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Aerodynamic evaluation of velopharyngeal incompetence in children with cleft palate

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Abstract

Objectives: Treatment choices in children with cleft palate include maintenance of speech therapy or surgery for correction of hypernasality and articulation disorders caused by velopharyngeal insufficiency. In this study, we aimed to determine the optimal treatment choice based on the measurement of aerodynamic velopharyngeal competence in children with cleft palate and velopharyngeal insufficiency after cleft palate closure.

Methods: Maximal nasal airflow leakage during articulation was measured by rhinomanometry and compared between children who received only speech therapy after cleft palate closure and those who underwent additional pharyngeal flap construction after cleft palate closure.

Results: The mean airflow leakage values during articulation were significantly higher in the children who received surgical therapy than in those who received only speech therapy.

Conclusions: The appropriate threshold of maximum nasal airflow leakage must be determined to facilitate identification of the optimal treatment choice in children with cleft palate and hypernasality.

Keywords: Aerodynamic evaluation, Rhinomanometry, Velopharyngeal competence, Cleft palate, Children

Introduction

Hypernasality is caused by velopharyngeal insufficiency after cleft palate closure in children with cleft palate. The resulting articulation disorder has been previously recognized in the literature.[1] Pharyngeal flap construction surgery is a useful treatment in children with velopharyngeal incompetence after cleft palate closure when speech therapy is ineffective.[2] However, this surgical therapy may result in obstructive sleep apnea.[3] Thus, appropriate evaluation standards are required to aid in the selection of the optimal treatment: either maintenance of speech therapy or surgery.

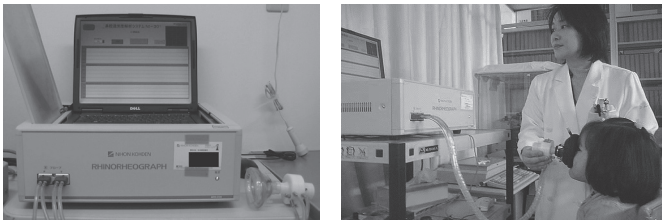
We considered that measurement of aerodynamic velopharyngeal competence might help to determine whether maintenance of speech therapy or additional surgical therapy is the best option for the treatment of hypernasality and articulation disorders caused by velopharyngeal incompetence in children with cleft palate. In this study, aerodynamic velopharyngeal competence was measured by rhinomanometry. The mean values of the maximum nasal airflow leakage during articulation of a vowel, an affricate, and a nasal sound were compared between children who received only speech therapy after cleft palate closure and children who underwent additional pharyngeal flap construction after cleft palate closure.

Methods

Twenty children with cleft palate, hypernasality, and articulation insufficiency after cleft palate closure performed by the dentists at our university hospital were studied in this investigation. The cleft palate team at our university hospital, which includes dentists, speech therapists, plastic surgeons, and otolaryngologists, determined the treatment to be performed for these children when they were aged 4 to 5 years. In 12 children (mean age, 4.8 years; 8 boys, 4 girls; speech therapy group), hypernasality and articulation disorders improved by speech therapy alone, whereas the remaining 8 children (mean age, 4.8 years; 4 boys, 4 girls; surgery group) required pharyngeal flap construction surgery to improve their nasality and articulation disorders.

An MPR-3100 rhinomanometer (NI-301 program; Nihon Kohden Co., Ltd., Tokyo, Japan), loaded with software for measurement of aerodynamic velopharyngeal competence, was utilized in this study. This system was jointly developed by the Department of Otolaryngology of Fujita Health University and Nihon Kohden Co. We quantitatively measured nasal airflow leakage during articulation by applying a mask to the patient's nose. Nasal airflow leakage (cm^3/s) during articulation of a vowel sound ("a"), an affricate sound ("sh"), and a nasal sound ("n") was detected using the rhinomanometer and an anesthetic mask, as shown in Figure 1. We recorded the vocal onset, the

Figure 1.



Rhinomanometer MPR 3100 manufactured by Nihon Kohden Co., Ltd.

Measurement of Aerodynamic Velopharyngeal Competence

Aerodynamic velopharyngeal competence measured by the MPR-3100 rhinomanometer.

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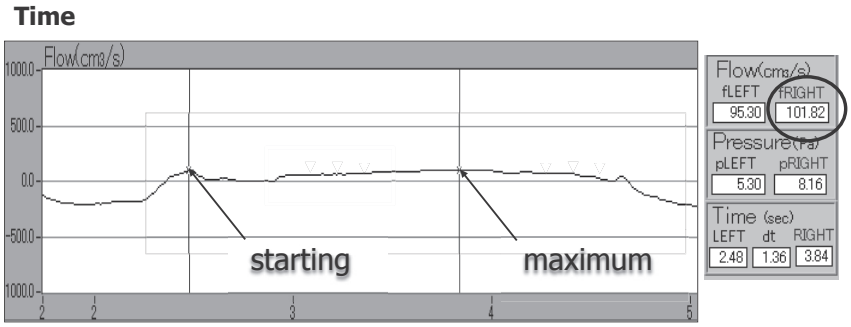
initial time point of lifting the soft palate at the starting point, and the stabilized period of articulation at the maximum point. The maximum value of reproductive measurements during articulation of each sound was estimated. Representative data of a vowel sound ("a") is shown in Figure 2.

The mean values of maximum nasal airflow leakage were compared between the speech therapy group and surgery group. The Mann–Whitney U-test was used to test statistical significance. A P value of <0.05 was considered statistically significant.

Figure 2.



Graph of maximum nasal airflow leakage through the nose during articulation of the vowel sound "a."

Results

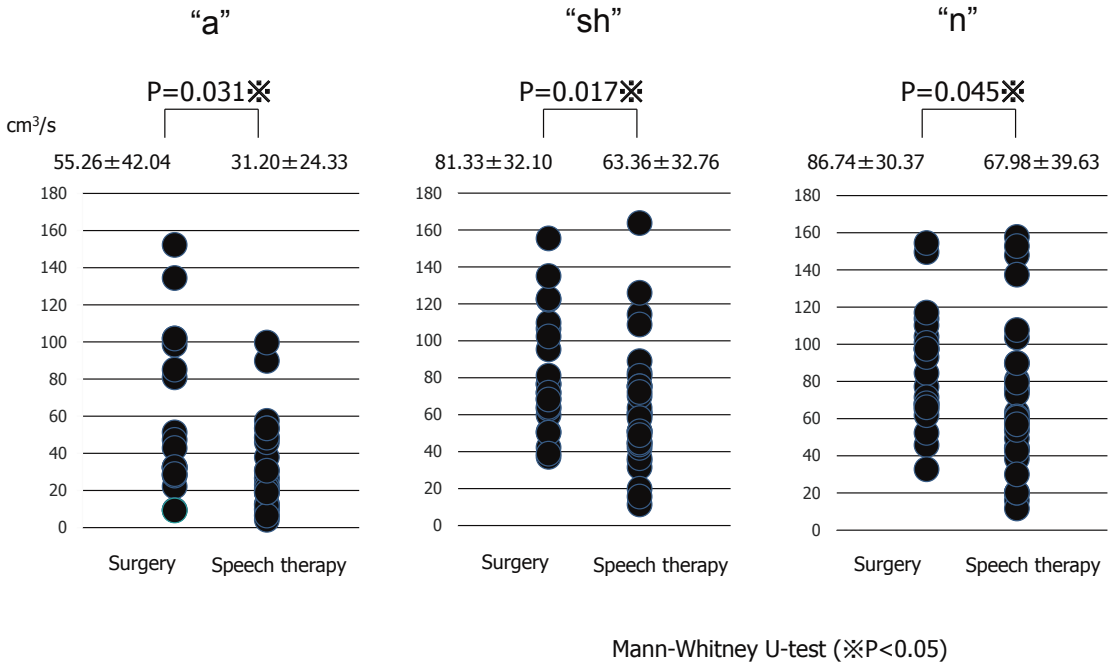
In the speech therapy group, the mean maximum nasal airflow leakage was 31.2 cm^3/s during the sound "a," 63.4 cm^3/s during the sound "sh," and 68.0 cm^3/s during the sound "n." In the surgery group, the mean maximum nasal airflow leakage was 55.3 cm^3/s during the sound "a," 81.3 cm^3/s during the sound "sh," and 86.7 cm^3/s during the sound "n." The difference in these values between groups was statistically significant during the articulation of all sounds (Figure 3).

Discussion

Hypernasality and articulation disorders caused by velopharyngeal insufficiency after cleft palate closure have been previously studied.[1] Adenoidal conditions due to aging are also occasionally associated with nasality.[4] Speech therapy usually alleviates these problems; however, it is not always effective in all cases. When speech therapy proves ineffective, surgical treatment such as pharyngeal flap construction is required to improve velopharyngeal competence.[2] However, surgical treatment has been identified as a cause of severe snoring and obstructive sleep apnea.[3,5] Death from this condition is the most serious potential result after surgical treatment.[6] Therefore, the decision to employ surgical therapy must be made with caution to prevent severe complications.

In this study, we compared the maintenance of speech therapy versus choosing surgical therapy for hypernasality and articulation disorders secondary to velopharyngeal incompetence in children with cleft palate by measuring aerodynamic velopharyngeal competence with a rhinomanometer. Movement of the soft palate is a coordinated activity that results in varying degrees

Figure 3.



Comparison of mean maximum nasal airflow leakage values between children treated with speech therapy only and those treated by additional pharyngeal flap construction. Significance was determined by the Mann–Whitney U-test (※ P < 0.05).

of closure between the soft palate and the pharyngeal walls during articulation. Therefore, we considered that leakage of nasal airflow reflects the individual's velopharyngeal competence. The mean value of the maximum airflow leakage in the children who required additional surgical therapy was significantly higher than that in the children who received only speech therapy. Therefore, measurement of the nasal airflow during articulation in children with cleft palate could be valuable for choosing the most suitable treatment for their hypernasality.

In conclusion, measurement of the maximum nasal airflow leakage during articulation might aid in the selection of the most beneficial treatment in children with cleft palate and hypernasality. We expect to determine the appropriate threshold values for maximum nasal airflow leakage in the future.

Acknowledgements

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Conflict of interest

None.

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