Cephalometric Evaluation of Facial Growth in Operated and Non-Operated Individuals with Isolated Clefts of the Palate*

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Introduction

There has always been a keen interest in evaluating the effects of surgery on the growth of the cranio-facial complex of cleft lip and/or palate patients. Many attempts have been made which have shed some light on one aspect or another of this complex problem. From the time cephalometrics have been successfully used to evaluate craniofacial growth on both normal and cleft individuals, different investigators either totally or partially agreed, or on the other hand, disagreed completely among themselves about the effects of clefts and/or surgery on facial growth.

Literature Review

One concept generally agreed upon is that there is a different growth pattern in the operated cleft lip and palate patients when compared to normals (*6, 7, 8, 9, 10, 11, 17, 19, 20*), although a few have not observed this (*1, 16*). The controversy lies in the cause of this limitation of growth. Millard (*11*) believes that several factors are underestimated in claims of growth arrest due to early surgery, such as: (*1*) the variations in the primary tissue deficiency in the congenital cleft; (*2*) variation in growth potential of all individuals, cleft or not; and (*3*) a multitude of "surgical sins" committed on the tissue of the region.

Mazaheri (*9*), Subtelny (*19*), and Tsuji (*20*) also allude to the fact that there is an apparent difference in growth potential of the cranial base to be characteristic of all types of cleft palate deformity which might account for the variation in growth potential.

It would be very informative if one could examine cleft faces where all the variables introduced by surgery were eliminated.

Although such theoretical comparisons are not possible, the literature contains a few instances where patients with different types of unoperated clefts were examined.

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Ortiz-Monasterio et al (*14*) cephalometrically examined 19 Mexican adult patients with unoperated complete unilateral or bilateral clefts, 4 of which had lip operations at different ages. Means and ranges were calculated and compared to Down's normals. In this study they examined the facial angle, the angle of convexity and the Frankfort mandibular plane angle. They concluded that normal or greater than normal forward maxillary growth was possible in the cleft group and attributed this to a lack of the retention action of the lip. They further concluded that palatal surgery should be postponed until facial development is well advanced.

Shibasaki and Ross (*17*) examined 60 children with isolated clefts of the palate. They divided the sample into three groups according to age and according to sexes. The age ranged between 5.4 years and 15.8 years. All patients were operated. Their conclusion was that there is a progressive maxillary underdevelopment but with acceptable facial balance due to positional changes of the mandible.

Dahl (*5*) examined 57 Danish males with clefts of varying extent in the soft and hard palate; 41 of these cleft patients were repaired surgically by the same method of palatoplasty and 16 were unoperated.

In the discussion he stated:

> The aberrations in cranio-facial morphology which characterized the entire group of isolated cleft palate were present in operated as well as unoperated patients. In contrast, Mestre, DeJesus and Subtelny (*10*) found no significant aberrations in facial morphology in adult Puerto Ricans with unoperated cleft palate as compared with a non-cleft, but not further defined control group. The disagreement between the results may be due to differences in the populations studied and to differences in the method of the studies.

Purpose of the Study

The purpose of this study is to cephalometrically compare the anteroposterior craniofacial relations of a cleft palate only group to a normal group. If significant differences exist between these two groups, the cleft palate only group will be subdivided into an operated and an obturated subgroup. These two subgroups will be compared to each other in an attempt to evaluate whether such differences are primarily related to palate surgery or are part of the characteristic facial morphology of the cleft palate face.

The presence of an obturator conceivably should not prevent the maxilla from being carried downward and/or forward which is the general direction of the growth of the middle face. Moreover the mean age of obturation in our group is 6.7 years with a range from 4.9 to 10.5 years. In this age range, arch length for all clinical purposes is practically established. According to Moorrees (*12*) and Sillman (*18*) arch length is established early in life between 2 and 3 years, on the average, with little

change thereafter. Therefore, if obturated cleft individuals are examined cephalometrically at a time when most of the growth potential has been accomplished, one can assume that the findings would reflect the facial characteristics "normal" for this group.

Materials and Methods

The cleft sample consisted of 20 Caucasian females with isolated clefts of the palate. The mean age of the sample was 18.2 years with a range between 15.9 and 21.5 years.

Lateral cephalometric roentogenograms were taken, oriented to Frankfort Horizontal plane with the teeth in occlusion.

Details of the cleft sample are presented in Table 1.

The *normal sample* consisted of 32 Caucasian females randomly selected but with no apparent facial deformities. Lateral cephalometric roentogenograms were taken on these individuals using the same procedure as that of the cleft group. The mean age of the group examined was 19.4 years with a range between 18.2 and 23.4 years.

LANDMARKS AND MEASUREMENTS. The landmarks used are illustrated in Figure 1. These are; Nasion (N), Sella (S), Subspinali or Point A (A), Tip of Anterior Nasal Spine (ANS), Supramentale or Point B (B), Pogonion (Pog), Gnathion (Gn), Gonion (Go), Menton (Me), Pterygomaxillary Fissure (PTM), Anterior Nasal Spine Prime (ANS') which is a projected point from ANS on N-Me and Postpogonion (postp). Midsagittal points were used for all bilateral landmarks.

The angular measurements used included SNA, SNB, ANB, SNPog,

TABLE 1. Details of the cleft palate only sample used.

	operated	*obturated*	*total group*
	12	*8*	*N = 20*
Mean age and range at examination in years	18.5 16.7 to 21.5	17.7 15.9 to 20.3	18.2 15.9 to 21.5
Mean age and range at operation or obturation in years	3.3† 1.3 to 7.0	6.7†† 4.9 to 10.5	
Cleft type* 2	4	3	7
3	7	4	11
4	1	1	2

* Cleft type 2: Bifid uvulae and soft palate but not hard palate. Cleft Type 3: Bifid uvulae and soft palate and hard palate but not including the incisive papilla. Cleft type 4: Bifid uvulae and soft palate and hard palate including the incisive papilla.

† 85% operated between 1.8 and 2.5 years.

†† Fixed type of obturators (Fitzgibon).

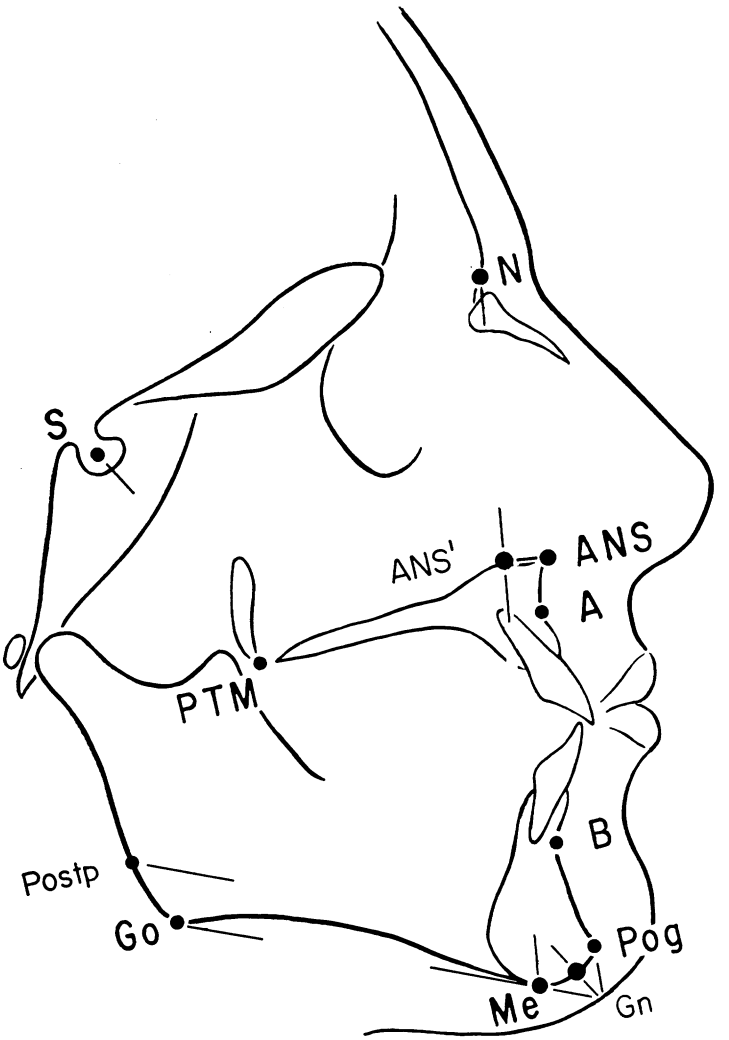

FIGURE 1. The landmarks and angular measurements used are shown.

SNANS, NAPog, SNGn, Sn to Mandibular Plane (Go-Me) and the angle formed by the long axis of the lower incisor and the mandibular plane ($\overline{1}$ to MP).

The angles relate various points on the anterior cranial base, maxilla and mandible to each other in both an anteroposterior and vertical direction.

The following linear measurements were made on each cephalogram: ANS-PTM, S-N, N-Me, N-ANS'. All linear measurements were corrected for magnification. Five different ratios of craniofacial form were computed using the above mentioned linear measurements. The ratios derived

were: N-ANS′/N-Me, ANS-PTM/S-N, S-N/N-Me, N-ANS′/S-N and ANS-PTM/Pog-Postp.

The definitions of the various landmarks and the significance of each angle are discussed at length elsewhere (*2, 15*).

Reliability of the Measurements. The reliability of the measurement technique was evaluated using the same methodology as the one described in detail in a previous article (*2*).

Statistics Used. Means and standard deviations were calculated for 1) the total cleft palate group; 2) the two cleft palate sub-groups and 3) the normal group. Student t-tests were calculated between the total cleft and normal groups as well as the two cleft subgroups (operated and obturated) and significance was pre-determined at the 0.05 and 0.01 levels of confidence.

Findings

A. Comparative data between the *normal* and the *total cleft palate only* group are presented in detail in Table 2. Only a summary of the findings will be presented in the text.

1. Comparisons of Maxillary Relations: indicates a relatively more posterior position of the maxilla in relation to the anterior cranial base in the cleft group (P = .01).

2. Comparisons of Mandibular Relations: The changes in angles SNB, NSGn, and SN-MP indicate that the mandible is also in a relatively posterior position in relation to the cranial base in the cleft group (P = .05, .05 and .01).

3. Comparisons of Maxillary-Mandibular Relations: Angles ANB and NAPog which relate the maxilla and mandible to each other and to the cranial base showed no significant differences between the cleft and normal groups.

B. Comparisons of the angular and linear measurements as well as ratios between the *operated and obturated* (*non-operated*) *cleft palate* only subgroups are presented in detail in Table 2.

No statistically significant differences (P = .05) were found between the two groups in *all* the parameters studied in this investigation.

Discussion

Many investigators have found that the maxilla in cleft patients is in a posterior position relative to the cranial base when compared to normal individuals (*3, 17*).

Several explanations were given. Among these the following were the most pertinent: 1) Surgical interference—the assumption here is that any surgical interference will result in a scar tissue formation. Such a scar might retard or affect the growth potential of the maxilla; 2) Type of surgery—some surgical procedures are more extensive than others. The

TABLE 2. Statistics on 19 measurements from lateral X-ray cephalograms between adult female normals and adult cleft palate only females. (The cleft palate group was further subdivided into operated and obturated subgroups and statistically compared.)

measurements	*normal group* $N = 32$		*CPO group* $N = 20$		*t-test*	*operated group* $N = 12$		*obturated group* $N = 8$		*t-test*
	$\bar{x}$	*S.D.*	$\bar{x}$	*S.D.*		$\bar{x}$	*S.D.*	$\bar{x}$	*S.D.*	
SNA (in °)	79.6	3.3	76.9	4.6	2.45**	77.2	5.2	76.5	3.3	0.30
SNB (in °)	77.6	3.1	75.4	6.0	1.72*	75.6	6.7	75.2	4.7	0.16
ANB (in °)	1.9	2.5	1.5	3.6	0.46	1.6	3.6	1.4	3.5	0.12
SNPo (in °)	78.9	3.2	77.4	5.4	1.24	77.8	5.6	76.9	4.8	0.34
SN ANS (in °)	85.1	3.6	81.7	4.4	3.00**	82.0	4.9	81.4	3.6	0.25
N-A-Po (in °)	1.5	6.3	−1.1	8.3	0.27	1.4	9.2	−0.7	6.8	0.52
N-S-Gn (in °)	67.8	3.3	70.5	4.9	−2.35*	69.9	5.1	71.4	4.5	0.62
MP-SN (in °)	32.6	6.0	38.9	8.0	−3.20**	36.7	8.4	42.4	6.0	1.57
$\bar{1}$-MP (in °)	93.2	8.6	83.5	9.8	3.70**	84.6	9.0	81.8	10.8	0.61
N-ANS′ (in mm)	47.1	2.2	48.0	3.9	−1.05	48.2	2.9	47.4	4.9	0.44
N-Me (in mm)	108.0	6.0	110.6	7.7	−1.35	110.3	7.2	110.5	5.4	0.15
ANS-PTM (in mm)	50.8	3.3	47.9	3.2	3.08**	48.5	3.2	46.2	2.8	1.50
S-N (in mm)	64.4	4.2	64.4	3.5	0.04	64.7	3.2	63.9	3.8	0.48
Po-Post (in mm)	75.7	4.0	74.6	5.6	0.82	75.7	5.2	71.3	4.8	1.80
$\frac{\text{N-ANS}'}{\text{N-Me}} \times 100$	43.6	2.3	43.4	3.5	0.25	43.8	2.8	42.8	4.0	0.62
$\frac{\text{ANS-PTM}}{\text{SN}} \times 100$	77.7	4.6	74.1	5.9	2.43**	75.2	6.8	72.4	3.8	1.00
$\frac{\text{SN}}{\text{N-Me}} \times 100$	60.6	3.2	58.5	4.5	1.94*	58.9	5.2	57.9	3.2	0.46
$\frac{\text{N-ANS}'}{\text{SN}} \times 100$	72.1	4.1	74.3	4.8	−1.75*	74.6	4.8	74.0	4.4	0.27
$\frac{\text{ANS-PTM}}{\text{Po-Post}} \times 100$	67.2	5.6	64.5	5.2	−1.72*	64.2	5.0	65.1	6.9	0.33

* Significance at the 0.05 level of confidence.
** Significance at the 0.01 level of confidence.

more the tissues are traumatized the more growth is affected; 3) The age at which surgery is performed is considered to be an important factor. The earlier the surgery the more growth is affected; 4) Pre- and post-operative care including orthodontic and prosthodontic treatment; 5) The mere presence of the cleft may affect the growth of the area either due to lack of the "proper parts" to support the midface in its normal growth or because of the lack of optimal stimuli which are produced by normal function; 6) The severity of the palatal cleft—both in an antero-posterior direction and in width.

Undoubtedly the above mentioned factors, individually or in combination, might affect the growth potential of the face particularly the maxilla.

It is, therefore, essential for us to know the growth potential and morphological relation of the "unoperated" cleft face before attributing the changes in the "operated" cleft face to any of the above mentioned factors.

It is both customary and convenient in attempting to answer such questions to resort to comparisons between cleft and normal populations.

In so doing we are assuming that the non-surgically treated cleft face should grow (or at least have the same growth potential) as the normal face. Is that assumption correct?

Comparisons between the total cleft group and the normal group indicated that there is a significant difference in the relative position and size of many of the different craniofacial parameters studied in this investigation. To be specific, 1) the maxilla (SNA and SNANS) and mandible (SNB, NSGn and SN-MP) were relatively posteriorly positioned in the cleft group when compared to the normal group. Yet the maxilla and mandible still showed a normal or acceptable relation to each other (ANB and NAPog) in the cleft group 2) maxillary depth (ANS-PTM) was smaller in the CPO group.

When the cleft group was divided into an operated and non-operated group and means and standard deviations were compared (Table 2), no statistically significant differences were found between the two cleft subgroups.

Correlating the above mentioned findings to those of Dahl (*5*), it is strongly suggested that a "natural" tendency for the maxilla and mandible in both the unoperated and operated cleft groups to be in a more posterior relation to the cranial base when compared to the normal group. In other words the cephalometric data presented here can be considered as the "normal" morphogenetic pattern for the CPO face.

Conclusion

Although a difference between the cephalometric morphological characteristics of the cleft palate face and the normal face does exist, such differences are not necessarily the result of palate surgery. Part of this difference is due to the morphogenetic tendency of the cleft palate face to have both the maxilla and mandible in a relatively more posterior position in relation to the cranial base even in unoperated (obturated) subjects.

When cleft palate only individuals are compared to normal individuals the latter should be used mainly as a reference or base line rather than to detect differences since the cleft and normal samples are essentially representatives of two different populations with different cranio-facial characteristics.

References

1. Bill, Jr., A. H., A. W. Moore and H. E. Coe. The Time of Choice for Repair of Cleft Palate in Relation to the Type of Surgical Repair and Its Effect on Bony Growth of the Face. *Plastic reconstr. Surg. 18,* 469–473, December, 1956.
2. Bishara, S. E. and C. R. Kremenak. Facial morphology and the Demjen V-Y Procedure: Cleft Lip and Palate. In *Some Results of Cleft Lip and Palate Surgery: The V-Y Procedure As Modified by Demjen,* Hughlett L. Morris, Editor. In preparation.
3. Bishara, S. E. Facial morphology and the Demjen V-Y Procedure: Cleft Palate Only. In *Some Results of Cleft Lip and Palate Surgery: The V-Y Procedure As Modified by Demjen,* Hughlett L. Morris, Editor. In preparation.

4. Bjork, A. FACE IN PROFILE. *Svensk. Tandl. Tidskr. Supp. 40,* Lund, Berlingska Boktryckeriet, 1947.
5. Dahl, E. Craniofacial Morphology in Congenital Clefts of the Lip and Palate. *Acta Odontologica Scandinavia, 28,* Supplementum 57, 1970.
6. Foster, T. D. A Survey of the Results of Cleft Palate Operation. *Transactions of the International Society of Plastic Surgeons.* 2nd Congress, pages 36–39, 1959.
7. Herfert, O. Fundamental Investigations into Problems Related to Cleft Palate Surgery. *Brit. J. Plast. Surg. 11,* 97–105, July 1958.
8. Jolleys, A. A Review of the Results of Operations on Cleft Palates with Reference to Maxillary Growth and Speech Functions. *Britist J. Plastic Surg. 7,* 229–241, 1954.
9. Mazaheri, R. L., R. L. Harding and J. A. Cooper. Maxillary Growth in Cleft Patients Before and After Surgery as Compared to Normal. *Transactions of the 4th International Congress of Plastic and reconstr. Surg.* pages 439–449, 1967.
10. Mestre, J., J. DeJesus and J. D. Subtelny. Unoperated Oral Clefts at Maturation. *A.O. 30,* 78–85, 1960.
11. Millard, R. D. Wide and/or Short Cleft Palate. *Plastic reconstr. Surg. 29,* 40–57, January 1962.
12. Moorrees, C. F. A. The Dentition of the Growing Child. A Longitudinal Study of Dental Development between 3 and 18 Years of Age. Chapter 6. Cambridge 1959. Harvard University Press.
13. Moss, M. L. Malformations of the Skull Base Associated with Cleft Palate Deformity. *Plastic reconstr. Surg. 17,* 226–234, March 1956.
14. Ortiz-Monasterio, F., A. Rebeil, M. Valderrame and R. Cruz. Cephalometric Measurements on Adult Patients with Non-Operated Cleft Palates. *Plastic reconstr. Surg. 24,* 53–69, 1959.
15. Salzmann, J. A., T. M. Graber and W. M. Krogman. First Roentgenographic Workshop. *A.J.O. 44,* 899–939, 1958.
16. Sgouras, N. Late Aspect of Cleft Palate Treatment. *International Surg. 45,* 619–621, June, 1966.
17. Shibasaki, Y. and R. B. Ross. Facial Growth in Children with Isolated Cleft Palate. *Cleft Palate J. 6,* 290–301, 1969.
18. Sillman, J. H. Dimensional Changes in the Dental Arches: Longitudinal Study From Birth to 25 Years. *A.J.O. 50,* 824–842, 1964.
19. Subtelny, J. D. A Review of Cleft Palate Growth Studies Reported in the Past 10 Years. *Plastic reconstr. Surg. 30,* 56–67, July, 1962.
20. Tsuji, T. Development of the Maxillary Bone and Dental Arch in Cleft Lip and/or Cleft Palate Subjects. *J. Japanese Stomatogical Society 15,* 467–488, 1966.