Morris HL. Clinical assessment by the speech pathologist. In: Bardach J, Morris HL, eds. Multidisciplinary Management of Cleft Lip and Palate. Philadelphia : WB Saunders, 1990.
11. Dalston RM, Warren DW, Dalston ET. Identification of nasal obstruction through clinical judgements of hyponasality and nasometric assessment of speech acoustic. Am J Ortho Dentofad Orthop 1991; **10** : 59-65.
12. Dalston RM, Warren DW, Dalston ET. A preliminary investigation concerning the use of nasometry in identifying patients with hyponasility and/or nasal airway impairment. J Speech Hear Res 1991; **34**: 11-18.
13. McWilliams BJ, Witzel MA. Cleft palate. In : Shames GH, Wig EH, Wayne A, eds. Human Communication Disorders : an Introduction. New York : Macmillan College Publishing, 1994: 438-79.
14. Bzoch KR. Measurement and assessment of categorical aspect of cleft palate speech. In : Bzoch KR, ed. Communication Disorders Related to Cleft Lip and Palate. Boston : Little Brown, 1979: 162-90.
15. Schneider E, Shprintzen RJ. A survey of speech pathologists : curreat trends in the diagnosis and management of velopharyngeal insufficiency. J Cleft Palate 1980; 17: 249-53.

16. Trost-Cardamone JE. The development of speech : assessing cleft palate misarticulations in speech anatomy, physiology and pathology. In : Kernahan DA, Rosenstein SW, eds. Cleft Lip and Palate : A System of Management. Baltimore : Williams & Wilkins, 1990 : 91-105.
17. Weinberg B, Hirsi Y. Acoustic features of pharyngeal /s/ fricatives produced by speakers with cleft palate. J Cleft Palate 1975; **12:** 12-16.
18. Warren DW. The determination of velopharyngeal incompetence by aerodynamics and acoustical techniques. Clin Plast Surg 1975; **2:** 299-304.
19. Dalston RM, Warren DW. Comparison of Toinar II, pressure flow, and listener judgements of hypernasality in the assessment of velopharyngeal function. 1986; **23:** 108-15.
20. Seaver EJ, Dalston RM, Leeper HA, Adams LE. A survey of nasometric value for normal nasal resonance. J Speech Hear Res 1991; **34:** 715-21.
21. Pigott RW, Benson JF, White FD. Nasoendoscopy in the diagnosis of velopharyngeal incompetence. Plast Reconstr Surg 1969; **43:** 141-47.
22. Miyazaki T, Matsuya T, Yamaoka M. Fiberscopic methods for assessment of velopharyngeal closure during various activities. J Cleft Palate 1975, **12:** 107-14.
23. Matsuya T, Tamaoka M, Miyazaki T. A fiberscopic study of velopharyngeal closure in patients with operated cleft palates. Plast Reconstr Surg 1979; **63:** 497-500.
24. D' Antonio L, Chait D, Lotz W, Netsell R. Pediatric videonasendoscopy for speech and voice evaluation. Otolaryngol Head Neck Surg 1986; **94:** 578- 83.
25. D' Antonio L, Muntz HR, Marsh JL, et al. Practical application of flexible fiberoptic nasopharyngoscopy for evaluating velopharyngeal function. Plast Reconstr Surg 1988; **82:** 611-18.
26. Golding – Kushner KJ, et al. Standardizing for the reporting of nasoendoscopy and multi-view videofluoroscopy: a report from an international working group. J Cleft Palate 1990; **27:** 337-47.
27. Shprintzen RJ, Golding– Kushner K. Evaluation of velopharyngeal insufficiency. Otolaryngeal Clin N Am 1989; **22:** 519-36.
28. Kelsey CA, Minifie FD, Hixon TJ. Application of ultrasound in speech research. J Speech Hear Res 1969; **12:** 546-75.
29. Ryan WJ, Hawkins CF. Ultrasonic measurement of lateral pharyngeal wall movement at the velopharyngeal port. J Cleft Palate 1976; **13:** 156-64.
30. Hawkins CF, Wayne ES. Evaluation of a real-time ultrasound scanner in assessing lateral pharyngeal wall motion during speech. J Cleft Palate 1978; **15:** 161-66.
31. Honjo I, Mitome T, Ushire K, et al. Evaluation of velopharyngeal closure by CT scan and endoscopy. Plast Reconstr Surg 1984; **74:** 620-27.
32. Mitoma T, Honjo I, Ushiro K, et al. Evaluation of velopharyngeal closure by CT scan. J Jpn Soc Plast Surg 1984; **4:** 169-74.
33. Croft CB, Shprintzen RJ, Rakoff SJ. Patterns of vepharyngeal valving in normal and cleft palate subjects: a multi-view videofluoroscopic and nasoendoscopic study. Laryngoscope 1981; **91:** 265-71.
34. Pigott RW, Mukepeace AP. Some characteristics of endoscopic and radiological systems used in elaboration of the diagnosis of velopharyngeal incompetence. Br J Plast Surg 1982; **35:** 19-32.
35. Sinclair SW, Davies DM, Bracka A. Comparative reliability of nasal pharyngoscopy and videofluoroscopy in the velopharyngeal incompetence. Br J Plast Surg 1982; **35:** 113-17.
36. Witt PD, Miller DC, Marsh JL, et al. Limited value of preoperative cervical vascular imaging in patients with velocardiofacial syndrome. Plast Reconstr surg 1998; **101:** 1184-95.
37. Trost-Cardamone JE. Coming to terms with VPI: a response to Loney and Blueme, J Cleft Palate 1989; **26:** 68-70.
38. Boone DR. Is your voice telling on you? San Diego: Singular Publishing Group, 1991.
39. Peterson-Falzone SJ. Speech characteristics : updating clinical decisions. Semin Speech Language 1986; **7:** 269-74.
40. Peterson-Falzone SJ, Graham MS. Phoneme-specific nasal emission in children with and without physical anomalies of the velopharyngeal mechanism. J Speech Hear Dis 1990; **55:** 132-39.
41. Bzoch KR, ed. Communication disorders related to cleft lips and palate. Boston; Little Brown, 1979.
42. Russel VJ. Cleft palate and other craniofacial anomalie in children. In : Leahy MM, ed. The Science of Intervention. London: Whurr Publisher, 1995: 169-87.
43. Manochiopinig S, Prachariipukdee N, Lertsarunyapong S. The articulation characteristics of normal Thai children aged 3-10 years assessing by using the Thai Articulation Test. Siriraj Hosp Gaz 1998; **50:** 763-69.
44. Prachariipukdee N, Manochiopinig S, Lertsarunyapong S, Sutantawibon P. The Thai nasality test for cleft palate patients. Chula Med J 1991; 43 : 711-21.
45. Manochiopinig S, Hunnangkul S, Udompuntarak S. Applicability of the Thai nasality test. Siriraj Hop Gaz 2000; **52:** 151-63.
46. Hardcastle J. Physiology of speech production. London: Academic Press, 1976.

47. Kimura D, Whatson N. The relationship between oral movement control and speech. Brain Lang 1989; **37:** 565-90.
48. Ellis RE, Flack FC, Carle HJ, Selly WG. A system for the assessment of nasal airflow during speech. Br J Dis Com 1978; **13:** 31-40.
49. Perkell JS. Phonetic features and the physiology of speech production. In : Butterworth. ed. Language production. London: Academic Press,1980: 337-72.
50. Kanjana N. The Thai phonological system. Bangkok : Chulalongkorn University Press, 1998: 30-40.
51. Pintip T. Phonetics and practical phonetics. Bangkok : Thammasat University Press. 1990: 1-25.
52. Lubit EC, Larson RE. The Lubit palatal exercise: a preliminary report. J Cleft Palate 1969; **6:** 120-33.
53. Tash EL, Shelton RL, Knox AW, Michel JF. Training voluntary pharyngeal wall movements in children with normal and inadequate velopharyngeal closure. J Cleft Palate 1971; **8:** 277-90.
54. Russello DM. A selected review of palatal training procedures. J Cleft Palate 1982; **18:** 181-93.
55. Tudor C, Selley WG. A palatal training appliance and a visual aid for use in the treatment of hypernasal speech: A preliminary report. Br J Disord Commun 1974; **9:** 117-22.
56. Posnick WR. Prosthetic management of palatopharyngeal incompetency for the pediatric patient. ASDC J Dent Child 1977; **44:** 117-21.
57. Marsh JL, Wrag RC. Speech prosthesis versus pharyngeal flap: a randomized evaluation of the management of velopharyngeal incompetency. Plast Reconstr Surg 1980; **65:** 592-94.
58. McGrath CO, Anderson MW. Prosthetic treatment of velopharyngeal incompetence in multidisciplinary management of cleft lip and palate. Philadelphia: WB Saunders, 1990.
59. Massengill R, Quinn GW, Pickrell K. The use of a palatal stimulator to decrease velopharyngeal gap. Am Otol Rhinol Laryngol 1971; **80:** 135-37.
60. Furlow LT, Williams WN, Eisenback CR, Bzoch KR. A long term study on treating velopharyngeal insufficiency by teflon injection. J Cleft Palate 1982; **19:** 47-56.
61. Remacle M, Bertrand B, Eloy P, Marbaix E. The use of injectable collagen to correct velopharyngeal insufficiency. Laryngescope 1990; **100:** 269-74.
62. Witzel MA, Tobe J, Salyer K. The Use of nasopharyngoscopy biofeedback therapy in the correction of inconsistent velopharyngeal closure. Int J Pediatr Otorhinolaryngeal 1988; **15:**137-42.
63. Smith A. The control of orofacial movement in speech: critic reviews. Oral Bio Med 1992; **3:** 233-67.
64. Massengill R Jr, Quinn GW, Pickrell KL, Levinson C. Therapeutic exercise and velopharyngeal gap. J Cleft Palate 1968; **5:** 44-48.

Appendix A

The Siriraj Speech Stimuli Resonation Test (Manochiopinig and Chuangsuwanich, 2001)

มามามา พาพาพา ทาทาทา คาคาคา

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ปิติซักขวดสิ

คุณพ่อคุณแม่พาฉันทรานั่งรถไฟไปเที่ยวน้ำตกไทรโยคจังหวัดกาญจนบุรี