Scientific Poster

Three-Dimensional Comparison in Palatal Forms Between Modified Presurgical Nasoalveolar Molding Plate and Hotz's Plate Applied to the Infants With Unilateral Cleft Lip and Palate

Nobutaka Isogawa,[1] Satoru Ochiai,[2] Toshinori Mito,[3] Junko Kindaichi,[4] Naho Ishibashi,[5] Yuzo Takagi,[5] and Masaaki Ishikawa[6]

[1]*Dental Clinic, Kameda Hospital, Chiba, Japan.*
[2]*Clinic of Paediatric Dentistry, St. Mary's Hospital, Fukuoka, Japan.*
[3]*Sendai Children's Orthodontics, Miyagi, Japan.*
[4]*Division of Dentistry, National Center for Child Health and Development, Tokyo, Japan.*
[5]*Developmental Oral Health Science, Tokyo Medical and Dental University, Tokyo, Japan.*
[6]*Paediatric Oral Health Care Science, Tokyo Medical and Dental University, Tokyo, Japan.*

Abstract

The presurgical nasoalveolar molding plate appliance with stent (PNAM) extended from the palatal molding plate; to correct the nostril shape of infants with cleft lip and palate is well known. The PNAM appliance is based on the finding that a high degree of plasticity is maintained in the cartilage of infants during the first 6 weeks after birth. However, on the current PNAM protocol described by Grayson et al. the nasal stent is supposed to be an adjunct to the palatal molding plate after reducing the severity of the alveolar cleft width. We have used the modified Hotz's plate from the setup model and built up the nasal stent even before reducing the severity of the alveolar deformity. In this study we assess the effects of the modified Hotz's plate and the modified PNAM appliance for the alveolar and palatal form. The lateral deviation of the incisal point, the width of the palatal cleft, and the degree of curvature of the palatal vault were first evaluated on plaster models. The PNAM group is smaller on the lateral deviation of the incisal point than the modified Hotz's group. The decreased average width of the palatal cleft and curvature of the palate, was almost the same in both the modified Hotz's and PNAM groups. In comparison with the modified Hotz's plate, the modified PNAM appliance also improves the molding of the alveolar segments and reduces cleft width. [*Singapore Dent J* 2010;31(1):36–42]

Key Words: unilateral cleft lip and palate, presurgical orthopedics, presurgical nasoalveolar molding three-dimensional, morphology

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Correspondence to:
Dr Nobutaka Isogawa, DDS, PhD
3-14-14, #311, Mokushi Kimitsu City, Chiba, Japan 299-1163.
E-mail: isopedo@tmd.ac.jp

Introduction

The presurgical nasoalveolar molding plate with stent (PNAM) extending from the palatal molding plate to correct the nostril shape is the most well known[1–5] appliance for the presurgical

orthopaedic treatment of infants with cleft lip and palate (CLP). The PNAM appliance is based on the finding that a high degree of plasticity is maintained in the cartilage of infants during the first 6 weeks after birth after which, there is a gradual in plasticity.[1,6] The 'Active Soft Tissue and Cartilage Molding Plate' therapy like the PNAM is more successful during this period. However, on the current PNAM protocol described by Grayson et al the nasal stent is supposed to be an adjunct to the palatal molding plate after reducing the severity of the alveolar cleft width.[2] Using the modified Hotz's plate from the idealized setup model (Figure 1), we built up nasal stents even before reducing the severity of the alveolar deformity for the palatal molding plate part of the PNAM procedure, called the modified PNAM (Figure 2). We have previously reported that this modified PNAM was effective in reducing both nasal and palate deformity.[7,8] We had not however compared the degree of effectiveness between both procedures. The aim of this study is to assess the effect of the palatal molding plate appliance (the modified Hotz's plate, the modified PNAM) on the alveolar and palatal form through a quantitative and three-dimensional evaluation.

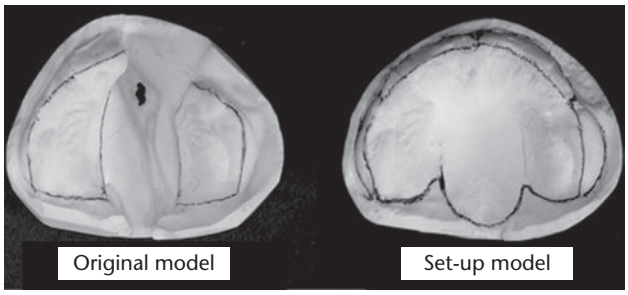
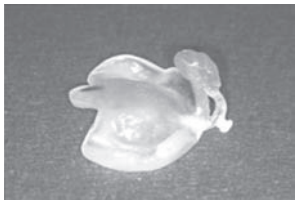
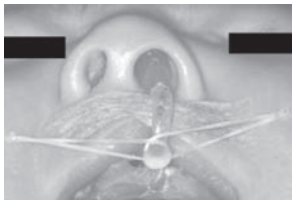


Figure 1. *An idealized set-up model.*



(i) Modified PNAM for UCLP



(ii) Facial picture of a UCLP infant with modified PNAM

Figure 2. *Modified PNAM for UCLP.*

Materials and Methods

The subjects in our study were infants with unilateral CLP who were treated with the modified Hotz's plate—Hotz's group or the modified presurgical nasoalveolar molding plate (PNAM)—PNAM group appliance, at (i) National Center for Child Health and Development (NCCHD), (ii) St. Mary's Hospital, and (iii) Tokyo Medical and Dental University Dental Hospital (TMDU) (Table 1). Each group consisted of five infants. Treatment protocol was as in Figure 3. The changes of palatal forms in patients with CLP were evaluated quantitatively using plaster models. The plaster models were taken at the initial visit and later after the modified Hotz's or PNAM appliance was inserted. The use of these plaster models for this study was agreed to by their parents under the code of ethics of each hospital.

The width between the edges of the major and minor alveolar ridge on an alveolar cleft was measured, to assess the changes in the width of the alveolar cleft (WA) (Figure 4). The changes in the lateral deviation of the incisal point (LDI) were assessed by measuring the plaster casts as shown in Figure 5.

The width between the crossing points of the palatal cleft edges and the line between the maxillary tubers was measured, to assess the changes in the width of the palatal cleft (WP) (Figure 4).

The changes in the curvature of the palate (CP) were assessed by using Grating Projection Systems for Profiling (GRASP, Technoarts Lab. Co.) (Figure 6). The plaster casts were scanned by GRASP and the points along the surface of the cast converted to a three-dimensional Cartesian coordinate system. The vertical section from the right and left crossing points of a canine groove and the alveolar ridge (C(r), C(l)) to the plane passing through C(r), C(l) and the crossing point of an alveolar ridge. The line from an incisive papilla to a frenulum, was converted in the dispersion diagram. An approximated quadratic curve of this dispersion diagram of the vertical section was calculated by Excel (Microsoft Co.). The coefficient of x^2 in this approximated quadratic curve was taken, to evaluate the curvature of the palate.

All measurements (WA, LDI, WP, and CP) each time were compared with paired *t* tests while the differences between the Hotz's and PNAM groups

Table 1. Breakdown of subjects

	Institute	Day of taking an impression before Hotz's/NAM appliance from BD	Day of setting a palatal plate from BD	Day of setting a stent from BD	Day of impression after Hotz's/ PNAM appliance from BD
H1	NCCHD	17	29		142
H2	NCCHD	14	21		147
H3	St. Mary	4	7		161
H4	St. Mary	1	4		91
H5	St. Mary	1	6		111
Average of Hotz's group		7.4	13.4		130.4
P1	NCCHD	18	25	39	116
P2	St. Mary	6	10	34	104
P3	St. Mary	4	9	29	115
P4	St. Mary	1	6	21	183
P5	TMDU	6	13	17	130
Average of PNAM group		7	12.6	28	129.6

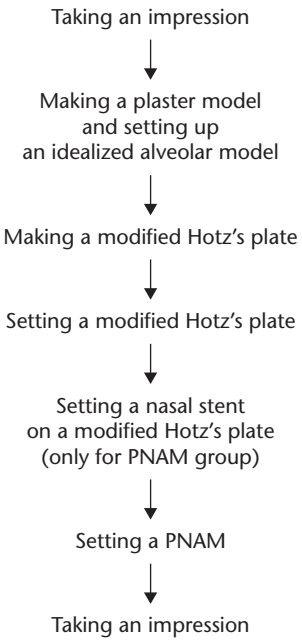
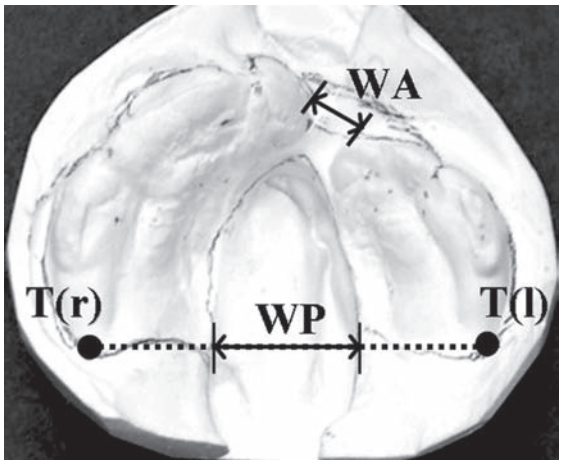


Figure 3. *Treatment protocol.*

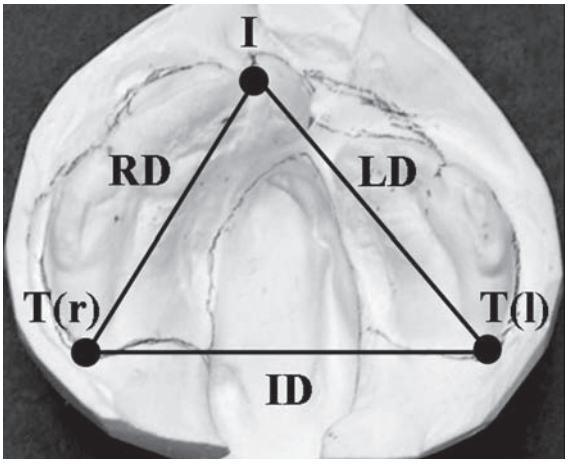


WA : The width between edges of a minor and a major segment each alveolar ridge on an alveolar cleft side.
WP : The width between the crossing points of palatal cleft edges and the line between the maxillary tubers (T(r,l)).

Figure 4. *The assessment of the width of the alveolar cleft (WA) and the palatal cleft (WP).*

were compared with unpaired *t* tests. $p<0.05$ was considered to be statistically significant.

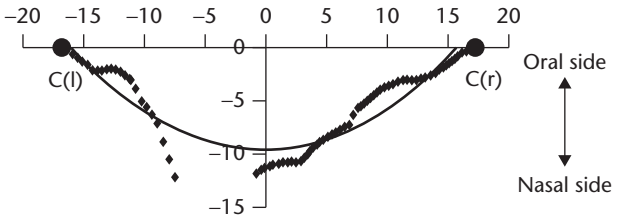
It was decided that two comparative pictures (before and after the modified PNAM treatment) be used (Figure 7). The patients shown are only from the Tokyo Medical Dental University to allow for this comparison. Data from other hospitals is still under evaluation.



The lateral deviation of the incisal point (LDI)
$= | RD^2 - LD^2 | / 2\,ID$

I : The crossing point of alveolar ridge and the line from incisive papilla to frenulum
T(r,l) : The maxillary tubers
RD : The length between I and T(r)
LD : The length between I and T(l)
ID : The length between T(r) and T(l)

Figure 5. *The assessment of the lateral deviation of the incisal point (LDI).*



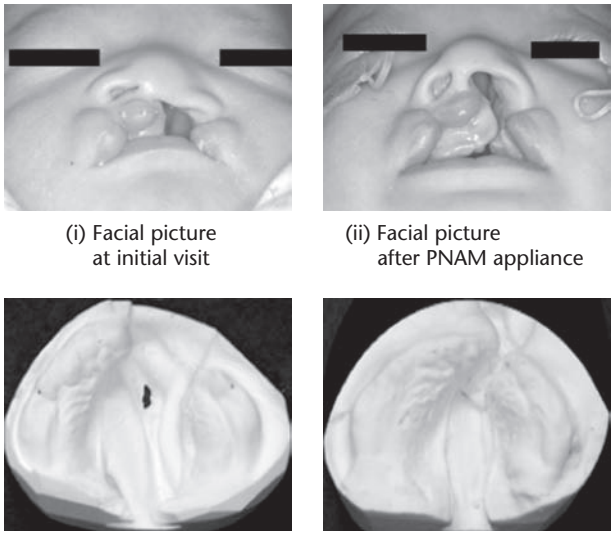
C(r,l) : The crossing point of a canine groove and an alveolar ridge
◆ Dispersion diagram of the vertical sectional palatal view
— Approximated quadratic curve
$y = 0.0382x^2 + 0.0107x - 9.6356$
$R^2 = 0.8909$
This coefficient was assessed as CP.

Figure 6. *The assessment of the curvature of the palate (CP).*

Results

The width of the alveolar cleft (WA) was decreased in all cases (Table 2, Figure 8). And there were no significant differences in the change between the Hotz's group and the PNAM group ($p < 0.05$).

The lateral deviation in the incisal point (LDI) was improved in all cases (Table 3, Figure 9). There were no significant differences in the change of LDI between the Hotz's group and the PNAM group ($p < 0.05$).



(i) Facial picture at initial visit
(ii) Facial picture after PNAM appliance
(iii) Plaster model at initial visit
(iv) Plaster model after PNAM appliance

Figure 7. *Unilateral CLP case seen in TMDU.*

Table 2. Changes in the width of the alveolar cleft (WA)

	WA	
	Initial visit	Post Hotz's/ PNAM appliance
H1	8.76	1.76
H2	13.1	7.39
H3	9.65	1.75
H4	8.65	1.09
H5	13.18	6.94
Average of Hotz's group	10.668	3.786
P1	11.78	4.66
P2	12.22	5.1
P3	8.89	3.84
P4	19.43	7.65
P5	9.39	2.41
Average of PNAM group	12.342	4.732

The width of palatal cleft (WP) was also decreased in all cases (Table 4, Figure 10) and there was no significant difference between the Hotz's group and the PNAM group ($p < 0.05$). The average decrease in the widths of the palatal cleft were almost the same between the Hotz's and PNAM groups (approximately 11 mm) (Figure 10).

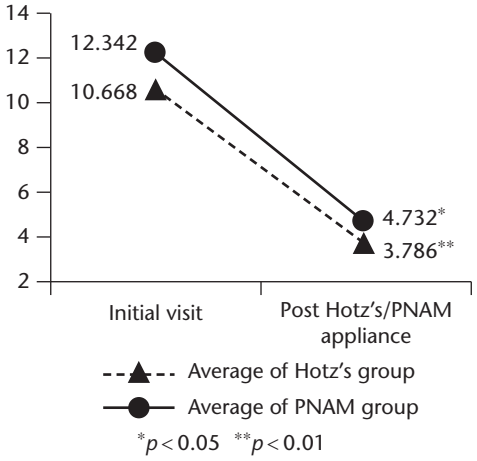


Figure 8. *Changes in the width of the alveolar cleft (WA).*

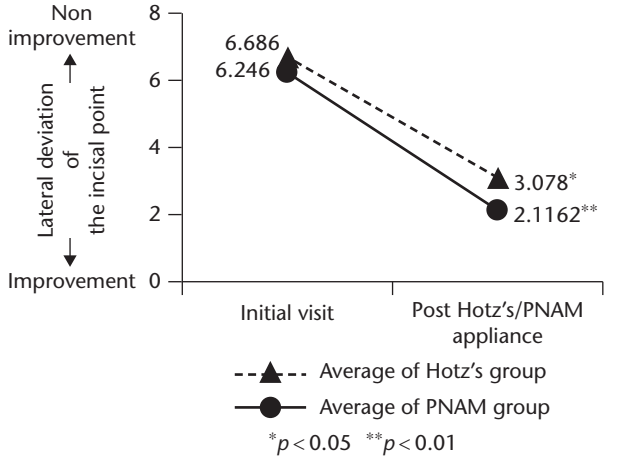


Figure 9. *Changes in the lateral deviation of the incisal point (LDI).*

Table 3. Changes in the lateral deviation of the incisal point (LDI)

	LDI	
	Initial visit	Post Hotz's/ PNAM appliance
H1	4.68	1.07
H2	7.41	4.33
H3	6.74	2.65
H4	5.65	1.08
H5	8.95	6.26
Average of Hotz's group	6.686	3.078
P1	6.38	3.31
P2	7.3	4.51
P3	3.92	1.05
P4	9.86	1.56
P5	3.77	0.151
Average of PNAM group	6.246	2.1162

Table 4. Changes in the width of the palatal cleft (WP)

	WP	
	Initial visit	Post Hotz's/ PNAM appliance
H1	14.13	7.75
H2	19.51	10.98
H3	15.75	11.23
H4	14.12	9.15
H5	19.5	16.64
Average of Hotz's group	16.602	11.15
P1	11.25	9.25
P2	11.5	10.42
P3	11.65	9.99
P4	19.46	12.9
P5	14.46	11.29
Average of PNAM group	13.664	10.77

There was a decrease in the curvature of the palate (CP) in all cases (Table 5, Figure 11) and there was no significant difference in the change of CP between the Hotz's group and the PNAM group ($p < 0.05$). The average decrease in the curvatures of the palate were almost identical for the Hotz's and PNAM groups (approximately 0.026) (Figure 11).

Discussion

In both the Hotz's and PNAM groups the lateral deviation of the incisal point (LDI) was decreased in all cases (Table 3, Figure 9) as was the width of the alveolar cleft (WA) (Table 2, Figure 8). There was an improvement in the positions of the pre-maxilla segment too. These results were obtained

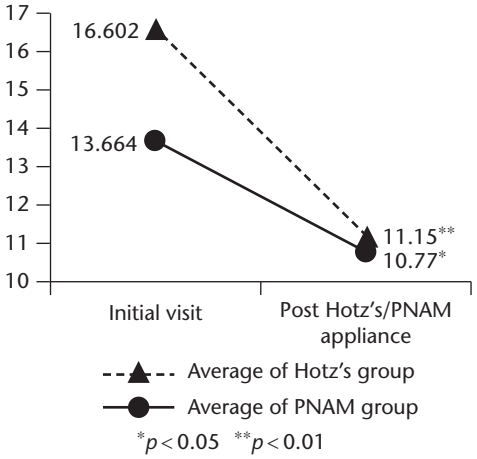


Figure 10. *Changes in the width of the palatal cleft (WP).*

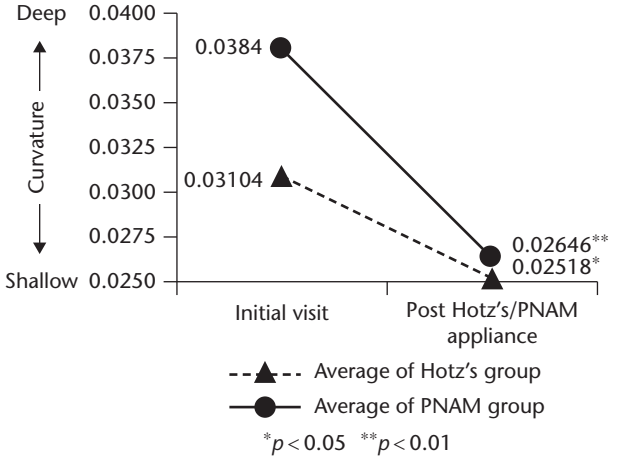


Figure 11. *Changes in the curvature of the palate (CP).*

Table 5. Changes in the curvature of the palate (CP)

	CP	
	Initial visit	Post Hotz's/ PNAM appliance
H1	0.031	0.0279
H2	0.0245	0.0192
H3	0.0439	0.031
H4	0.0275	0.0243
H5	0.0283	0.0235
Average of Hotz's group	0.03104	0.02518
P1	0.0335	0.0235
P2	0.0413	0.0259
P3	0.0379	0.0301
P4	0.0383	0.0205
P5	0.041	0.0323
Average of PNAM group	0.0384	0.02646

by the early fitting of the palatal plate on the presurgical orthopedic appliance guide and the anterior growth of the major and minor segments.[9–11] Although the PNAM appliance is disadvantageous in improving the alveolar form when compared with the Hotz's plate appliance in applying the nasoalveolar molding plates to the unilateral cleft lip and palate (CLP) cases, because of the asymmetrical pressure from the stent to the palatal plate; these results suggest that the modified PNAM appliance could obtain better alveolar form than the modified Hotz's plate appliance in these cases.

The width of the palatal cleft (WP) and the curvature of the palate (CP) was decreased in all cases (Tables 4 and 5, Figures 10 and 11) and showed an improvement in the palatal form. These results were obtained by positioning the tongue such that the abnormal force exerted by the tongue on the palate was removed.[9,11–13] These results suggest that there was no significant difference in the techniques of molding the palatal form between the modified Hotz's plate and the modified PNAM for the palatal plate to improve the tongue posture.

After the Hotz's or PNAM procedure, the decreased average WP was similar (approximately 11 mm—Figure 10) as was the decreased average CP (approximately 0.026—Figure 11) in both the Hotz's and PNAM groups. These results suggest that this could be the limit of the effectiveness of this type of pre-surgical orthopedic appliance on the palatal form.

Grayson et al described that an attempt to correct the nasal cartilage deformity present in a larger alveolar cleft defect, may result in an undesirable increase in the circumference of the lateral alar wall.[2] However, it seems that the nasal cartilage can be molded more easily in the first three months. The modified Hotz's plate was made from the idealized setup model and may indicate the idealized occlusal plane. We therefore expect that by using the modified Hotz's plate for the PNAM we could add and adjust the nasal

stent by imaging the idealized nasal form properly even before the alveolar cleft width reduces by less than 6 mm. On the other hand we were afraid of the negative influence from the asymmetrical pressure of the nasal stent on the palatal molding plate. On the nasal form, a favourable effect was obtained using the modified PNAM in the TMDU case (Figure 7). The modified PNAM appliance could obtain the same results as the modified Hotz's plate appliance on the alveolar and palatal form. These results suggest that the set of the nasal stent on the modified Hotz's plate before the severe alveolar deformity, did not show any negative influence on the improvement of the alveolar and palatal deformity in unilateral CLP patients.

Conclusions

The favourable effects of treatment using the Hotz's plate and the modified PNAM on both the alveolar and palatal forms in all cases for the unilateral CLP are quantitatively confirmed. On the nasal form, the favorable effect was obtained with the modified PNAM. As such, the modified PNAM appliance would be a better appliance than the modified Hotz's appliance for the improvement of the nasal form in unilateral CLP patients. The modified Hotz's plate would be a better for setting the nasal stent early.

References

1. Grayson BH, Cutting CB, Wood R. Preoperative columella lengthening in bilateral cleft lip and palate. *Plast Reconstr Surg* 1993;92:1422–3.
2. Grayson BH, Santiago PE, Brecht LE, Cutting CB. Pre-surgical nasoalveolar molding in infants with cleft lip and palate. *Cleft Palate Craniofac J* 1999; 36:486–98.
3. Maull DJ, Grayson BH, Cutting CB, Brecht LL, Bookstein FL, Khorrambadi D, Webb JA, Hurwitz DJ. Long-term effects of nasoalveolar molding on three-dimensional nasal shape in unilateral clefts. *Cleft Palate Craniofac J* 1999;36:391–7.
4. Pai BCJP, Ko EWC, Huang CS, Liou EJW. Symmetry of the nose after presurgical nasoalveolar molding in infants with unilateral cleft lip and palate: a preliminary study. *Cleft Palate Craniofac J* 2005; 42:658–63.
5. Aminpour S, Tollefson TT. *Recent advances in presurgical molding in cleft lip and palate Facial Plast Surg* 2008;16:339–46.
6. Matsuo K, Hirose T, Tomono T, Iwasawa M, Katohda S, Takahashi N, Koh B. Nonsurgical correction of auricular deformities in the early neonate: a preliminary report. *Plast Reconstr Surg* 1984;73:38–50.
7. Isogawa N, Ochiai S, Morita K, Omura K, Takagi Y. The effect of presurgical nasoalveolar molding plate appliance on alveolar and nasal form in infants with cleft lip and palate. *J Jpn Soc Disability Oral health* 2005;26:449.
8. Ochiai S, Ohya S, Morishita T, Mikawa N. The effectiveness of presurgical nasoalveolar molding plate treatment for cleft lip and palate. *J Jpn Cleft Palate Assoc* 2007;32:141.
9. Hotz M, Gnoinski W. Comprehensive care of cleft lip and palate children at Zürich university: a preliminary report. *Am J Orthod* 1976;70:481–504.
10. Hochban W, Austermann KH. Presurgical orthopaedic treatment using hard plates. *J Craniomaxillofac Surg* 1989;17:1:2–4.
11. Mishima K, Mori Y, Sugahara T, Minami K, Sakuda M. Comparison between palatal configurations in UCLP infants with and without a Hotz plate until four years of age. *Cleft Palate Craniofac J* 2000;37:185–90.
12. Huddart AG. Presurgical changes in unilateral cleft palate subjects. *Cleft Palate J* 1979;16: 147–57.
13. Haishima H, Ayano R, HIrakawa T, Matsuda E, Suzuki T, Haishima H, et al. Ultrasonographic study of the sucking movements of the cleft lip and palate patients. *Jpn J Ped Dent* 2001;39:69–78.