

Pre and postoperative changes in the morphology of pharyngeal
airway in patients with skeletal mandibular prognathism
— A comparison between Class 1 malocclusion and
simultaneous maxillomandibular surgery —

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Abstract

Objective: Many reports mentioned the reduction of pharyngeal airway space after orthognathic surgery in patients with skeletal mandibular prognathism. We examined the pharyngeal airway space in patients treated with simultaneous maxillomandibular surgery and presented our findings.

Materials and Methods: Records of 31 patients treated with simultaneous maxillomandibular surgery (case group) and 28 patients with Class 1 malocclusion treated with orthodontic treatment alone (control group) were examined from the pre treatment. The size of the pharyngeal airway (at 5 locations) in the control and case groups at pre- and post-treatments were analyzed through ANCOVA. Also the change in the size of the pharyngeal airway (at 5 locations) between pre- and post-treatments in each group were analyzed through ANCOVA.

Results: (1) At the pre treatment, we found out that SPPS (soft palate to the posterior pharyngeal wall) in the case group was significantly wider than the control group ($p<0.05$) however, multiple comparisons showed no significant difference. (2) After treatment, the SPPS and MPS (PSP to the posterior pharyngeal wall) in the case group were significantly wider than in the control group ($p<0.05$) nevertheless, multiple comparisons showed no significant difference. (3) The width of the pharyngeal airway before and after treatment was compared between the control and the case group. In the control group, PPS (PNS to the posterior pharyngeal wall) after treatment was signif-

icantly larger than before treatment but multiple comparisons showed no significant difference. In the case group, PPS was larger after treatment than before treatment and multiple comparisons showed significant difference ($p < 0.01$).

Discussion: Before treatment, we found out that the upper pharyngeal airway space was narrower and the lower part is wider than after treatment whereby we predicted that after treatment, the upper part would be wider and the lower part would be narrower. However, no significant difference was obtained in the group treated with simultaneous maxillomandibular surgery due to the complex three-dimensional movement of the maxilla. The trend shown in the hypothesis was not recognized.

Conclusion: When simultaneous maxillomandibular surgery was carried out to treat cases of skeletal mandibular prognathism, the pharyngeal airway (PPS) significantly increased after surgery. Meanwhile, the lower part of the airway decreased.

Introduction

A number of pre and post-operative changes in the morphology of pharyngeal airway in patients with skeletal mandibular prognathism, in particular, patients with maxillary and mandibular skeletal deformities, have been extensively reviewed and reports have shown changes in the width of pharyngeal airway and its recovery after surgery¹⁻¹¹⁾. Emata et al.¹⁾ reviewed the effect of orthognathic surgery on skeletal mandibular prognathism showing a slight decrease in the anteroposterior diameter of the airway with the setback of the mandible. However, a slight recovery occurred with a tendency of becoming stable thereafter. Furthermore, Yoshida et al.⁸⁾ showed a slight decrease of the upper part of the pharyngeal airway in patients with skeletal mandibular prognathism treated with SSRO and significant changes occurred in the middle and lower parts of the airway. They mentioned that narrowing of the entire pharyngeal airway was recognized after orthognathic surgery. Furthermore, the significant decrease in pharyngeal airway after mandibular setback may cause respiratory disorder¹²⁾. Mandibular setback surgery narrows the pharyngeal airway, and recent studies showed the adverse effects of the procedure on breathing during sleep^{13,14)}.

On the other hand, other reports have shown that patients with skeletal mandibular prognathism have pharyngeal airways that are originally wider than normal¹⁵⁻¹⁸⁾. Based on our many years of clinical experience, we consider that the pharyngeal airway of patients with skeletal mandibular prognathism is wider than patients with normal jaw relationship. No studies have compared the changes in pharyngeal airway between orthognathic surgery cases with skeletal mandibular prognathism and cases with normal occlusion or treated with orthodontics alone. Therefore, in our first report¹⁹⁾, we used a case of mandibular setback surgery and predicted that although the pharyngeal airway decreased after mandibular setback surgery, the airway is still nearly normal in width. The purpose of the study was to examine: (1) the width of the pharyngeal airway before mandibular setback surgery and (2) to determine the change in the width of the airway before and after surgery. The study group was compared to the control group who only had orthodontic treatment. Results showed that the pharyngeal airway in a patient with mandibular prognathism was wider than the patient with normal jaw relationship. After surgery, the pharyngeal airway decreased as we predicted. Although the pharyngeal airway decreased, the space was still nearly normal¹⁹⁾.

On this report, as the second it, we analyzed a case group treated with simultaneous maxillo-

mandibular surgery for the correction of skeletal mandibular prognathism. This procedure is different from the mandibular setback alone. Before treatment, the upper pharyngeal airway space in the case group was wider than the control group and the lower pharyngeal airway space was narrower. Our goal was to test the new hypothesis that after treatment with simultaneous maxillo-mandibular surgery, the upper pharyngeal space would be wider and the lower part would be narrower. In order to verify the hypothesis: (1) pre and post-operative changes in the width of the pharyngeal airway were measured in patients who underwent orthodontic treatment alone as the control group (2) and in patients who underwent simultaneous maxillomandibular surgery as the case group.

Materials and methods

Records of 439 patients with jaw deformities who completed dynamic treatment at the orthodontic clinic between June 30, 1998 and June 30, 2012 were reviewed for case group selection. After a thorough review, 182 who underwent simultaneous maxillomandibular movement were selected regardless of gender. Although equal number of male and female patients was desirable, the cases were dominated by female patients therefore, only female cases were used as subjects. Cases with asymmetrical face, those with congenital anomalies and cases with significant overbite were excluded. Finally, only 31 patients ($28Y11M \pm 1Y8M$) were selected.

For the control group, 196 patients who completed general orthodontic alone at the orthodontic clinic between June 30, 1998 to June 30, 2012 were reviewed. Following the selection criteria, 28 adult female patients ($28Y5M \pm 2Y3M$) without skeletal deformity and those who completed orthodontic treatment alone were selected (Table 1). Table 1 shows the average age, treatment period, post-operative correction period (case group) and retention period of the cases used at the first visit for both groups, before surgery (case group) and at the end of treatment. Table 2, 3 shows the measurement from the cephalogram (Table 2, 3).

Lateral cephalograms were taken following the conventional method; in a standing position, with the head positioned so that the Frankfurt plane is parallel to the floor. The patients were instructed to bite in central occlusion and to keep the tongue in a resting position while breathing through the nose. Evaluation of the pharyngeal airway space using lateral cephalogram was performed according to the method of Mochida et al.²⁰⁾. An example of simultaneous maxillomandibular surgery case was shown in Fig. 1.

Measurement on lateral cephalogram

Each parameter below was measured from the tracing done on lateral cephalogram at each point for both groups. Measurement was performed by a single operator to eliminate errors between operators (Fig. 2).

Table 1 : Mean age and treatment period

	Average age at pre treatment	Treatment period	Post operative treatment period	Retention period
Case group	$28Y11M; \pm 1Y8M$	$2Y11M \pm 1M$	$1Y3M \pm 1M$	$3Y4M \pm 3M$
Control group	$28Y5M \pm 2Y3M$	$2Y11M \pm 1M$	0	$3Y11M \pm 3M$
			Case group	n=31 mean \pm SD
			Control group	n=28 mean \pm SD

Table 2 : Comparison of cephalometric analysis between the case and the control group

	Case group Pre treatment	Pre operation	Post treatment	Control group Pre treatment	Post treatment
SNA	79.3 ± 3.1	79.4 ± 3.0	80.9 ± 3.2	81.1 ± 3.4	80.7 ± 3.4
SNB	80.8 ± 4.1	80.7 ± 3.8	80.1 ± 3.2	77.7 ± 3.5	77.6 ± 3.8
ANB	- 1.5 ± 3.3	- 1.5 ± 3.1	0.8 ± 2.4	3.4 ± 1.5	3.1 ± 1.7
Facial angle	89.1 ± 4.5	114.7 ± 4.6.3	88.5 ± 3.9	85.5 ± 2.6	85.3 ± 2.9
Y-axis	62.7 ± 4.6	62.6 ± 4.6.4	62.7 ± 4.2	65.2 ± 3.3	65.3 ± 3.5
MD angle	30.9 ± 6.0	30.9 ± 5.9	31.3 ± 6.0	29.9 ± 5.4	30.1 ± 5.6
Gonial angle	128.6 ± 5.9	128.6 ± 5.9	129.4 ± 5.8	124.8 ± 4.8	124.8 ± 4.8
FH to SN	8.2 ± 2.9	8.2 ± 2.9	8.2 ± 2.9	7.7 ± 2.9	7.7 ± 2.9
U1 to FH	113.6 ± 8.9	116.4 ± 6.4	117.8 ± 6.4	115.1 ± 8.4	109.6 ± 7.1
L1 to Mandibular	84.0 ± 9.9	90.0 ± 7.1	87.4 ± 6.7	95.4 ± 5.7	93.4 ± 3.9
Inter incisal	131.6 ± 13.9	122.7 ± 7.8	123.5 ± 9.5	119.5 ± 9.6	127.0 ± 7.5

Case group n=31 mean ± SD
Control group n=28 mean ± SD

Table 3 : Mean value of measurements and their standard deviations (sd) at each time of measurements and mean value of differences between pre- and post-treatments, at time of diagnosis and before operation, before and after operations, at time of diagnosis and after operation and their sd. (a) Control group, (b) Case group.

(a) Control group (N=28)

	Pre treatment	Post treatment	*Difference
Variable	mean (sd)	mean (sd)	mean (sd)
PPS	28.0 (2.44)	28.6 (2.63)	0.6 (1.37)
SPPS	12.8 (3.22)	12.8 (2.80)	0.0 (2.29)
MPS	11.2 (2.60)	11.2 (2.38)	0.0 (1.33)
IPS	12.2 (3.65)	11.9 (3.63)	-0.3 (2.25)
EPS	11.9 (3.39)	11.7 (3.75)	-0.2 (2.20)

(b) Case group (N=31)

	Pre treatment	Pre Operation	Post treatment	**Difference	***Difference	****Difference
Variable	mean (sd)	mean (sd)	mean (sd)	mean (sd)	mean (sd)	mean (sd)
PPS	28.0 (3.50)	28.0 (2.95)	29.2 (3.42)	0.1 (1.51)	1.2 (2.25)	1.3 (2.36)
SPPS	14.5 (2.70)	14.4 (2.80)	14.5 (3.42)	-0.1 (2.64)	0.1 (2.75)	0.0 (2.97)
MPS	12.2 (2.68)	12.7 (2.47)	12.6 (2.66)	0.6 (1.74)	-0.1 (2.31)	0.5 (1.92)
IPS	14.2 (4.68)	14.5 (4.30)	13.0 (4.04)	0.3 (3.88)	-1.5 (4.00)	-1.2 (4.28)
EPS	13.6 (3.51)	14.1 (4.15)	13.7 (3.87)	0.5 (3.65)	-0.4 (3.79)	0.1 (2.71)

*Difference =(Post-treatment)-(Pre-treatment)

**Difference=(before Operation)-(at Diagnosis)

***Difference=(after Operation)-(before Operation)

****Difference=(after Operation)-(at Diagnosis)

Measuring the width of the pharyngeal airway (mm)

- (1) Palatal pharyngeal space (PPS): the distance between PNS and posterior pharyngeal wall, with a line parallel to the FH plane passing through the PNS
- (2) Superior posterior pharyngeal space (SPPS): the distance between the soft palate and the posterior pharyngeal wall, with a line parallel to the FH plane passing through the midpoint of PNS and PSP
- (3) Middle pharyngeal space (MPS): the distance between PSP and posterior pharyngeal wall, with a line parallel to FH plane through PSP
- (4) Inferior pharyngeal space (IPS): the distance between the tongue and the posterior pharyngeal wall, with a line parallel to the FH plane passing through the lowest point of the 2nd cervical

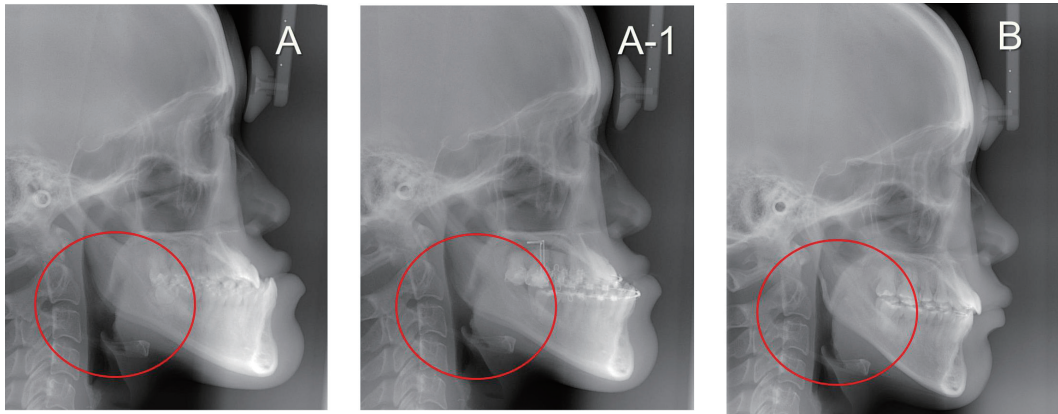


Fig. 1 : Changes in the lateral cephalograms before and after treatment in class III patient

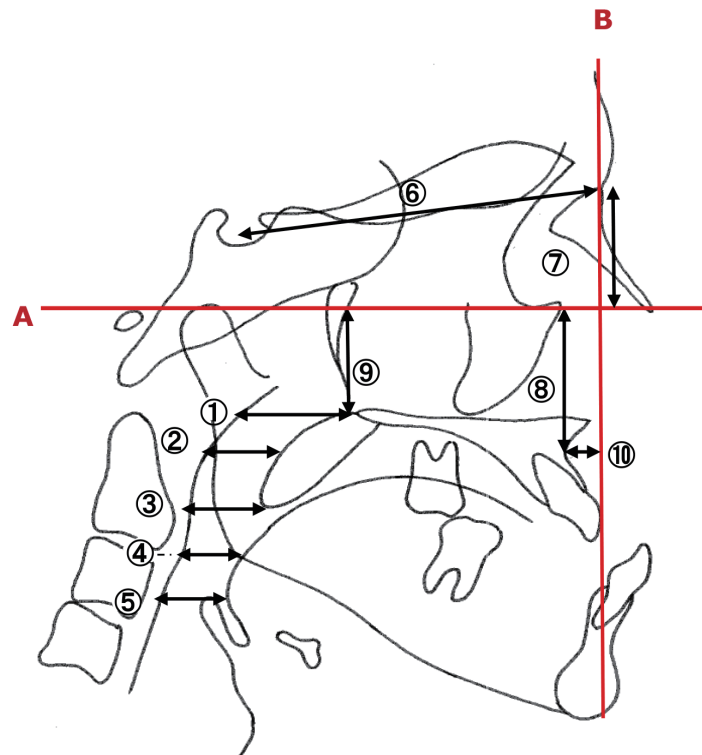


Fig. 2 : Cephalometric land marks

① PPS, ② SPPS, ③ MPS, ④ IPS, ⑤ EPS, ⑥ SN, ⑦ N-FH,
⑧ FH-A, ⑨ FH-PNS, ⑩ M-A

A : FH plane, B : McNamara line

Mochida, M., et al.: Effect of maxillary distraction osteogenesis on the upper-airway size and nasal resistance on subjects with cleft lip and palate. *Orthod Craniofac Res* 2004 ; 7 : 189–197.

spine

- (5) Epiglottic pharyngeal space (EPS): the distance from tongue and posterior pharyngeal wall, with a line parallel to the FH plane passing through the pharyngeal tip

Measurement of skeletal indicators (mm)

(6) S–N: distance from Sella–Nasion

(7) N–FH:: distance from Nasion perpendicular to FH plane

(8) FH–A: distance from FH plane perpendicular to point A

(9) FH–PNS: distance from the FH plane perpendicular to PNS

(10) M–A: distance from point A perpendicular to McNamara line

A: FH plane

B: McNamara line: line passing through Nasion perpendicular to the FH plane

Statistical analysis

First, ANCOVA was used to examine a difference of pharyngeal airway size (at 5 locations) between the control and case groups, where each size of the pharyngeal airway was used as a response variable and indicator variable discriminating between control and treatment groups (control: 0; case: 1), age at diagnosis, size of SN and size of N–FH were used as explanatory variables. Secondly, a change of each size of the pharyngeal airway between pre- and post-treatments in the control and case groups was analyzed with ANCOVA, where age at diagnosis, SN and N–FH were used as explanatory variables.

Since the pharyngeal airway used for the objective variable was measured at five locations (PPS, SPPS, MPS, IPS and EPS), the p-values, indicating the level of statistical significance of changes in pharyngeal airway size, were adjusted with Bonferroni correction taking into account the effect of five multiple comparisons.

R software version 3.5.1 and SPSS version 8 were used to implement the analysis.

This research was reviewed and approved by the Matsumoto Dental University Ethics Committee on October 31, 2010 (Permit number 0119).

Results

- 1) Difference in the size of the pharyngeal airway between the control and the case group at the pre treatment. During the pre treatment, the SPPS in the case group was significantly larger than the control group ($p < 0.05$). Nevertheless, multiple comparisons showed no significant difference. The results obtained were contrary to the original hypothesis (Fig. 3).
- 2) Difference in the size of the pharyngeal airway between the control group and the case group at the end of treatment. After surgical correction, the size of the PPS in the upper oropharynx was significantly wider ($p < 0.05$), and the lower SPPS and MPS were significantly wider than the control group in the case group, although no significant difference was obtained in multiple comparisons.

As expected, this point was significantly different in PPS. Although that trend was observed with other parameters, no significant difference was obtained.

After correction, SPPS and MPS (PSP–posterior pharyngeal wall) in the case group was significantly larger than the control group ($p < 0.05$) but multiple comparisons showed no significant difference (Fig. 4).

- 3) Comparison of pharyngeal airway size before and after treatment in the control group PPS (PNS–pharyngeal wall) was significantly wider after treatment than before treatment but no significant difference was obtained in multiple comparisons (Fig. 5).

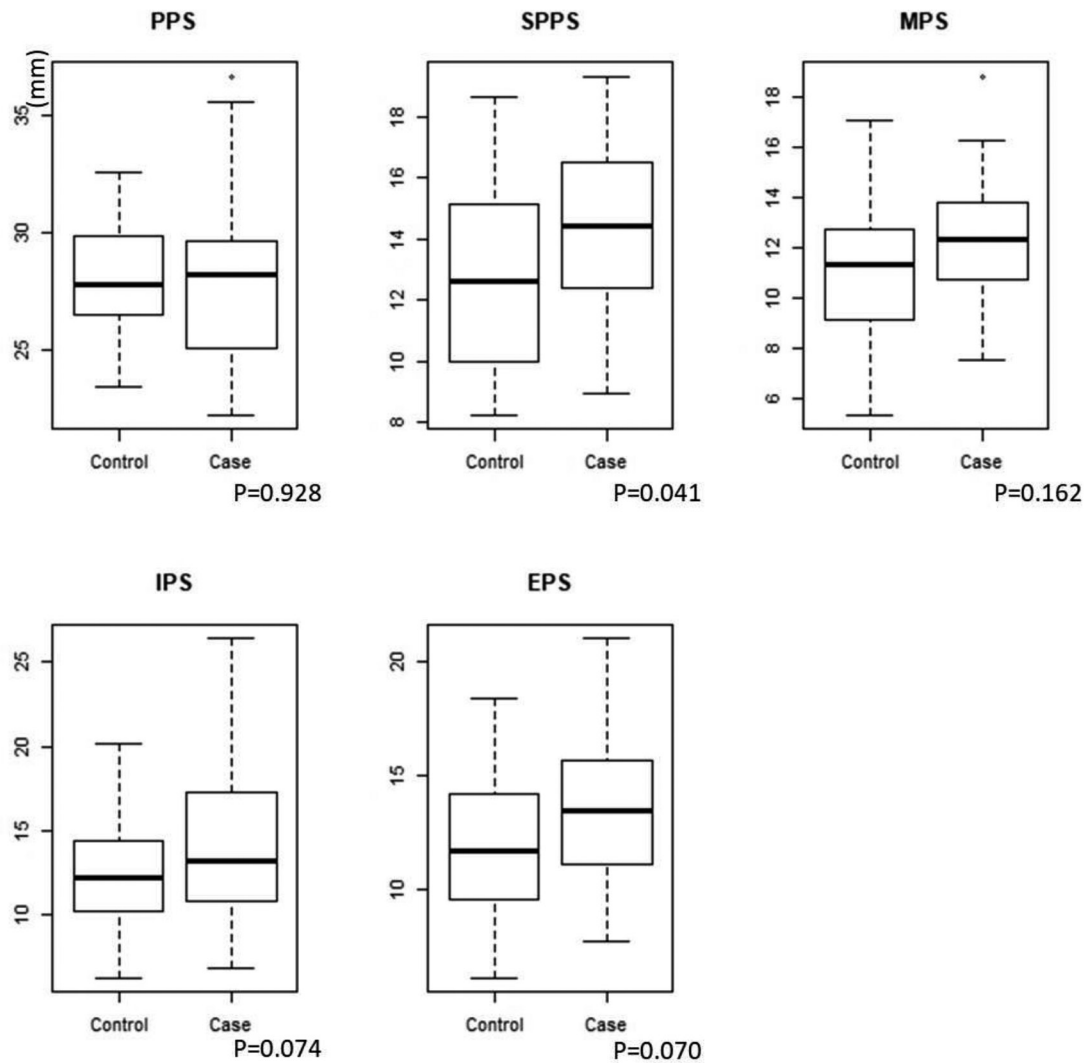


Fig 3 : Each parallel boxplot shows adjusted sizes of the pharyngeal airway in the control and case groups at the time of diagnosis, where each size of the pharyngeal airway was adjusted for age at diagnosis, period of treatment, size of SN and size of N_FH using ANCOVA. Each p-value shows the statistical significance regarding difference of mean value of adjusted sizes of the pharyngeal airway between in the control and case groups.

4) In the case group, PPS was significantly wider after treatment than before treatment in multiple comparisons ($p < 0.01$) (Fig. 6).

Discussion

Verifying the hypothesis

Isono et al. mentioned that upper airway muscle activity and airway pressure fluctuate dynamically regardless of waking up and sleeping and that diagnosis of airway obstruction by measuring the area cross-sectionally is difficult²¹⁾. However, Chen et al proposed an equation that could predict the morphology of pharyngeal airway that is likely to develop Obstructive Sleep Apnea Syndrome (OSAS) after surgical correction; taking into account various risk factors during surgery²²⁾.

Tonogi et al.¹⁷⁾ reported that changes in the maxilla are more important than the changes in

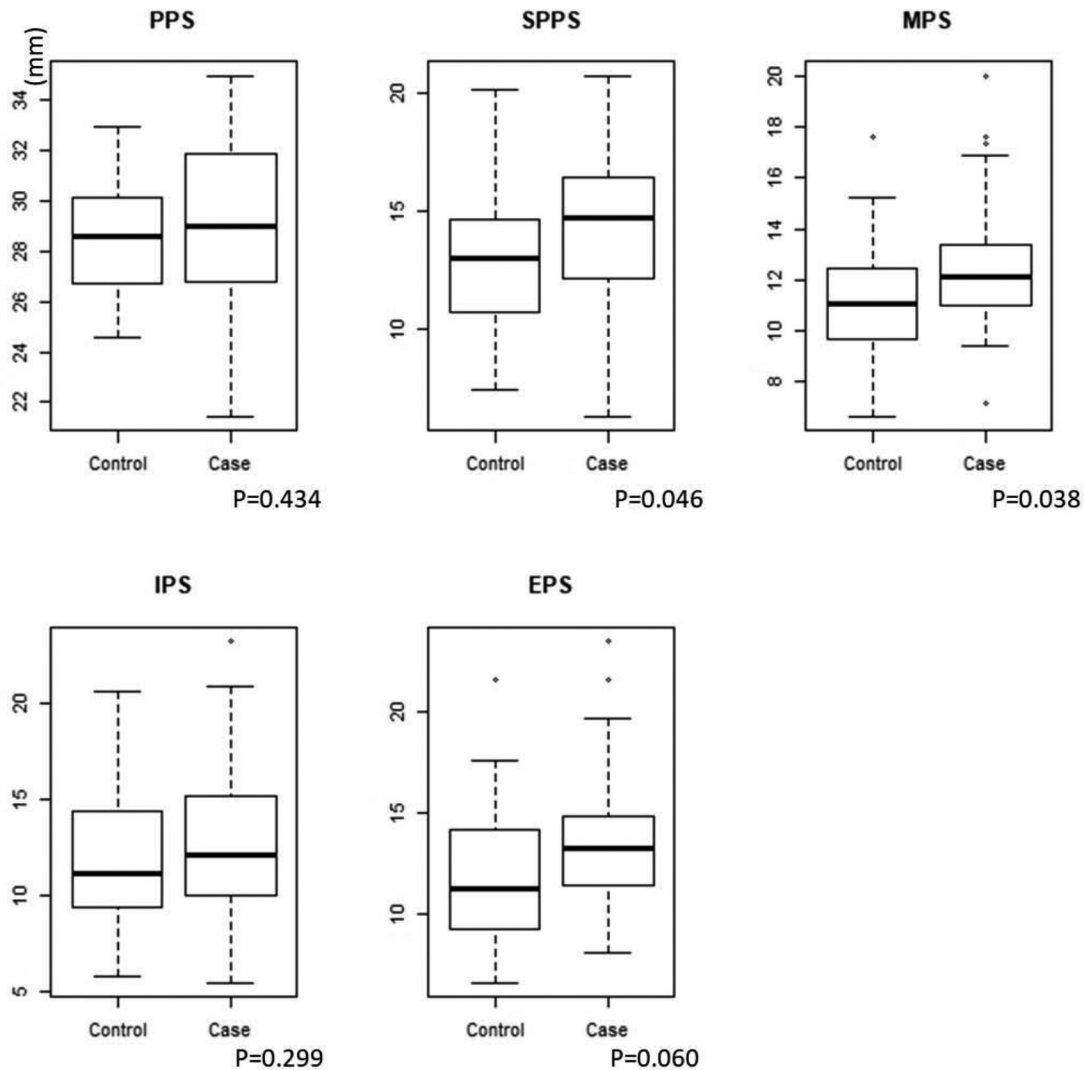


Fig 4 : Each parallel boxplot shows adjusted sizes of the pharyngeal airway in the control and case groups just after the end of treatment, where each size of the pharyngeal airway was adjusted for age at diagnosis, period of treatment, size of SN and size of N_FH using ANCOVA. Each p-value shows the statistical significance regarding difference of mean value of adjusted sizes of the pharyngeal airway between in the control and case groups.

the mandible. Hence, we tried to verify the hypothesis taking OSAS into consideration. It was predicted that the upper pharyngeal airway in the case group would be smaller and the lower part would larger than the control group. Although that trend was observed, there was no significant difference between the control and the case group.

Almuzian et al.²³⁾ reported in 40 patients who had undergone a single Le Fort I to correct Class III malocclusion with maxillary hypoplasia. As a result, the single Le Fort I osteotomy was found to increase the retroglossal airway volume.

It was hypothesized that during the pre treatment, the upper pharyngeal airway would originally be narrow and the lower part would be wide. However, no significant difference was obtained between the control and the case group. After surgery, it was predicted that the upper pharyngeal airway would be larger and the lower part would be smaller. However, the results showed no change between the control and the case groups. The three-dimensional movement of the bone dur-

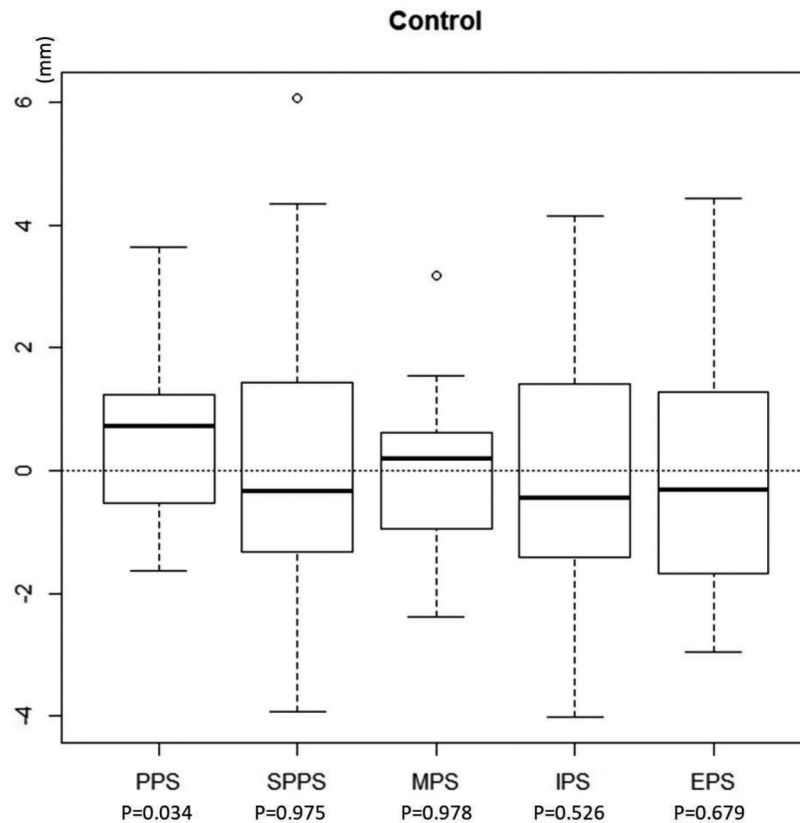


Fig 5 : Each boxplot shows the adjusted difference of pharyngeal airway size between the pre- and post-treatments in the control group, where differences of pharyngeal airway sizes between the pre- and post-treatments were adjusted for age at diagnosis, period of treatment, size of SN and size of N_FH using ANCOVA. Each p-value shows a statistical significance regarding the difference of pharyngeal airway sizes between pre- and post-treatments.

ing simultaneous maxillomandibular surgery seemed to complicate the data obtained. Orthognathic surgery of the maxilla and the mandible can improve occlusion, masticatory functions, and esthetics but multiple movements in the jawbone may cause significant changes in the morphology of the pharyngeal airway as well as changes in the position of the tongue and soft palate²⁴⁾.

Subject selection and research limitations

In this study, we were able to utilize a large number of cases selected from a huge pool of data. However, due to the peculiarities in the treatment, only female patients were selected because data collection from many male patients was not possible. Results could have been different if male cases were analyzed.

Method of evaluating pharyngeal airway

In this study, an analysis was carried out on two-dimensional lateral cephalogram. Lateral cephalograms have the advantage of evaluating the lower face and pharyngeal airway under the same condition. Since lateral cephalogram is standard radiography, images can be easily compared. Many studies in the past used two-dimensional lateral cephalogram to measure the size of pharyngeal airway^{1,8,11)} however recently, the use of three-dimensional CT images in researches is

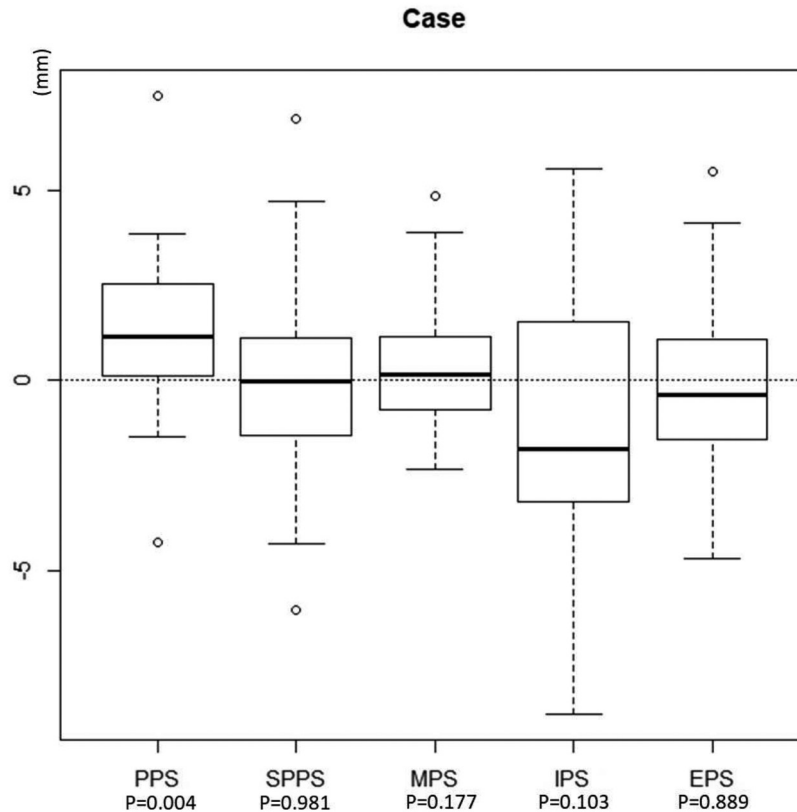


Fig 6 : Each boxplot shows the adjusted difference of pharyngeal airway size between the pre- and post-treatments in the case group, where differences of pharyngeal airway sizes between the pre- and post-treatments were adjusted for age at diagnosis, period of treatment, size of SN and size of N_FH using ANCOVA. Each p-value shows the statistical significance regarding the difference of pharyngeal airway sizes between pre- and post-treatments. Regarding PPS, the adjusted p-value with Bonferroni correction was 0.02, which was significant in multiple comparison.

rapidly becoming a practice. Kiryu et al.²⁵⁾ suggested that although three-dimensional CT image is qualitatively excellent, it is not clinically applicable quantitatively. Furthermore, the diagnosis of jaw deformity has not been established using CT image compared to using lateral cephalogram. Notwithstanding, recently a study showed that data obtained from three-dimensional images is four to five times more precise (error within 0.1 mm) than the data obtained from two-dimensional images²⁶⁾. If the present study was evaluated using three-dimensional radiographs, more interesting findings could have been obtained and not just limited to anteroposterior data.

Currently, orthodontic clinics equipped with CT scan are limited and many medical institutions routinely perform treatments based on two-dimensional images. Besides, CT imaging exposes the patients at an extremely high dose of radiation than lateral cephalogram²⁶⁾. From the viewpoint of whether it is justifiable to use CT imaging in daily clinical practice for orthodontic correction is questionable because of the disadvantage of radiation exposure leading carcinogenicity thus, outweighs the merit. For that reason, we should be more cautious in considering the use of CT. Needless to say, CT imaging is essential when performing surgery.

In the present study, the control group did not consist of a population without orthodontic treatment, rather it was selected from patients who underwent and have completed orthodontic

treatment alone (without skeletal deformities). Thus, the results of this study were based on patients treated orthodontically and not compared to untreated normal individuals. So far, numerous studies regarding changes in pharyngeal airway before and after orthognathic surgery have been presented. Pushkar et al.²¹⁾ mentioned that maxillary and mandibular surgery caused an increase in the pharyngeal airway when the maxilla was moved forward and a decrease during a mandibular setback. Moreover, during orthognathic surgery involving the maxilla and the mandible, the pharyngeal airway was reduced to 47%, and that the position of the base of the tongue was altered by 65% due to the mandibular setback. Aoki et al.²⁷⁾ analyzed the effect of orthognathic surgery on the morphology of pharyngeal airway after doing Le Fort I on the maxilla and SSRO on the mandible. They found out that surgically moving the jaw increased the upper pharyngeal airway and decreased the lower pharyngeal airway.

The anterior movement of the maxilla caused the posterior part of the nasal lobule to move forward thereby increasing the anteroposterior diameter of the pharyngeal airway. Also, the posterior movement of the mandible reduced the oral cavity region. The posterior movement of the tongue and the base of the tongue likewise reduced the oral cavity region. The posterior movement of the tongue together with the base of the tongue caused stenosis and movement of the soft palate since the posterior part of the tongue is connected to the soft palate. Kouno et al.¹¹⁾ compared the changes in pharyngeal airway before and after surgery in patients with mandibular prognathism treated with simultaneous maxillomandibular surgery. They found that although surgery involving the maxilla and the mandible relatively changed the anteroposterior pharyngeal airway in comparison with mandibular setback alone, stenosis of the posterior part of the soft palate especially the laryngeal airway is low.

Until now, there have been plenty of studies on the changes in pharyngeal airway before and after orthognathic surgery. We reviewed those studies and as far as we know, the difference between surgical and non-surgical cases has not been reported. Therefore, after examining the case treated with mandibular setback and comparing it with orthodontic correction alone, we observed that after treatment, pharyngeal airway became smaller than before treatment. Although the pharyngeal airway became smaller, the size was not different from those that were not treated surgically. Our results showed no significant difference in the pharyngeal airway between those treated with maxillomandibular surgery and those treated with orthodontics alone. Brunetto et al.²⁸⁾ tried three-dimensional prediction in orthognathic surgery patients. As a result, it was reported that there was no strong correlation between the amount of movement and volume change of the pharyngeal airway in cases of mandibular prognathism that performed simultaneous maxillomandibular surgery.

In the case of simultaneous maxillomandibular movement for the correction of mandibular prognathism, the upper pharyngeal airway before treatment is narrower than the control group and the lower part of the airway is wider. Our hypothesis was that the upper airway would become wider and the lower airway would be narrower after treatment. Nevertheless, after maxillomandibular surgery, only slightly significant difference was obtained. The slight difference was considered due to the complex three-dimensional movement of the bone – upward-forward-rotation of the maxilla and downward-backward movement of the mandible. All points of measurement did not show a significant difference which proved our null hypothesis. Neither sufficient data was obtained to support the originally intended hypothesis. However, it was established that cases with jaw deformity (mandibular prognathism) requiring simultaneous

maxillomandibular movement create a larger upper pharyngeal airway and a smaller lower pharyngeal airway than the pre treatment.

As stated in the introduction, this is the first report stating that pharyngeal airway in mandibular prognathism is wider than normal. After surgical correction, the pharyngeal airway becomes narrower nevertheless we predicted and demonstrated that the size was not abnormal and in fact, it was nearly normal. However, during simultaneous maxillomandibular movement, the slight significant difference was considered due to the complex three-dimensional movement of the jaw – upward–forward–rotation of the maxilla and downward–backward movement of the mandible. It was demonstrated and proven that this is not abnormal and was close to normal. However, the case of simultaneous movement of the upper and lower jaw was considered to have little significant different due to complicated three-dimensional movement such as backward, upward and rotation of the maxilla.

Conclusion

A comparison of the morphology of pharyngeal airway, before and after surgery was carried out in patients with skeletal mandibular prognathism treated with simultaneous maxillomandibular movement and in patients treated with orthodontics alone. Our data on multiple comparisons showed no significant difference at all points; neither did we obtain sufficient results to support our originally intended hypothesis. However, patients with mandibular prognathism requiring simultaneous maxillomandibular movement tended to have a smaller upper pharyngeal airway and larger lower pharyngeal airway at the pre treatment. After mandibular prognathism was improved by simultaneous maxillomandibular movement, the upper pharyngeal airway became larger and the lower pharyngeal airway became smaller. The results showed slightly significant difference in the dimension of the pharyngeal airway between the case and the control group. The slight change was considered due to the complex three-dimensional movement of the maxilla – in an upward, forward and rotation. The morphology of the pharyngeal airway and the presence of respiratory disorder should be taken into consideration when considering performing orthognathic surgery.

Disclosure

The gist of this research was reported during the 24th Annual Meeting of the Non-Profit Organization of Japanese Society for Jaw Deformities in June 2014. The authors declare no conflict of interest (COI) in this study to their affiliated clinics or hospitals.

Acknowledgments

We deeply express our appreciation to Dr Megu Ohtaki and Dr Keiko Otani (deCult Inc.) for supporting for statistical analysis.

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抄録：顎変形症（骨格性下顎前突症）における咽頭気道形態の術前術後の変化
—上下顎同時移動術と1級不正咬合の比較—

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【目的】骨格性下顎前突症の外科的矯正治療において術後に咽頭気道形態が狭小化したとの報告が多い。今回上下顎同時移動術を用いた骨格性下顎前突症例の咽頭気道形態について検討し、知見を得たので報告する。

【資料および方法】上下顎同時移動術31例（ケース群）、1級矯正単独28例（コントロール群）の初診時、術前矯正終了時（ケース群のみ）、終了時の3ステージ（コントロール群は2ステージ）の側方セファロX線写真の中咽頭部における5点（PPS, SPPS, MPS, IPS, EPS）の距離計測を行った。（1）初診時、および矯正治療後における対照群とケース群の各点での咽頭気道の広さの違い、（2）コントロール群とケース群について、初診時と治療後の各点での咽頭気道の広さの変化について共分散分析（ANCOVA）を用いて検討を行った。

【結果】1）初診時では、ケース群のSPPS（軟口蓋—咽頭後壁）はコントロール群と比較して有意に広がったが（ $p<0.05$ ）、多重比較では有意差は認められなかった。2）矯正後では、ケース群のSPPSとMPS（PSP-咽頭後壁）はコントロール群に比べ有意に広がったが（ $p<0.05$ ）、多重比較では有意差は認められなかった。3）コントロール群とケース群について治療前後の咽頭気道の広さを比較した結果、コントロール群では治療後のPPS（PNS-咽頭後壁）が治療前に比較して有意に広がっていたが、多重比較では有意差が認められなかった。ケース群では治療後のPPSが治療前に比較して多重比較の意味において有意に広がっていた（ $p<0.01$ ）。

【考察】治療前は中咽頭上部のスペースはコントロール群と比較して狭く、下部は広く、治療後では上部は広くなり下部は狭くなるという仮説を立てた。しかしながら、上下顎同時移動術症例は上顎骨の複雑な三次元的移動を伴うために、有意差が少ないと考えられた。

【結論】骨格性下顎前突症例が上下顎同時移動術により改善すると同時に中咽頭気道上部（PPS）は術前と比較し有意に広がっていた。また、中咽頭下部は狭くなる傾向がみられた。