Effects of the Wardill-Kilner (V/W-Y) Palatoplasty on Facial Growth

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INTRODUCTION

This report is the second in a series of studies designed to assess effects of certain programs of cleft palate physical management on maxillofacial growth. The first series of reports addressed themselves to facial and dental morphology in patients having complete clefts of the lip and/or palate which were repaired by the Wardill-Kilner (V/W-Y) procedure as modified by Demjen in which the posterior (greater and lesser) palatine neurovascular bundles were routinely severed during mobilization of the mucoperiosteal flap.[1,4,5,8]

OBJECTIVES

The primary objectives of this study are:

1. To describe craniofacial skeletal morphology in three groups of individuals with clefts of the palate only (CPO) examined in Aarhus, Denmark. All patients had their palatal clefts repaired by the conventional Wardill-Kilner (V/W-Y) palatoplasty.

2. To compare facial morphology of these patients with a sample of normal (noncleft) Aarhus subjects.

3. To compare differences in facial morphology between the cleft palate only patients and the normal subjects and to draw inferences, where justified, about possible determinants of the differences.

This investigation was supported in part by P.H.S. Research Grant DE-00853, National Institute of Dental Research.

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LITERATURE REVIEW

Cleft Surgery and Facial Growth

Management of a child with a facial cleft is an ever-imposing task due to the demands of function, esthetics, and social norms. Care must be taken to properly time all rehabilitative procedures to complement growth in attainment of desired results. Unfortunately, no formula has yet been devised to fit all cases, and individual cleft types must, therefore, be examined separately and treated likewise.

The subject of facial growth in cleft palate patients has been of great concern for a number of years. Unfortunately, the many variables associated with such growth have left numerous questions unanswered, and confused many, otherwise, good studies. Subdivision of clefts into individual types has often been disregarded, usually because samples were too small or various in background. In many studies the surgical technique for palatal repair has been completely ignored.

Conflicting views are reported in the literature concerning the growth potentials and effects of surgery on patients with clefts of the palate. Law *et al.*[15] and Mestre *et al.*[17] reported on similar samples of 22 unoperated "cleft palate" Puerto Rican patients whose age ranged from 15-57 years. These were compared with 36 normal persons of comparable ages. The findings were similar in that both found that the cleft cases progressed on a normal pattern and achieved near normal skeletal dimensions. The maxilla was not found to be retruded.

Graber[11] found similar results on 37 patients with unoperated cleft palates.

The unoperated sample closely approximated the normal in anterior, posterior, and vertical development. In the operated cleft groups no significant differences were shown in maxillary growth.

In the above three studies some of the individuals in the samples had lip closure; therefore, the samples were not exclusively collected of individuals with isolated clefts of the palate.

On the other hand, children with operated clefts of the palate only were studied by Shibasaki and Ross.[20] They concluded that there was evidence of progressive maxillary underdevelopment when cleft individuals were compared with normals. However, acceptable facial balance was observed due to changes in the mandibular relation.

Comprehensive cephalometric studies of the effect of a single surgical procedure on facial growth is lacking. With the exception of a few studies[1,2,7] the exclusive effect of any surgical procedure on growth could not be found in the literature.

A comprehensive study of Danish male adults was conducted by Dahl;[7] in part of this study, 41 operated and 16 unoperated cleft palate only patients were compared with each other and with a normal sample of 102 individuals. Ages for the entire sample ranged from 18-53 years. The palatal clefts were closed on the operated group using the same procedure. Dahl found significant differences between the normal and the cleft palate groups in maxillary size and relation, in mandibular position and in total facial height. Although he found no statistically significant differences between the operated and unoperated groups, he reported differences when he superimposed their facial diagrams.

Bishara[1] examined lateral cephalograms and facial photographs of 38 individuals with isolated clefts of the palate from Bratislava, Czechoslovakia, all operated by the V-Y procedure as modified by Demjen. The surgical procedure involves the severance of the greater and lesser palatine neurovascular bundles. The cleft group was compared with 30 normal individuals from the same population. The conclusions derived from this study were that severance of the neurovascular bundles does not cause gross deficiencies in either the spatial relations or absolute dimensions of the maxillary complex which might disfigure the facial profile or alter the anteroposterior relation of the maxilla and mandible to each other. He postulated that the posterior positioning of the maxilla in the older cleft group when compared with the corresponding normal group may be due to any or all of the following factors: presence of the cleft, surgical interference (whether or not it involves the severance of the neurovascular bundle), or facial morphology.

It is clear from the literature cited on the effect of surgery on facial growth that the study of clefts (operated or unoperated) at different periods of growth is little more than a study of variables. The type of surgery coupled with the individual's growth potential and environmental factors will result in a subject which is more complex and difficult to analyze than many of the previous studies have recognized. It would seem, then, that to obtain more accurate and precise information, it should be the objective of further studies to either eliminate or account for as many of the variables as possible.

Grabb[10] summarized the state of the art by saying:

"Though there has been much written on the subject, there is no biostatistically valid study comparing the results of the various cleft palate operations as measured by the patient's speech, facial growth and hearing. At this point in history there are several accepted operative techniques for closing a cleft palate but no valid data as to whether one, two or all of these operations give the maximum

result as measured against the patient's speech, facial growth and hearing several years after operation.

There is an abundance of subjective opinion and only a moderate amount of objective data to permit one to make a judgment as to the best technique for cleft palate closure."

Cleft Surgery in Denmark

Dahl in his excellent investigation described the surgical procedure used on his sample as:[7] "After incision of the cleft margins and long lateral incisions the palatal mucoperiosteum was mobilized, and in most cases the hamuli of the pterygoid processes were fractured. Vessels and nerves traversing the greater palatine foramen were preserved. Thereafter, the nasal mucosa and the mucoperiosteal flaps were sutured. If the operation was in two stages, lateral incisions, mobilization of the palatal mucoperiosteum and fracturing of the hamuli were done in the first stage, whereupon new mobilization of the mucoperiosteal flaps and suturing of the cleft margins were done in the second stage. Two patients were operated on according to the Wardill procedure which has now become the usual type of palatoplasty in Denmark."

Later P. Fogh-Anderson utilized the Wardill procedure in closing the clefts of the secondary palate. Fogh-Anderson and Dahl[20] in their description of the surgical technique used now to operate on palatal clefts of the Danish subjects, stated: "In posterior palate repair we use the Wardill V-Y or 4-flap procedure depending on the size of the cleft, with fracture of hamulus, preservation of the artery, and lateral relaxation incisions far backwards, combined with Ecker's rotation flap from cheek mucosa to cover the lateral defect. Suture with plain catgut."

Thus, the method of palatal repair utilized now in Denmark is the conventional V/W-Y (Figs. 1 and 2) which was started by two British surgeons, Wardill[23] and Kilner[14] who independently devised a technique for palatal repair which is much more radical than the classical Veau[21] technique.

Materials and Methods

Cleft Samples Studied

This investigation was designed to study facial morphology on operated individuals with clefts of the palate only (CPO) at three different age groups: age group A between 6-8 years; age group B between 9-14 years, and age group C older than 15 years. Short of a longitudinal study on the same individuals, it was thought that this procedure would enable us to describe facial morphology of CPO individuals operated by the conventional Wardill-Kilner procedure at three different growth periods, namely: before the pubertal growth spurt, during the pubertal growth spurt, and at an age where (particularly in females) most of the growth has practically been completed.

Of a total of 93 CPO female individuals on which records were obtained, eight were excluded because they were either obturated or had a different type of surgery other than the Wardill-Kilner. Of the remaining 85, 34 were in group A with a mean age of 7.6 years, 29 were in group B with a mean age of 11.8 years, and 22 were in group C with a mean age of 18.0 years. Details of the cleft palate sample are presented in Table 1.

All cases were operated using the conventional V-Y or W-Y surgical procedure; the mean age of palatal surgery for the whole group was 2.2 years with a range between 1.8 and 7.2 years, yet 87.6% of the cases were operated between the ages of 1.8 and 2.3 years.

Normal Samples Studied

A sample of normal (noncleft) subjects from all the children of a given age were randomly selected from the

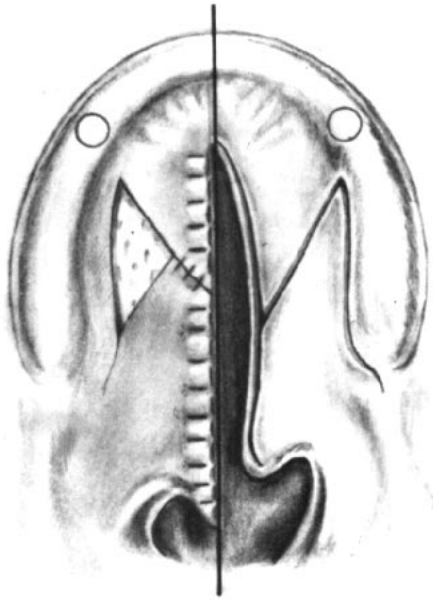

Fig. 1 Repair design for complete clefts of the hard and soft palate from the Demjen monograph. Teeth are omitted—circles indicate positions of deciduous canines. The right half of the diagram shows lines of incision for the 4-flap W-Y design while the left half shows flap positions after mobilization and suturing.

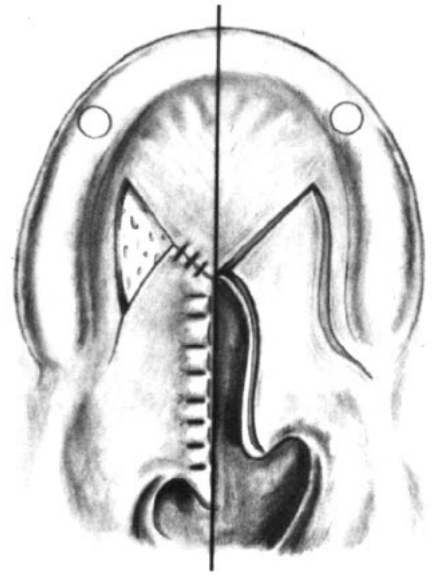

Fig. 2 Repair design for complete clefts of the soft palate from the Demjen monograph. The right half of the diagram shows lines of incision for the 3-flap V-Y design while the left half shows flap positions after mobilization and suturing.

files of the Aarhus school system orthodontic department with the cooperation of Dr. H. Møller. X-rays were taken within one month of the child's birthdate. Three age groups were selected corresponding to the three cleft groups. Group A included 20 individuals with a mean age of 7.1 years. Group B included 19 individuals with a mean age of 13.5 years and Group C comprised 27 individuals with a mean age of 16.5 years.

Cephalometric Techniques and Procedures

Lateral x-ray cephalograms were taken with the head oriented to Frank-

TABLE I

Descriptive Data about the Aarhus Cleft Palate Only (CPO) Patients

		Group A	*Group B*	*Group C*	*Total*
Sample Size		34	29	22	85
Mean age and range (years)		7.6	11.8	18.0	
		6-2 - 8.7	9.1 - 14.1	15.5 - 23.1	
Mean age at surgery (years)		2.2	2.4	2.1	2.2
Cleft type*	1	0	3	0	3
	2	12	4	5	21
	3	15	19	14	48
	4	7	3	3	13

*Cleft type 1 Bifid uvula and/or partial palate cleft.
2 Complete soft palate cleft not involving hard palate.
3 Soft and hard palate cleft but not involving the incisive papilla.
4 Complete soft and hard palate cleft.

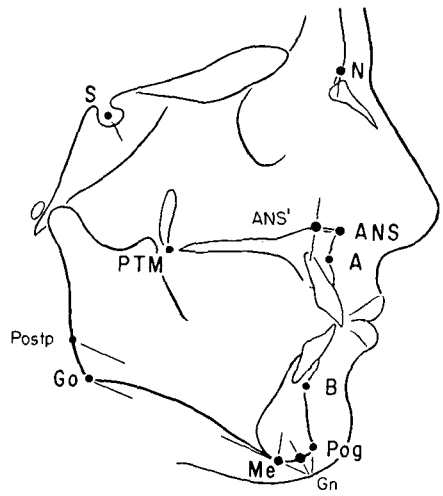

Fig. 3 Landmarks used in the study.

fort horizontal plane and the teeth in occlusion.

The following points were identified on each lateral x-ray film for use as measurement landmarks (Fig. 3): Sella (S), Nasion (N), Subspinale (A), Supramentale (B), Pogonion (Pog), Gnathion (Gn), Menton (Me), Gonion (Go), Pterygomaxillary fissure (PTM), Anterior nasal spine (ANS) and Postpogonion (Postp). For all bilateral landmarks the midpoint between projections was used where appropriate.

The following angles were measured on each cephalogram: SNA, SNANS, both of which relate points on the maxilla (A and ANS) to line SN (representing the anterior cranial base); angles SNB, SNPog and NSGn, all of which relate points on the mandible (B, Pog, and Gn) to anterior cranial base line SN; and angles NAPog and ANB both of which are descriptive of the skeletal profile since they reflect relationships between profile points on both jaws (A, B and Pog) to the anterior terminus of the cranial base line SN. Also measured was the angle between SN and the long axis of the upper central incisor.

Two additional angles which involve the use of the mandibular plane designated as MP (Go-Me) were measured. Angle MP-SN and the magnitude of its opening is an index of the position of the lower border of the mandible related to the anterior cranial base, and the $\bar{1}$-MP angle which describes the relationship between the long axis of the most labially positioned mandibular incisor and the mandibular plane.

The following linear measurements were made on each cephalogram, the distance ANS-PTM was taken as a measurement of maxillary depth; the distance S-N, depth of the anterior cranial base; the distance N-Me was used for total face height; the distance N-ANS' was taken as a measurement of upper face height (the ANS' landmark was used instead of ANS in the latter measurement to eliminate the influence of variations in the anteroposterior position of ANS on measurements of upper face height), and finally, the distance Pog-Postp was regarded as a measurement of mandibular depth.

Each linear measurement was corrected for magnification and for geometric unsharpness or blurring.[4] These derivations were performed to facilitate valid comparisons between linear dimensions, and to aid in future comparisons of statistics from cephalograms made using different x-ray apparatus.

Five different ratios or indices of craniofacial form were computed using various of the above linear measurements. Such indices are useful in the identification of possible intergroup differences in shape or form, as assumed from differences in absolute size. They are, in addition, unaffected by systematic variation in data resulting from films being made on different x-ray apparatus. The ratios derived were: 1) N-ANS'/N-Me, or upper face height/total face height; 2)

TABLE II

Paired t-test Scores for Interexaminer Reliability and Measurement Technique for 10 Angular and 5 Linear Measurements

Dimension	*Paired t-test*
SNA	0.04
SNB	0.13
ANB	0.001
SNPog	0.05
SNANS	0.03
NAPog	0.04
NSGn	0.10
MP:SN	0.02
$\overline{1}$:MP	0.02
$\underline{1}$:SN	0.03
$\overline{N}$:ANS'	0.02
N:Me	0.00
ANS:PTM	0.13
S:N	0.01
Pog:Postp	0.07

ANS-PTM/S-N, maxillary depth/anterior cranial base depth; 3) N-ANS'/S-N, upper face height/anterior cranial base depth; 4) S-N/N-Me, anterior cranial base depth/total face height; and 5) ANS-PTM/Pog-Postp, maxillary depth/mandibular depth.

Measurement Technique and Procedure

The technique for obtaining data on the ten angular and five linear dimensions was based on methods previously reported[4,6] which included a) the independent acquisition of double sets of measurements by each of the two investigators; b) the elimination by each investigator of excessive measurement disagreements with self; c) the averaging by each investigator of his own double determination data; and d) the averaging of the individual measurements of the two investigators to yield the final set of data for analysis.

Table II represents the results of paired "t"-test comparisons of inter-investigator reliability. The conclusion was that, for the purposes of this study, the obtained levels of measurement technique reliability were more than adequate.

Analysis of Data

Means and standard deviations were obtained and "t"-tests performed to test the hypothesis of no differences between the CPO and normal population means for each of the twenty parameters studied.

Significance was predetermined at the .05 and .01 levels of confidence.

Findings

Details of the findings are presented in Table III. Only a summary of the findings will be presented and is divided into: a) anteroposterior position as well as depth, and height of the maxillary complex; b) mandibular position and depth; and c) maxillary mandibular relationship.

Maxillary Complex

In age group A, the maxillary complex shows a significant posterior position in relation to the cranial base (SNA, SNANS) in the cleft group when compared with the corresponding normal group. Yet in absolute (ANS-PTM, N-ANS') and relative anteroposterior (ANS-PTM/S-N) and vertical (N-ANS'/S-N, N-ANS'/N-Me) dimensions there were no significant differences between the two groups.

The comparative findings in age group B indicate that the maxilla is in a more posterior position relative to the cranial base in the cleft group. Also, maxillary depth is shorter in the cleft group.

In age group C, the maxillary position is not significantly different in the normal and cleft groups while maxillary depth is significantly shorter in the cleft group.

Mandible

In age group A, the mandible in the cleft group shows a significantly more posterior relation to the cranial base than in the normal group (SNB,

TABLE III

t-test Scores for Comparisons between Normals and CPO Individuals on 10 Angular Measurements, 5 Linear Measurements and 5 Ratios Derived from these Linear Measurements

Comparisons were done at different ages as well as for the total group.

Measurement		*Age Group A Normals (N=20) vs CPO (N=34)*	*Age Group B Normals (N=19) vs CPO (N=29)*	*Age Group C Normals (N=27) vs CPO (N=22)*	*All Age Groups Normals (N=66) vs CPO (N=85)*
SNA	(in °)	5.032*	3.688**	0.316	5.942**
SNB	(in °)	2.541*	1.676	0.668	2.250*
ANB	(in °)	3.086**	2.900**	3.048**	4.694**
SNPog	(in °)	2.057	1.897	1.566	1.666
SNANS	(in °)	4.552**	3.110**	0.815	5.086**
NA Pog	(in °)	3.303**	2.751**	4.486**	4.074**
NS Gn	(in °)	2.416*	1.748	0.317	2.352*
MP:SN	(in °)	3.473**	2.009*	0.602	3.709**
$\bar{1}$:MP	(in °)	6.694**	4.189**	5.361**	9.201**
$\underline{1}$:SN	(in °)	2.800**	2.017*	0.544	3.155**
N-ANS	(in mm)	0.195	1.525	0.418	1.485
N-Me	(in mm)	1.476	1.364	0.588	0.930
ANS-PTM	(in mm)	1.993	2.237*	2.911**	4.372**
S-N	(in mm)	0.266	2.598*	1.400	3.042**
Pog-Postp	(in mm)	0.039	2.870**	1.099	1.950
$\frac{\text{N-ANS'}}{\text{N-Me}}$	x 100	1.177	0.420	0.170	1.192
$\frac{\text{ANS-PTM}}{\text{S-N}}$	x 100	1.981	0.707	1.903	2.589*
$\frac{\text{S-N}}{\text{N-Me}}$	x 100	1.559	0.556	1.352	1.547
$\frac{\text{N-ANS'}}{\text{S-N}}$	x 100	0.414	0.275	1.427	0.611
$\frac{\text{ANS-PTM}}{\text{Pog-Postp}}$	x 100	1.451	0.234	4.057**	2.158*

*Significant at the .05 level of confidence
**Significant at the .01 level of confidence

SNPog, NSGn). The mandibular plane (SN:MP) was steeper and the incisors ($\bar{1}$:MP) were more lingually inclined in the cleft group.

In age group B, the positions of Points B, Pog, and Gn in the cleft group were not significantly different from the normal group, yet the mandibular plane was steeper and the lower incisors were more upright in the cleft group. Mandibular depth (Pog-Postp) was shorter in the cleft group.

In age group C, all measurements of normal and cleft groups were not significantly different in both position and dimension with the exception of angle $\bar{1}$:MP. The lower incisors were decidedly more lingually inclined in the cleft group.

Maxillary-Mandibular Relation

In the three age groups (A, B and C), the skeletal facial profile (ANB, NAPog) of the cleft group tends to be significantly less convex than that of the corresponding normal group.

Discussion

In the discussion of the findings two

points need to be remembered:

1. This investigation limits itself mostly to findings derived from the cephalograms, other dental findings; for example, molar classification, crossbites, arch collapse, fistulas, etc. will not be discussed.

2. This is a cross-sectional study at three age intervals.

The findings in this investigation indicate that there are certain significant differences in craniofacial relations between the cleft and normal samples in each of the three age group comparisons. How can such differences occur?

In a previous investigation we compared adult females with isolated clefts of the palate with a matched normal sample; the cleft group was subsequently divided into operated and obturated subgroups which were also compared.[2] From the findings we concluded that although differences between the cleft palate face and the normal face do exist, such differences are not necessarily the result of palatoplasty alone, but might also be due to a morphogenetic characteristic of the cleft palate face. In other words, both the maxilla and mandible tend to be in a relatively more posterior position in relation to the cranial base even in unoperated (obturated) subjects. We further suggested that when cleft palate only individuals are compared with normal individuals the latter should be used mainly as a reference baseline, since the cleft and normal samples are essentially representative of two different populations with different craniofacial characteristics and relations.

Therefore, in addition to the normal cleft cephalometric comparisons, we will attempt in this investigation to look at the cleft group in a different way.

Standardized frontal and profile facial photographs were used to evaluate the cumulative effect of both surgery and growth on the face. Photographs were obtained on all individuals in the CPO sample, and were divided into three groups (A, B and C) corresponding to the three age groups which were discussed before. Figures 4, 5 and 6 present what a panel of five orthodontists considered as the most balanced (esthetically pleasing) or most unbalanced faces in the three age groups as judged from the photographs.

By looking at the choices of these expert judges one can attest to the fact that no "apparent" maxillary retrusion can be observed on most of these patients. Even in Figure 6-6 the relative retrusion of both the upper and lower lip is accentuated by the exceptionally pronounced soft tissue chin and nose.

Therefore, from evaluations of both the cephalometric findings and facial photographs of the 85 CPO individuals examined in this investigation, one can state that on the average the skeletal and profile relations of the maxilla to the mandible can be considered acceptable. The question yet to be answered is: How can we then explain the differences between the cleft and the normal groups?

Isaacson[12] investigated three groups of noncleft individuals selected on the basis of measurements of the SN:MP angle (larger than 38°, smaller than 26°, and around 32°). From his tables one can recognize that with steeper mandibular planes (large SN:MP angles) there is a tendency for angles SNA and SNB to be smaller, e.g., the average SNA and SNB angles in the group with steep mandibular planes are 78.9° and 75.0°, respectively, while in the group with flat mandibular planes the corresponding angles

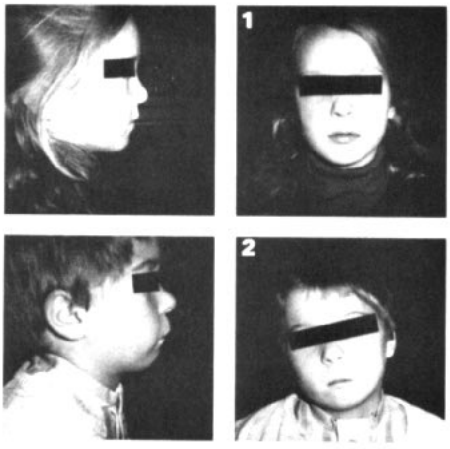

Fig. 4 (1) Representative of the most acceptable face chosen from Group A of the Aarhus sample. (2) Representative of the least acceptable face chosen from Group A of the Aarhus sample.

Fig. 5 (3) Representative of the most acceptable face chosen from Group B of the Aarhus sample. (4) Representative of the least acceptable face chosen from Group B of the Aarhus sample.

measured on the average 83.8° and 80.4°.

In the present study (in age groups A and B) and in three previous studies[1,2,8], the CPO subjects were found to have a definite tendency for a steep mandibular plane.

Another question now presents itself: What is the relation between the steepness of the mandibular plane and the size of the SNA and SNB angles?

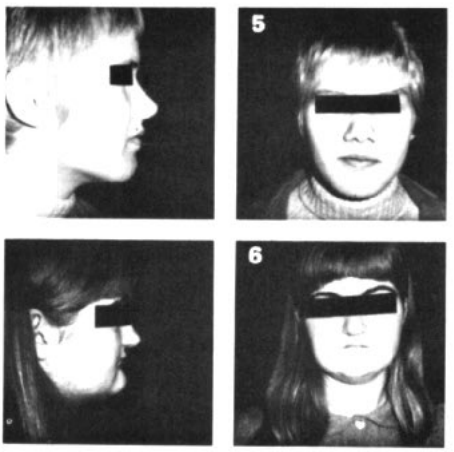

Fig. 6 (5) Representative of the most acceptable face chosen from Group C of the Aarhus sample. (6) Representative of the least acceptable face chosen from Group C of the Aarhus sample.

Such a relation (or variation) in the cephalometric readings of the cleft and normal individuals could be a result of a difference in the cranial base relation (flexion) and/or dimensions, or a posterior positioning of both the maxilla and mandible relative to the cranial base which is either morphogenetic or occurs as a result of the presence of the cleft.

Conclusions

From this study as well as from other studies it seems reasonable to conclude that modern palatal surgery and specifically the Wardill-Kilner palatoplasty performed on CPO individuals did not appreciably affect the normal anteroposterior and vertical skeletal and profile facial relations in the sample examined.

More research should be done to determine what causes the differences between the craniofacial morphology of CPO and normal individuals. Also, the effect of different palatoplasties on the dentition and on speech of those

individuals with isolated clefts of the palate needs to be investigated.

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ACKNOWLEDGMENTS

The author would like to express his gratitude to Drs. D. VanDemark, H. Eremark, A. Block and H. Møller whose help and cooperation made this study possible.

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