Prepubertal Midface Growth in Unilateral Cleft Lip and Palate Following Alveolar Molding and Gingivoperiosteoplasty

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Objectives: **To examine the long-term effect of nasoalveolar molding and gingivoperiosteoplasty (modified Millard type) on midface growth at prepuberty.**

Procedures: **In this retrospective study, 20 consecutive patients with a history of complete unilateral cleft lip and palate were evaluated. Ten patients had nasoalveolar molding and gingivoperiosteoplasty performed at lip closure; 10 control patients had nasoalveolar molding but no gingivoperiosteoplasty because of late start in treatment or poor compliance. A single surgeon (C.B.C.) performed all surgical procedures. Standardized lateral cephalometric radiographs were evaluated at two time periods: T1 at pre–bone-grafting age and T2 at prepuberty age. Superimposition and cephalometric analysis were undertaken to investigate the two groups. Two cephalometric reference planes, sella-nasion and basion-nasion, were used to assess the vertical and sagittal relations of the midface (ANS-PNS). The reference landmarks were procrustes fitted. The mean location and variance of ANS and PNS landmarks were computed. All results were analyzed by permutation test.**

Results: **No significant difference in mean location or variance of ANS-PNS in both vertical and sagittal planes at both T1 and T2 periods were found between the two groups ($p > .05$).**

Conclusions: **The results suggested that midface growth in sagittal or vertical planes (up to the age of 9 to 13 years) were not affected by presurgical alveolar molding and gingivoperiosteoplasty (Millard type).**

KEY WORDS: *alveolar bone graft, gingivoperiosteoplasty, GPP, midface growth, nasoalveolar molding, unilateral cleft lip and palate*

Many studies have reported the association of primary bone grafting, including Skoog type periosteoplasty, with inhibition of subsequent maxillary growth (Rehrmann et al., 1970; Harle and Duker, 1973; Friede and Johanson, 1974, 1982; Robertson and Jolleys, 1983; Ross, 1987; Brattstrom et al., 1991). Ross (1987) found that infant bone grafting, including Skoog-type periosteoplasty, caused growth attenuation of the maxilla vertically and anteroposteriorly. It is important to differentiate between gingivoperiosteoplasty (GPP) and primary bone grafting. Gingivoperiosteoplasty or periosteoplasty is not a bone graft procedure. It is a procedure that involves raising local periosteal flaps, creating a periosteal tunnel that supports bone growth across the cleft alveolus. This is performed at the time of initial lip repair, and, if successful, it may obviate the need for secondary bone grafting (Hellquist and Skoog, 1976; Ranta and Rintala, 1989; Brusati and Mannucci, 1994). In our series, it eliminated the bone graft in 60% of patients with unilateral cleft lip and palate (UCLP; Santiago et al., 1998). In this series, success was measured by provision of sufficient bone comparable with that provided by a conventional secondary alveolar bone graft to support the eruption of the permanent canine.

There are two types of GPP. The Skoog (1967) type GPP involves wide undermining of periosteal flaps to cover widely separated cleft alveolar segments (Fig. 1). In the second type

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FIGURE 1 **The Skoog-type gingivoperiosteoplasty involving wide undermining of periosteal flaps to cover widely separated cleft alveolar segments.**

of GPP (Millard and Latham, 1990; Millard et al., 1999), the procedure is performed on alveolar segments that are in direct apposition achieved by presurgical orthopedics (with pin-retained appliances). Minimally invasive local flap design is used to cover the small defect (Fig. 2).

Wood et al. (1997) reported that GPP (Millard type; Millard and Latham, 1990), used in conjunction with presurgical alveolar molding to bring the cleft alveolus together, does not inhibit early midface growth (up to age 6 years). This is a follow-up study of this initial group at prepubertal age.

Methods

Twenty Caucasian patients with complete UCLP from the previous study were followed up until 11.5 years (mean age). Patients with known syndromes that may affect craniofacial morphology were excluded. The same surgeon and orthodontist treated all patients. Group A (control) consisted of 10 age-matched patients with UCLP (seven girls, three boys) with alveolar molding and no GPP at the time of lip closure. GPP was not performed in these patients because of poor compliance or late start. Six patients received secondary alveolar bone grafting between 9 years 5 months and 11 years 8 months, and four patients did not have a bone graft at the time of evaluation, although this was recommended for every patient. Group B consisted of 10 consecutive patients with UCLP (four girls, six boys) receiving both alveolar molding and GPP (Millard and Latham, 1990) at the time of lip closure. Five patients received secondary bone grafting between 7 years 5

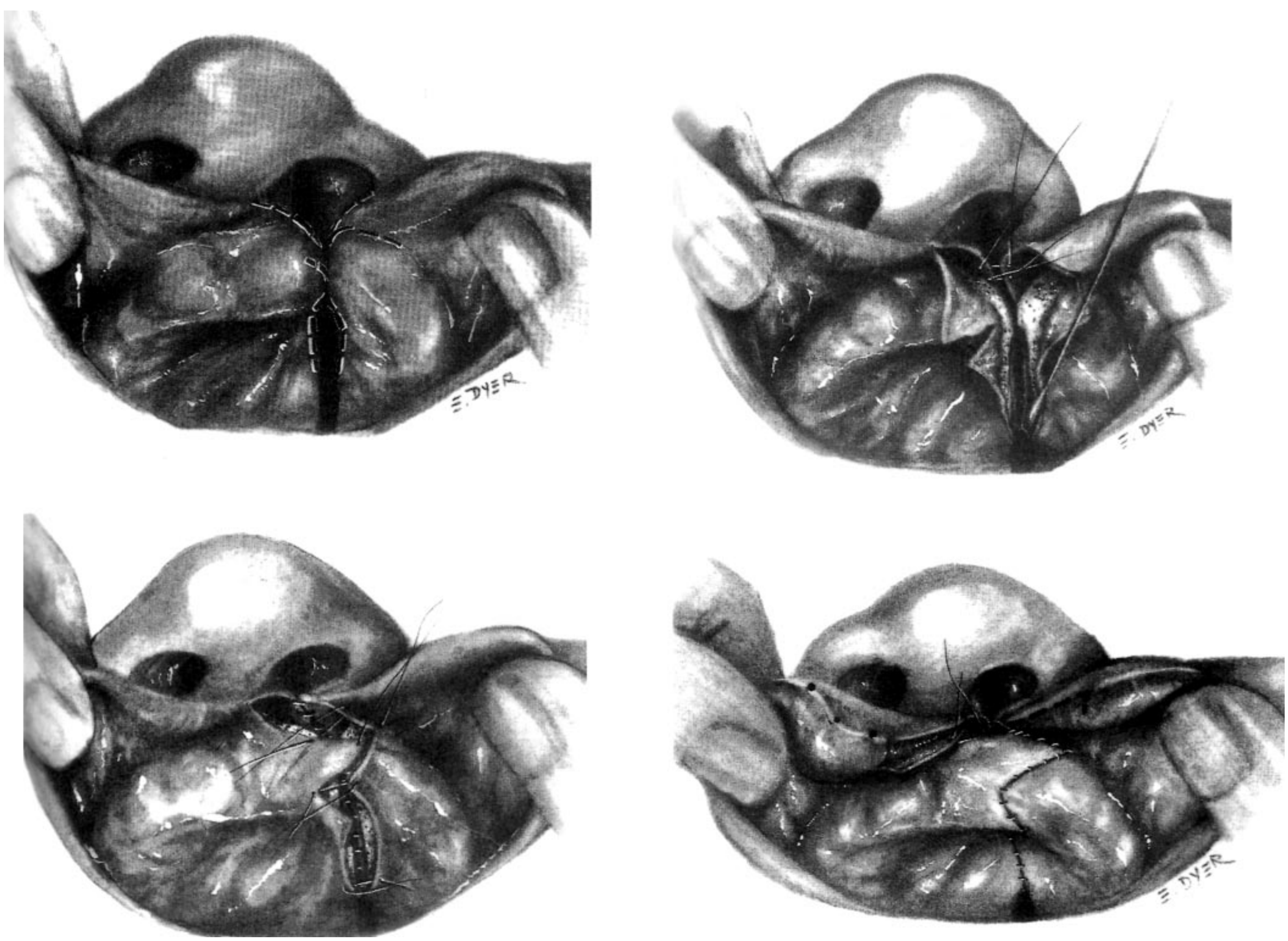


FIGURE 2 **The Millard Type gingivoperiosteoplasty involving minimal undermining of periosteal flaps to cover closely approximated cleft alveolar segments. The approximation of cleft alveolar segments is achieved by presurgical orthopedic molding.**

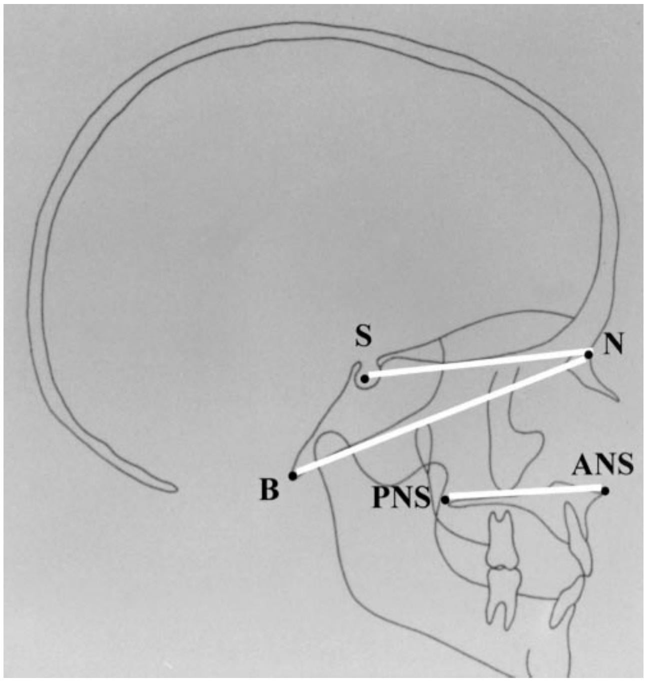


FIGURE 3 Cephalometric reference points (S, N, Ba, PNS, ANS) and planes (S-N, Ba-N, PNS-ANS).

months and 10 years 11 months. The remaining five patients had sufficient alveolar bone formation for GPP that secondary bone graft was not required for satisfactory eruption and orthodontic management of the permanent canine. The other elements of the primary repair (primary nasal reconstruction and lip repair method) were identical in both groups and thus should not influence the outcome.

The two groups were evaluated at two time periods: preschool (T1) between 4 years 5 months and 9 years 4 months (mean = 6.02 years, median = 6 years) and prepuberty (T2) between 8 years 9 months and 13 years 4 months (mean = 11.05 years, median = 10.8 years).

Lateral cephalograms were obtained from all patients at the Institute of Reconstructive Plastic Surgery at New York University Medical Center. The cephalometric reference points and the parameters measured are shown in Figure 3. The relation of hard palate (ANS-PNS) to cranial base (sella-nasion [S-N]) was evaluated. In this follow-up study, an additional reference plane (basion-nasion [Ba-N]) was also used to determine the position (vertical and sagittal) of the hard palate in both time periods because it was reputed that there is a large variability of sella turcica in clefts because of a more open saddle angle (Ross, 1987). Other radiographic maxillary anterior structures were not used (e.g., the A point, incisor edge) because these are dentoalveolar structures with high variability (e.g., abnormal pattern of tooth eruption, supernumerary, dentoalveolar effect of the tension of tissues of the repaired lip, orthodontics).

Four independent observers were involved in determining the cephalometric landmarks. All landmarks were digitized for shape coordinate analysis (Bookstein, 1982, 1983, 1984, 1991; Grayson et al., 1985, 1987; McNamara et al., 1985). This tensor biometric measures form change in a manner independent of shape coordinate reference frames and *a priori* choice of cephalometric analyses. All data were procrustes fit such that the S and N, Ba and N were perfectly aligned in all specimens. The mean location and variance of ANS and PNS landmarks were computed. All results were analyzed by permutation tests (Bookstein, 1997).

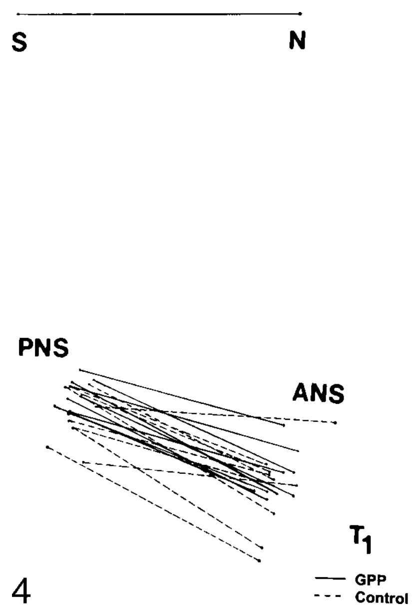
RESULTS

For S-N and Ba-N superimpositions at both T1 and T2 periods, no statistical differences in mean location and variance were found in position of ANS-PNS (vertically or sagittally) between the GPP and the controls groups ($p < .05$) (Table 1 and Figs. 4 through 7).

TABLE 1 Comparison of ANS and PNS Position Between GPP (Gingivoperioplasty) and Control Groups*

	Control		*GPP*		*Significance p*	
	X-Coordinate (SD)	*Y-Coordinate (SD)*	*X-Coordinate (SD)*	*Y-Coordinate (SD)*	*Mean Landmark Position*	*Variance*
S-N superimpositions						
T1						
ANS	85.34 (15.23)	−133.67 (11.32)	82.81 (11.12)	−130.74 (6.79)	0.75	.24
PNS	−57.53 (8.56)	−113.07 (7.34)	−61.0 (7.53)	−108.51 (4.73)	0.19	.21
T2						
ANS	82.689 (9.1778)	−150.67 (6.2320)	79.774 (12.829)	−147.55 (8.8006)	0.658	.199
PNS	−63.371 (8.2627)	−125.98 (4.3680)	−65.588 (8.8012)	−121.83 (8.3857)	0.455	.093
Ba-N superimpositions						
T1						
ANS	118.26 (13.96)	−98.03 (10.57)	116.44 (9.76)	−93.14 (6.40)	0.55	.16
PNS	−24.39 (7.67)	−69.54 (9.08)	−25.96 (6.92)	−64.09 (9.17)	0.36	.45
T2						
ANS	139.06 (9.87)	−80.08 (8.15)	138.75 (7.32)	−77.74 (6.17)	0.83	.11
PNS	−8.98 (6.00)	−80.86 (9.83)	−8.96 (6.99)	−80.67 (8.03)	1	.37

* ANS = Anterior nasal spine; PNS = posterior nasal spine; S-N = sella-nasion; T1 = time period 1 (preschool age); T2 = time period 2 (prepuberty age); Ba-N = basion-nasion.



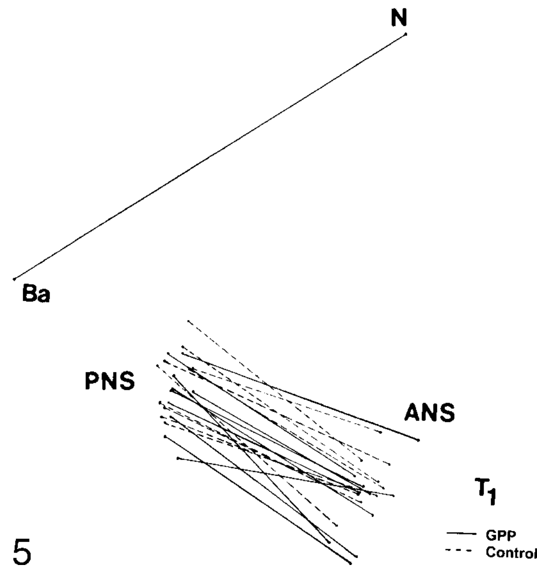


FIGURE 4 **Distribution of ANS and PNS in relation to S-N at time 1.**

FIGURE 5 **Distribution of ANS and PNS in relation to Ba-N at time 1.**

DISCUSSION

Although these patients have not yet gone through their pubertal growth spurt, it seems that the subsequent growth of the maxilla of the two groups in this study should not be different. Both groups would have undergone either GPP or secondary bone grafting by this time. The mechanism by which the bone arrived in the alveolar gap should be irrelevant. The maxillary growth rates of these two groups seem to be identical up to this prepuberty age. In this study, all patients in the control group should have been bone grafted at this time. To our detriment, we have included the sample without bone graft in the control group. Thus, the data may be biased against the GPP group. Even with this bias, statistically significant differences in growth were not observed between the two groups. These data will be reported again on completion of skeletal growth in both groups.

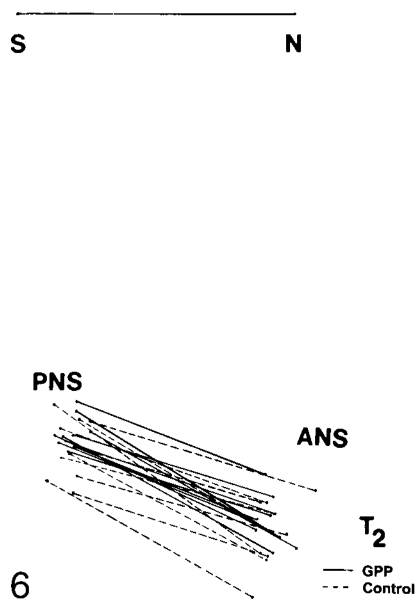
This study can be criticized for having a relatively small sample size. These were the first patients treated by this new method. We felt it important to publish a preliminary review of these patients to see whether large differences between these groups were present. As the series matures, investigation of a larger sample will look for more subtle growth differences.

Although the GPP performed in this study is different from the radical Skoog-type GPP, there are a number of studies reported on the latter. The six-part multicenter comparison study by Ross (1987) has been quoted frequently in many research articles on midface development, objecting to the use of the Skoog GPP at primary lip repair. In this study, the growth deficiency for the Uppsala group ($n = 23$) in which the Skoog-type GPP was used was found to be more in the vertical dimension (-2.1 mm below Toronto standard). Although this is statistically significant, it has very little clinical significance. The clinical significance of the reported shortfall of the horizontal dimension of the midface was even less (Ba-N-ANS at -0.7 degrees below the Toronto standard). It has been pointed out that the alveolus and the area of the maxilla in which the bone graft is placed is not a site of maxillary growth (Enlow, 1968). Any surgical procedure on the alveolus including the Millard-type GPP at infancy should then have minimal effect on maxillary growth. However, there remains the possibility that scar tissue in the alveolar ridge can potentially interfere with maxillary displacement and secondary fill-in growth at the growth sites, even if not located in that immediate area. In contrast, surgical closure of the hard palate has been implicated to have great consequence on midface growth. Andlin-Sobocki et al. (2001) reported that the procedure of primary periosteoplasty did not severely restrict the forward maxillary growth in the majority of their patients with bilateral cleft lip and palate up to the age of 16 to 20 years.

Presurgical nasoalveolar molding with Millard-type GPP has a number of advantages. In our series, 60% of children who underwent GPP did not require secondary bone grafting. This represents a reduction in morbidity and the financial cost (Pfeifer et al., 2002) associated with secondary alveolar bone grafting. Millard et al. (1999) reported 92% of these subjects do not require alveolar bone graft. The difference between these two studies (62% versus 92%) may be accounted for by a difference in definition of the standard required to declare the procedure a success.

Even with the failed GPP, secondary bone grafting is almost universally successful for the following reasons (Sato et al., 2002):

1. All the soft tissue surfaces are already closed.
2. The bone bridge, although inadequate, has occurred in near-



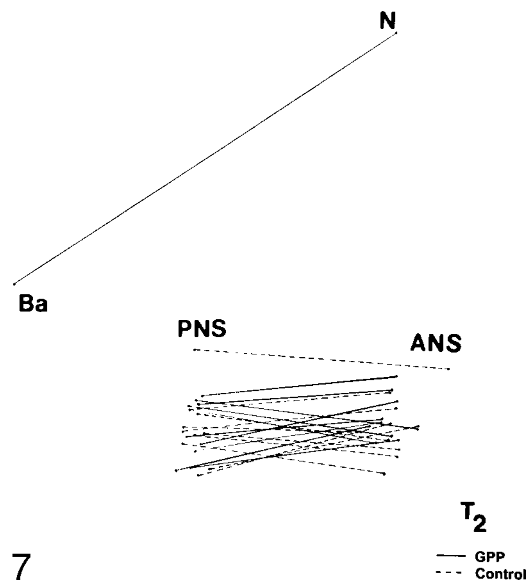


FIGURE 6 Distribution of ANS and PNS in relation to S-N at time 2.

FIGURE 7 Distribution of ANS and PNS in relation to Ba-N at time 2.

ly all patients, providing a vascularized scaffold for the bone graft.

3. The failed GPP usually fails to provide adequate bone around the piriform aperture, whereas secondary bone grafting seldom fails at this site. Secondary bone grafting tends to fail at the level of the alveolar ridge. GPP usually provides an excellent low bone level at the alveolar ridge. This complementary behavior results in a high success rate for secondary bone grafting following a failed GPP.

In conclusion, this study did not reveal a statistically significant difference in growth of the midface for a group of prepubertal patients who underwent alveolar molding and Millard-type GPP, compared with a control group who had no GPP. We plan to report the midface growth data on the GPP and control population again when both groups have completed skeletal growth.

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