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Longitudinal Analysis of Bony Nasopharynx Growth Pattern in Operated Unilateral Cleft Lip and Palate

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Abstract

Objectives: To analyze the nasopharyngeal characteristic of the operated unilateral cleft lip and palate (UCLP) cases from the cephalometric analysis on the bony nasopharyngeal structure.

Setting and Sampling Population: Two sets of cephalograms were obtained from 25 operated UCLP subjects at the age of 5 - 7 years and 10 - 12 years. For the purpose of comparison, 50 cephalograms were obtained from non-cleft subjects aged 5 - 7 years and 10 - 12 years (25 cephalogram on each age group).

Materials and Method: The bony nasopharynx landmarks were traced on the cephalogram as PMP (posterior maxillary points), Ho (hormion) and At (atlas), and being interconnected as a nasopharyngeal triangle, and being projected on the vertical and horizontal axis. The projection results were compared between UCLP and control groups and longitudinally at the age of 5 - 7 and 10 - 12.

Result: Points on the bones which surround the nasopharynx on anteroposterior and vertical dimensions in the UCLP were comparable to the controls. The position of posterior maxillary (PMP: posterior maxillary point) in cleft group showed a significantly different pattern of growth from those in the control group ($p < 0.005$), while the PMP in UCLP was more posterosuperior than control group. However, no significant differences were found in the cranial base (Ho: hormion) and cervical vertebra (At: atlas). Although these three points were found to be independent in growth, the 'nasopharyngeal triangle' of them showed harmonious growth in both the UCLP and control group.

Conclusion: The bony nasopharynx of the UCLP subjects have a harmonious growth and comparable to the non-cleft subjects. Nevertheless, PMP points on the UCLP cases were located more postero-superiorly with a harmonious growth of the triangle.

Keywords: *Cleft Lip and Palate; Bony Nasopharynx; Lateral Cephalometry*

Introduction

Operated cases of cleft lip and palate, often resulted in the disruption of the speech function. This might be due to the impaired anatomical structure, neuromuscular incompetence, or mislearning. The formation of speech is by itself a complex and coordinated task involving the interaction of the soft and hard structure and the integrity of velopharyngeal function. The integrity of velopharyngeal function, should not be assessed from the velopharyngeal structure per se. Coccaro., *et al.* [1] stated that the velopharyngeal function is strongly dependent on a close coordination in growth of the anatomic parts involved in the velopharyngeal closure, and emphasized the height and depth nasopharynx.

The nasopharynx is a passage located between the nasal cavity and the oral cavity that is surrounded by three types of bone (the cranial base, the cervical vertebrae, and the maxilla), here after called the bony nasopharynx. The harmonious growth of bony nasopharynx and

its interaction to the surrounding structures may be important to maintain the function of velopharyngeal closure. The longitudinal analysis of these growth patterns after the treatment is a part of important fundamental database in craniofacial growth and development in operated unilateral cleft lip and palate (UCLP) in comparison with control group. Several studies on growth of the bony nasopharynx have been done, but just a few longitudinal studies available (i.e. from early childhood to puberty) and compare the result with the non-cleft subjects.

Aim of the Study

The aim of the study is to evaluate the nasopharyngeal growth's characteristics on the operated UCLP cases by analyzing the bony nasopharynx from the lateral cephalogram.

Subjects and Methods

Subjects

The material consists of lateral cephalogram from 25 subjects with operated UCLP (12 males and 13 females). For each subjects, we obtained two sets of cephalogram, the first were taken at 5-7 years of age, and the second at 10 - 12 years of age. The control groups consisted of 50 non-cleft subjects (25 children aged 5 - 7 years, and 25 children aged 10 - 12 years. From each subjects in the non-cleft group we obtained one cephalogram. The ages and the genders of the subjects were presented on table 1. All surgeries were performed by single oral and maxillofacial surgeon. Cronin technique was the surgical procedure for the lip closure, and V-Y pushback was the surgical procedure which was performed to repair the palate. Specific criteria were established for selecting children used in this study. Those patients who had syndromic cleft cases was excluded (Table 2).

	Sex				Mean of Age (Years old)	Total	
Age (Years old)	Female		Male				
	N	%	N	%		N	%
5 - 7	13	52	12	48	6,84	25	100
10 - 12	13	52	12	48	11,36	25	100

Table 1: *The distribution of ages and genders of the UCLP subjects.*

	Sex				Mean of Age (Years old)	Total	
Age (Years Old)	Female		Male				
	N	%	N	%		N	%
5 - 7	15	60	10	40	6,04	25	100
10 - 12	11	44	14	56	11,32	25	100

Table 2: *Distribution of the non cleft subjects.*

Methods

Lateral cephalograms were obtained in natural head position in a cephalostat. Linear measurements of cephalometric landmarks to characterize point of bony nasopharynx were performed based on the previous studies [2-4] as references. There were using a coordinate system with the N-S line as the X-axis and the perpendicular Y-axis through the Sella. The landmarks were: 1) PMP (posterior maxillary point) which represents the posterior-most of the maxilla; 2) Ho (hormion) which represents the posterior wall of nasopharynx; and 3) At (atlas) which represents the cranial base. Those landmarks were interconnected into a triangle (nasopharyngeal triangle, and their position were correlated to the coordinate from the previously drawn X-Y axis. The horizontal relative position of the posterior-most of the

maxilla was designated as PMPX, and its' vertical position was designated as PMPY. This applied to the designation of At and Ho position (AtX, AtY, HoX, and HoY respectively). The landmarks for the linear measurements were presented on figure 1. Lateral cephalometric radiograph were traced by the first authors. Three points of bony nasopharynx included Ho, At and PMP were digitized using digital caliper (Mitutoyo Absolute Digimatic, Mitutoyo Co., Kanagawa, Japan). The tracing of the landmarks and measurements were made by the author at two different occasions (the second measurement was a week after the first). The random error was calculated according to Dahlberg's formula ($S^2=\Sigma d^2/2n$). All statistical procedures were carried out by using the statistical package SPSS/11.

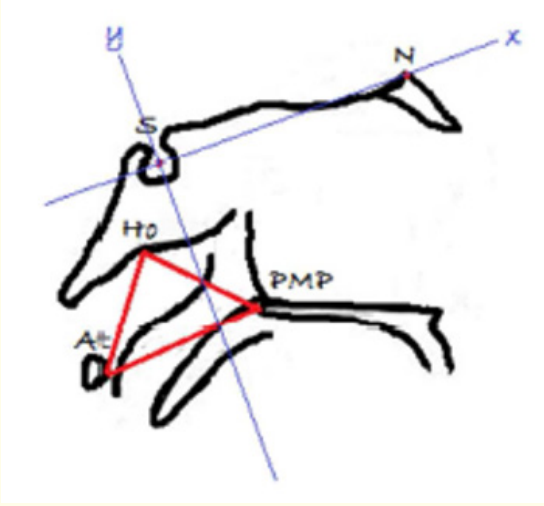

Figure 1: *Cephalometric landmark used in this analyzed: N: Nasion; S: Sella; Ho: Hormion; At: Atlas; PMP: Posterior Maxillary Point. The red lines (Ho-At-PMP) are the nasopharyngeal triangle.*

Results

In this study, we performed the measurement of the PMP, Ho, and At on this following basis: non-cleft subjects aged 5 - 7 years vs UCLP subjects aged 5 - 7 years; non-cleft subjects aged 10 - 12 years vs UCLP subjects aged 10 - 12; non-cleft subjects aged 5 - 7 years vs non-cleft subjects aged 10 - 12; and UCLP subjects aged 5 - 7 vs UCLP subjects aged 10 - 12. The measurement results were presented on table 3-6.

Variables		Control		UCLP		P
	Mean (mm)	SD	Mean (mm)		SD	
PMPX	12,88	1,14	10,19	10,19	1,61	0,037*
PMPY	39,51	1,67	34,86	34,86	2,77	0,000**
HOX	-3,79	1,23	-4,30	-4,30	1,74	0,443
HOY	17,69	0,53	17,82	17,82	0,93	0,565
ATX	-17,54	1,99	-17,51	-17,51	3,28	0,966
ATY	38,50	1,93	39,59	3,92	0,101	

Table 3: *Non-cleft subjects aged 5 - 7 years vs UCLP subjects aged 5 - 7 years.*

*P < 0.05-→*significant (T Test); P < 0.05-→*significant (Mann-Whitney test).*

Variables		Control		UCLP	P
	Mean (mm)	SD	Mean (mm)	SD	
PMPX	11,86	0,86	10,04	1,55	0,000*
PMPY	47,90	1,75	41,91	2,24	0,000**
HOX	-3,78	1,16	-4,26	1,06	0,381
HOY	21,70	1,29	21,55	1,79	0,698
ATX	-22,26	3,46	-20,80	3,46	0,610
ATY	48,65	2,49	50,29	3,54	0,065

Table 4: *Non-cleft subjects aged 10 - 12 years vs UCLP subjects aged 10 - 12 years.*

*P < 0.05-→*significant (T Test); P < 0.05-→*significant (Mann-Whitney test).*

Variables		Control		UCLP	P
	Mean (mm)	SD	Mean (mm)	SD	
PMPX	10,19	1,61	10,04	1,55	0,397
PMPY	34,86	2,77	41,91	2,24	0,000*
HOX	-4,30	1,74	-4,26	1,06	0,925
HOY	17,82	0,93	21,55	1,79	0,000*
ATX	-17,51	3,28	-20,80	3,46	0,000*
ATY	39,59	3,92	50,29	3,54	0,000*

Table 5: *Non-cleft subjects aged 5 - 7 years vs non-cleft subjects aged 10 - 12 years.*

*P < 0.05-→*significant (T Test); P < 0.05-→*significant (Mann-Whitney test).*

Variables		Control		UCLP	P
	Mean (mm)	SD	Mean (mm)	SD	
PMPX	12,88	1,14	11,86	0,86	0,397
PMPY	39,51	1,67	47,90	1,75	0,000*
HOX	-3,79	1,23	-3,98	1,16	0,925
HOY	17,69	0,53	21,70	1,29	0,000*
ATX	-17,54	1,99	-22,26	3,46	0,000*
ATY	38,50	1,93	48,65	2,49	0,000*

Table 6: *UCLP subjects aged 5 - 7 vs UCLP subjects aged 10 - 12 years.*

*P < 0.05-→*significant (T Test); P < 0.05-→*significant (Mann-Whitney test).*

The points were connected as a triangle (nasopharyngeal triangle) to assess their relative position toward the X-Y axis, and to observe the pattern of nasopharyngeal growth in the term of bony structures. The nasopharyngeal triangle grows harmoniously and comparable to the non-cleft subjects. Nevertheless, the final position of PMP on the UCLP subjects were located more superoposterior than the non-cleft subjects. The growth pattern of non-cleft subjects and UCLP subjects were presented on figure 2.

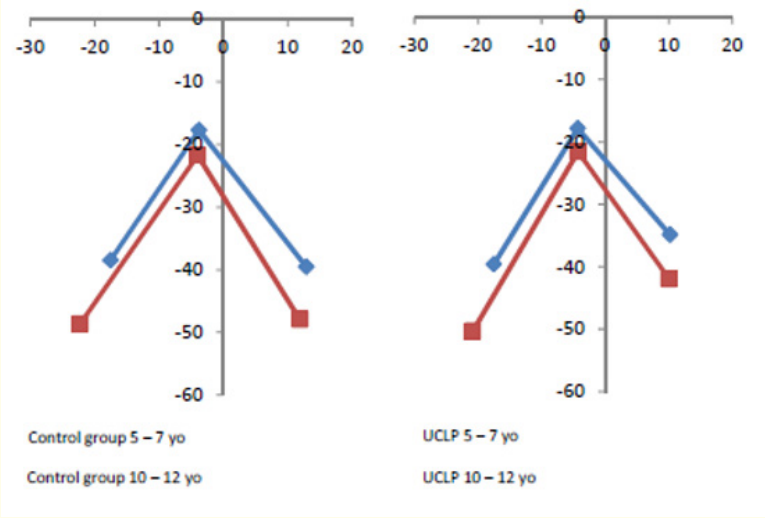

Figure 2: *The growth pattern of nasopharyngeal triangle on non-cleft subjects and UCLP subjects.*

Discussion

In the present study, the UCLP patient who had longitudinal cephalometric radiographs were chosen in order to analyzed the growth pattern of bony nasopharynx. As stated previously, 25 UCLP patient, 25 children without cleft at 5 - 7 years old dan 25 children without cleft at 10 - 12 years old were participated. The growth of bony nasopharynx at early childhood (5 - 7 years old) and puberty (10 - 12 years old) were compared between UCLP and control group. This study was based on morphometric approach. It did not characterize the actual function of velopharyngeal closure. However, the study of lateral cephalometry provides enough meaningful information for effectual appraisal not only of the skeletal skull but also the nasopharyngeal area [5].

The previous study has shown the certain characteristics of growth bony nasopharynx. In the present study, the position of posterior maxillary (PMP: posterior maxillary point) in cleft group showed a significantly different pattern of growth from those in the control group ($p < 0.005$), while the PMP in UCLP was more posterosuperior than control group. However, no significant differences were found in the cranial base (Ho: hormion point) and cervical vertebra (at: atlas point). This result provide indication that both the UCLP and control group show similar growth in the region of cranial base and the cervical vertebrae. The labioplasty and palatoplasty did not change the growth pattern of these region in patients with operated UCLP. These result were also consistent with the result reported by Satoh [4].

Although these three points (Ho, At and PMP) were found to be independent in growth, the 'nasopharyngeal triangle' of them showed harmonious growth in both the UCLP and control group. In the control group and UCLP the growth pattern was extended on downward direction with each age range, although the base line connecting At and PMP in UCLP were oblique because the inhibition of vertical (superoinferior) growth of PMP. These result were consistent with the result reported by Hayashi., *et al.* [6] and Satoh [7].

Conclusion

Although the bony nasopharynx grow independently and the posterior maxilla in the UCLP showed a different pattern growth from those in the control group, the 'nasopharyngeal triangle' connecting bone surrounding nasopharynx showed characteristic harmonious growth in both the UCLP and control group.

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