Orthodontic and Bone Grafting Procedures in a Cleft Lip and Palate Series: An Interim Cephalometric Evaluation

SHELDON W. ROSENSTEIN, D.D.S., M.S.D.

It has now been four years since we last reported on the progress of our cleft lip and palate series.[1] At that time some of the oldest in our sample were approximately four to five years of age and we were just beginning to assess them cephalometrically. Now, it would seem prudent to once again observe these children as they are growing to see if we can further explore some of the questions posed previously.

REVIEW OF LITERATURE

The concept of doing "something" early in the orthodontic rehabilitation of these children has matured and changed over the years. Where, originally, there was considerable emotion and subjective opinion concerning the efficacy of early procedures, in more recent years, definitive statements as to the need or lack of need for this approach have become more documented.

In 1973 Koberg presented what was then a most thorough review of the literature relative to the one aspect of bone grafting.[2] The pros and cons were discussed at length and the open questions left unanswered at the end of his review carried one general theme (from the surgeon's standpoint); we must have more and better long-term studies evaluating the results of early osteoplasty, especially since we are still confronted with so many differences of opinion.

Read before the Midwestern Component of the Angle Society, January, 1975.

From the Departments of Plastic and Reconstructive Surgery and Dentistry, Children's Memorial Hospital, Chicago, Illinois.

Johanson[3] who at first utilized dentofacial orthopedics with and without bone grafting procedures has, in essence, returned to arch and dental alignment via the more conventional approaches, i.e., orthodontics in the mixed and permanent dentition. Bergland,[4] who had never availed himself of this approach, has continued to publish and show excellent clinical results.

In the face of this, a further review of the literature in 1974 continues to show a positive interest on the part of many, at least in the early dentofacial orthopedic aspects, if not in bone grafting. Graf-Pinthus and Bettex[5] are quite pleased with their long term results. Hotz[6] and her group in Zurich are also pleased with their results. Both Troutman[7] and O'Donnell[8] et al. in separate, well-documented, but admittedly short term studies, speak favorably of presurgical orthopedics. In the area of bone grafting an interesting article was published by Boyne[9] wherein autogenous particulate cancellous bone and marrow grafts were studied in bilateral, surgically-produced palatal and alveolar clefts in young rhesus monkeys. Fluorescence and routine light microscopy indicated complete healthy osseous union and regeneration of the cleft areas and, additionally, no disturbance to the tooth buds by the grafting procedure. Further clinical assessment of a small group of our Veau Class III and Class IV cases was published late in 1974.[10]

However, it would appear that the general consensus at present is that the need for early dentofacial orthopedic procedures, of whatever nature

they may be, is at best somewhat dubious and, practically speaking, superfluous or unnecessary. Our thoughts have been stated previously along with our methodology and sequence of procedures.[11] In essence, it consists of:

1. The placement of an intraoral prosthesis prior to or at the time of lip closure.
2. Guided molding of the arch segments after lip closure.
3. Stabilization of the segments by means of autogenous bone graft.
4. Retention of the prosthesis until palatal closure.

We are generally finished with our early infant procedures by 15 to 18 months of age. This is *our* approach to the problem in *our* institution. We make no claim other than that for our sample, in our hospital, utilizing our team and our approach.

As we view the situation today, the burden of proof continues to lie with those of us still doing early infant procedures. Today, no less so than previously, we still look for long-term clinical assessment to document positively or negatively that which we have done. The attrition rate is phenomenal both among professional groups and patients when observed in this manner. We have to observe these children longitudinally and always be aware of two questions: do we do any harm and, if that obstacle is overcome, do we do any good? Attempting to answer both questions at the same time, and before growth has terminated and the permanent dentition is in place would seem to require some degree of finesse.

Our report in 1971 was an initial attempt to view cephalometrically some of the older children (approximately five years of age). At that time we came to the conclusion that nothing adverse had happened from a standpoint of growth anteroposteriorly, and overall they looked rather acceptable from an orthodontic standpoint. Then, one of our graduate students additionally studied a series of 10 noncleft lip and palate children, 10 Class III clefts with no bone grafts, and 10 Class III cleft cases from our sample with bone grafts.[12] Each child was five years of age, plus or minus three months. After extensive cephalometric measurement (after the method of Coben) and computer analysis, it was determined that there was no significant size difference in the maxillary area between any of the samples.

We would now like to give a continuing report on the oldest 16 cases ranging from six to nine years in age. It will concern itself with both a cephalometric and intraoral evaluation.

Of the total of 16 in the sample, 11 are male and 5 female; 15 are Caucasian and 1 Negro. Fifteen are complete unilateral clefts of the lip, ridge and palate (Veau III) and one is a bilateral complete (Veau IV). Comment should be made on the surgical procedures associated with one case in the sample; this patient had the palate closure and the bone graft done concurrently; we have since abandoned that procedure.

In assessing the status of the occlusion we are well aware of the broad range of age included, as well as the fractionalization of the sample which could be done in reference to race, sex and cleft classification. Dickson[13] et al., in their recent report on the status of research in cleft palate anatomy and physiology, emphasized the variables that can be attributed to both race and sex in maxillary growth development. In fact, if one wished to remove the five females from the sample, the one Negro, the Veau Cleft IV and those that did not follow the usual surgical sequence, one would be able to state this to be a study of 9 Caucasian males with Veau III clefts of the lip and palate. Since our sample is still so rela-

tively small, and we are at this time primarily concerned with general overall trends, we have not seen fit to fractionalize in such a manner.

Of the sixteen in the sample, nine have undergone first phase orthodontic treatment and seven have had no orthodontic intervention. First phase orthodontic treatment is here defined as any mechanical orthodontic appliance (fixed or removable) placed in the mixed dentition. Of the nine children treated only one had a crossbite (canine). Four of the seven others had crossbites (one canine, two anterior, canine and buccal segment, and one canine and buccal segment).

Admittedly, these figures are woefully small and, thus, we will make no attempt to compare them with other studies depicting crossbite incidence. They are included at this time so that one might become aware of the very realistic possibility of establishing a crossbite free situation in our sample at a relatively early age.

Cephalometric Evaluation

In assessing the lateral cephalometric films we are aware that sophisticated millimetric and angular evaluation could be undertaken. That is, specifically, not our intent at this time. This is an interim report and, as such, we are not prepared to analyze the roentgenograms in depth. These children have sufficient growth yet to be realized to warrant a more detailed cephalometric analysis at a time when the permanent dentition is in place, and they are chronologically adjacent to the circumpubertal growth spurt.

At this time we are primarily concerned with:

1. The anteroposterior relationship of the maxilla and mandible to each other and to the cranial base (SNA-SNB-ANB diff.)
2. The relative hard tissue convexity of the face (NAP).
3. The steepness of the mandibular plane angle (NS-MP).
4. Vertical Face Height, anteriorly (Upper face, N-ANS/Lower face, ANS-M).
5. Molar classification (Angle).

Through the generosity of Dr. B. H. Broadbent, Jr.[14] and the Bolton-Brush Growth Study Center of Case-Western Reserve University, we have obtained the yearly standards (combined male/female) of the original Broadbent-Bolton Study from one through eighteen years of age. With these standards we now have the facility by which we might compare our sample with a truly optimum norm. It should be emphasized that Dr. Broadbent would not like to consider these measurements as absolute "normals." He has stated and I quote, "We prefer to consider them as 'yardsticks' or morphological measurement patterns." Notwithstanding, we are able to make comparison and some value judgments and attempt to discern trends. In addition, this has afforded us the opportunity to compare maxillae and mandibles directly for definitive size comparisons.* The following millimetric measurements were then taken: maxilla, ANS-PNS, mandible-mid Go-Menton.

Table I shows the "cephalometric standards" obtained from the Bolton sample. Table II contains the cephalometric measurements obtained from the cleft lip and palate sample. Table III shows a composite cephalometric

*Since angular measurements require no conversion factor in comparing cephalometric films taken from different cephalometers, we were indeed aware of the fact that any millimetric comparisons necessitated a reduction of the variable of enlargement. As such, since all standards were radiographed with the cassette as close to the head as possible, we radiographed with the cassette in similar manner. Thus, with the midsagittal plane/cassette distances similar in both studies, potential variable of enlargement was eliminated.

TABLE I

Cephalometric Evaluation-Bolton Standards

Age	SNA°	SNB°	Diff°	NAP°	NS-MP°	MAX LENGTH ANS-PNS (mm)	MAND LENGTH Go-Me (mm)	ANT FACE HEIGHT (mm) N-ANS	ANS-Me
6	82.0	78.0	—4.0	7.5	35.5	47.0	59.5	41.5 (43.2%)	54.5 (56.8%)
7	82.0	78.0	—4.0	8.0	34.0	48.5	60.5	43.0 (43.9%)	55.0 (56.1%)
8	82.0	78.0	—4.0	5.5	35.5	50.5	64.0	44.5 (44%)	56.5 (56%)
9	81.0	78.0	—3.0	5.5	35.0	50.5	66.5	46.0 (44.5%)	57.5 (55.5%)

(All measurements to the nearest .5 mm and degree)

TABLE II

Cephalometric Evaluation-Cleft Lip and Palate Sample

Age	SNA°	SNB°	Diff°	NAP°	NS-MP°	MAX LENGTH ANS-PNS (mm)	MAND LENGTH Go-Me (mm)	ANT FACE HEIGHT (mm) N-ANS	ANS-Me
6	82.0	75.5	—6.5	12.0	35.5	49.5	60.0	40.5 (40.7%)	58.5 (59.3%)
7	74.5	72.5	—2.0	3.0	39.5	50.0	70.0	40.0 (37.8%)	66.0 (62.2%)
8	75.0	71.0	—4.0	6.0	42.0	49.0	63.5	49.5 (44.2%)	63.0 (55.8%)
9	75.0	71.5	—3.5	7.0	41.5	47.5	61.5	45.5 (40.6%)	64.5 (59.4%)

(All measurements to the nearest .5 mm and degree)

TABLE III

Composite Cephalometric Evaluation

Age	SNA°	SNB°	Diff°	NAP°	NS-MP°	MAX LENGTH ANS-PNS (mm)	MAND LENGTH Go-Me (mm)	ANT FACE HEIGHT (mm) N-ANS	ANS-Me
6-7-8 (Stand)	82.0	78.0	—4.0	7.0	35.0	49.0	62.5	43.0 (43.7%)	55.0 (56.3%)
6-7-8 (Cleft) (N=9)	77.0	73.0	—4.0	7.0	38.5	49.5	64.0	43.5 (41.0%)	62.5 (59.0%)
9 (Stand)	81.0	78.0	—3.0	5.5	35.0	50.5	65.5	46.0 (44.5%)	57.5 (55.5%)
9 (Cleft) (N=7)	75.0	71.5	—3.5	7.0	41.5	47.5	61.5	45.5 (40.6%)	64.5 (59.4%)

(All measurements to the nearest .5 mm and degree)

evaluation of the 6, 7 and 8 year cleft lip and palate sample compared with the same age range of the Bolton sample along with a similar comparison of the 9 year-old samples.

Discussion

In any discussion of these cephalometric measurements, along with crossbite observation, one must be guided by the fact that we are looking at an extremely small sample, so small as to exclude the practical application of formal statistical interpretation. To apply a statistical level of confidence, even at the 5% level, to a sample whose number totals two is highly impractical and unwarranted.

What, then, might we do with some of the figures obtained? For one thing we might look for the more obvious trends and make note of them. Secondly, we might look to legitimately broaden the sample size. As such, when the Broadbent standards are observed through the 6, 7 and 8 year age range (Table I) one can see that four of the angular measurements remained relatively constant (SNA, SNB, diff, and NS-MP) along with the percentage relationships of upper anterior face height to lower anterior face height (N-ANS%-ANS-Me%). Both maxillary length (ANS-PNS) and mandibular length (Go-Me) increased and NAP decreased during this period as one would expect. We can, then, "pool" these numbers overall and obtain a composite standard for the 6 through 8 year range. This will raise the sample size of the cleft lip and palate group to nine and allow for more discernible cross-sectional trend observation (Table III).

Initially, one would be moved to say that in the 6 through 8 year range, when compared with the standard, the ANB difference, at least in this small sample, has not been adversely affected,

nor has the NAP reading, which can be said to be an assessment of hard tissue facial convexity. The mandibular plane angle (NS-MP) is slightly greater than the standard. The definitive maxillary length (ANS-PNS) shows no attenuation, although mandibular length (Go-Me) is larger. The vertical assessment of anterior face height (N-ANS: ANS-Me) shows no appreciable percentage deviation, although the contribution of the maxilla to upper face height in the cleft palate sample is smaller by almost 3%.

In interpreting these figures we were impressed first by the lack of anteroposterior attenuation both angularly (A-B diff) and millimetrically (ANS-PNS) of the maxilla in the cleft palate sample. The vertical assessment interpretation is interesting in that, though it appears definitively that the maxilla contributes as much as the standard, the percent contribution is less. It is not unreasonable to account for this by the fact that, since the mandibular plane angle is steeper in the cleft palate sample, the anterior reference point on the mandible would thus position itself more vertically, which appears to be the case.

In the 9 year range the sample which, though smaller in number ($N = 7$), is not a composite and the ANB difference again would appear not to have been adversely affected. NAP and NS-MP are both larger than the standard. Definitive maxillary length (ANS-PNS) and mandibular length (Go-Me) are both smaller than the standard, the latter appreciably so. The vertical assessment of the anterior face height shows the maxilla contributing appreciably less percentagewise in the cleft sample when compared with the standard.

In interpreting the figures for the 9 year range we can take note that, though the ANB reading shows no change from the standard, the definitive measurement does (ANS-PNS). However, although this reading is smaller, it is also correspondingly smaller for the mandible (Go-Me). Here, too, the maxilla would appear to contribute definitively about as much to anterior face height as in the standard, but from a percentage standpoint, considerably less. Why? Again this may be explained by the fact that the mandibular plane angle (NS-MP) in the cleft palate sample is considerably larger than the standard, and thus would position the anterior aspect of the mandible more vertically.

Interesting, too, in any discussion of this type is that variables, over which we have little or no control, come into play. Factors to reckon with are, of course, surgeons, type of surgery, timing of surgery, sequence of surgery, and resultant surgical influence on overlying soft tissue. Then, too, in a study of any cleft lip and palate sample regardless of the introduction of osteoplasty in rehabilitation, there is always the distinct possibility of tissue hypoplasia. It has been stated previously that the maxilla in the cleft lip and palate case starts out at a disadvantage and continuously struggles to stay abreast. As orthodontists we should also be aware of the random tendency to inheritable skeletal dysplasia in the form of malocclusion. These children have the cleft insult superimposed. In our sample of sixteen, six presented with end-to-end molar relationship, nine with Class I molar relationship, and one with Class II molar relationship.

Case Reports

Two cases will now be reported, one illustrative of no orthodontic intervention to date, and the other of a limited first phase orthodontic approach.

The case having had no orthodontic treatment to date is now over 9 years of age and has been observed the longest period of time using this sequence

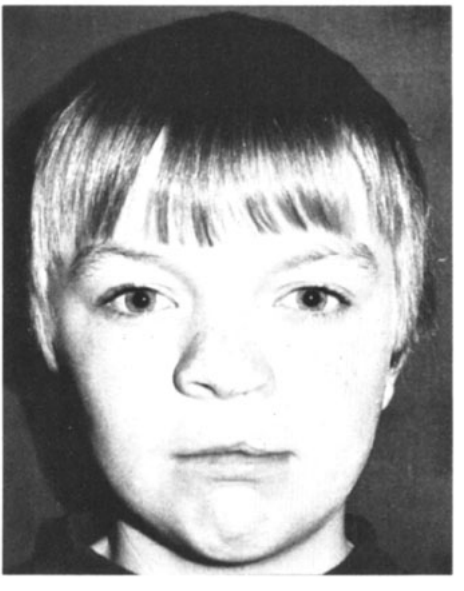

Fig. 1 Above, at birth, before lip closure. Below, at nine years of age.

Fig. 2a Maxillary models of case. Upper left, birth defect was 20 mm across bony void. Upper right, beginning modeling effect after placement of maxillary appliance. Lower center, arch form at the end of first year of life.

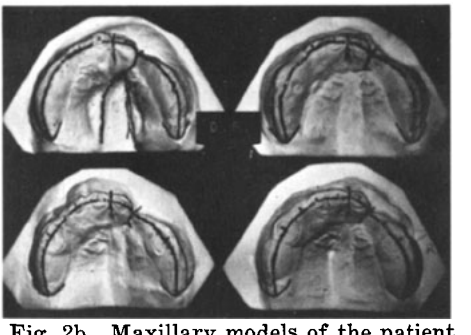

Fig. 2b Maxillary models of the patient taken during the second year of life with the teeth cut away to emphasize general arch form. Upper left, at the time of bone graft. Upper right, at the time of palate closure. Lower left and right, arch form subsequent to palatal closure.

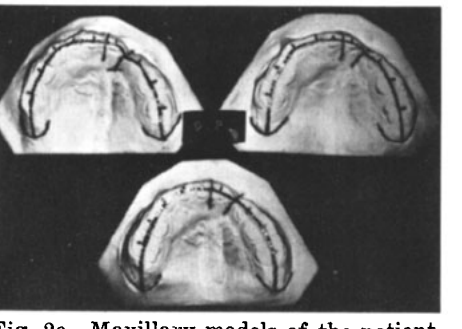

Fig. 2c Maxillary models of the patient taken during the third year of life with teeth cut away again to emphasize the maintenance of good arch form.

est period of time using this sequence of procedures (Figs. 1, 2, 3). The maxillary-mandibular anteroposterior relationship appears to be very acceptable as shown in Figure 4.

The second case is at present also nine years of age (Fig. 5). Because the deciduous canine on the side of cleft was in minimal crossbite and the maxillary central incisors were in need of alignment (Figs. 6, 7), as first phase orthodontic treatment was undertaken. At this time, though all anterior teeth in

Fig. 3 Intraoral view of patient at 9 years of age. No orthodontic treatment has been done on this patient to date. Note lack of anterior crossbite of the central incisors and maintenance of good buccal segment alignment.

Fig. 4 Lateral cephalometric radiograph of same patient at 9 years of age. Anteroposterior relationship of maxilla and mandible to each other and to cranial base is favorable.

the maxilla are present except the lateral incisor on the side of cleft, there is the distinct possibility that it may be esthetically and functionally aligned at a later date for its position in the bone is quite favorable. The lateral cephalometric radiograph (Fig. 8) in this case also shows a favorable anteroposterior mandibular-maxillary relationship.

Do our procedures do any good? It is still too early for a definitive yes or no but, hopefully, we think so. As an example we would like to show one

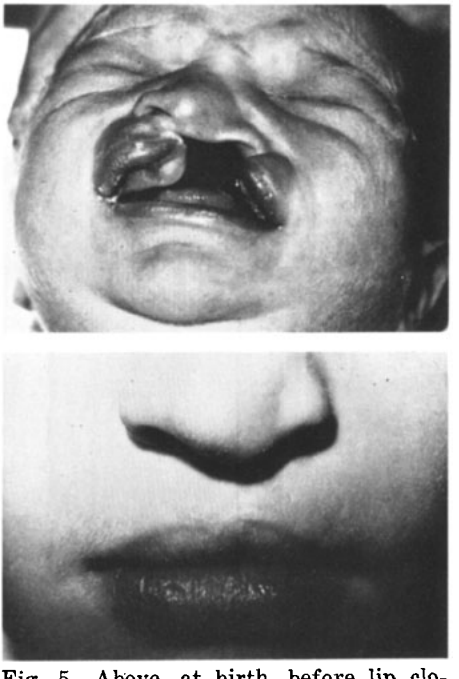

Fig. 5 Above, at birth, before lip closure. Below, at nine years of age.

case, not included in this particular sample simply because he was 5 years of age at the time we were beginning our graft procedures. The cleft was a bilateral complete (Fig. 9) and the premaxilla was stabilized at that time with a bilateral bone graft. At 12 years of age he presented for full comprehensive orthodontic treatment (Fig. 10). Full edgewise appliances were placed in both arches. The particular challenge in this case concerned both maxillary canines which were high, palatally impacted. This, therefore, presented our first opportunity to move both canines through a resolved bone graft. One side at a time was attempted. At present both canines are through the graft area and the premaxilla remains firm and the graft intact. We feel this young man will have a better chance for good esthetic and functional anterior bridgework when the time arrives than if we had not been able to do this.

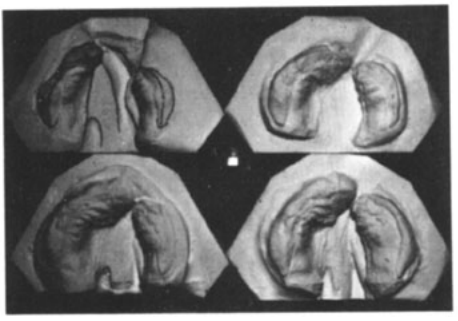

Fig. 6a Maxillary models of case (K.B.) during first year of life showing extent of cleft across bony void and general arch form.

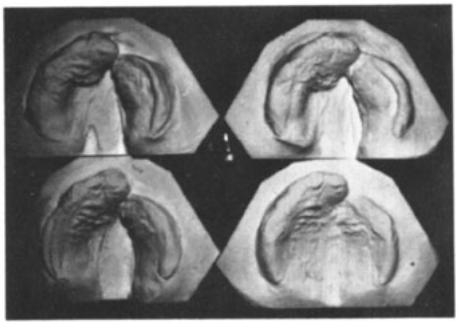

Fig. 6b Maxillary models of patient taken during the second year of life with teeth cut away to emphasize general arch form.

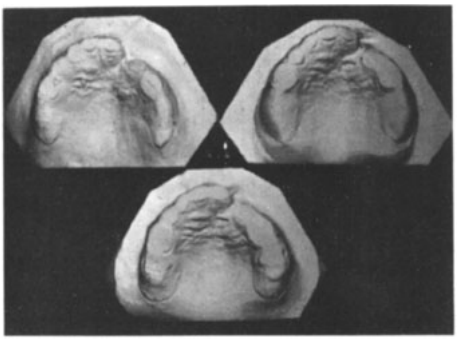

Fig. 6c Maxillary models of the patient taken during the third year of life with teeth cut away once more to emphasize the maintenance of good arch form.

Fig. 7 Above, intraoral view of patient showing left maxillary deciduous canine crossbite, and need for central incisor alignment. Below, intraoral view showing retainer in place.

Fig. 8 Lateral cephalometric radiograph of patient at 9 years of age. Anteroposterior relationship of maxilla and mandible to each other and to cranial base is favorable.

Fig. 9a Above, occlusal view of maxillary cast of patient at birth showing complete bilateral cleft (Veau Class IV). Below, occlusal radiography of firm bony union and stabilization of premaxilla five years after bone graft.

Fig. 10 Above, intraoral view of occlusion at the time the patient presented for orthodontic treatment. Below, intraoral view of occlusion showing one canine in place in the arch and the other in the process of being aligned.

Summary and Conclusions

An attempt is being made to observe the facial and dental development of a cleft lip and palate sample. The study is continuing and, hopefully, offers insight into what happens to these children who have undergone the placement of a dentofacial maxillary orthopedic appliance early at the time of lip closure and an additional surgical procedure and autogenous osteoplasty. Though the final answers to the two previously posed questions are not yet available, we are able to make some value judgments by observing the lateral cephalometric films of these children, and observing their occlusion intraorally.

Thus far, we are able to state that in our sample, using our treatment procedures in the sequence advocated, we

have seen no growth attenuation in the posterior/anterior dimension. The maxilla, at least to the ages observed, does not appear to have been attenuated by our procedures.

Further, it would seem that after a limited first phase of orthodontic treatment to align dental units, the degree of crossbite is considerably smaller from that reported in the literature by those using more conventional approaches; thus it is possible that we are doing some good.

We are still using these procedures on our newborn and continue to feel that we have a real opportunity to be able to do more orthodontically for these children when they possess a full, permanent dentition and are ready for comprehensive treatment.

3425 W. Peterson Ave.
Chicago, Illinois 60659

REFERENCES

1. Rosenstein, S. W., et al.: A series of cleft lip and palate children five years after undergoing orthopedic and bone grafting procedures, *Angle Orthod.* 42:1-8, 1972.
2. Koberg, W. R.: Present view of bone grafting in cleft palate (a review of the literature), *J. Max.-Fac. Surg.* 1:185-193, 1973.
3. Friede, H. and Johanson, B.: A follow-up study of cleft children treated with primary bone grafting, *Scand. J. Plast. Reconstr. Surg.* 8:1-16, 1974.
4. Bergland, O. and Sidhu, S. S.: Occlusal changes from the deciduous to the early mixed dentition in unilateral clefts, *Cleft Palate J.* 11:317-326, 1974.
5. Graf-Pinthus, B. and Bettex, M.: Long-term observation following presurgical orthopedic treatment in complete clefts of the lip and palate, *Cleft Palate J.* 11:253-260, 1974.
6. Hotz, M.: Personal communication, 1974.
7. Troutman, K. C.: Maxillary arch control in infants with unilateral clefts of the lip and palate, *Am. J. Orthod.* 66:198-208, 1974.
8. O'Donnell, J. P., Krischer, J. P., and Shiere, F. R.: An analysis of presurgical orthopedics in the treatment of cleft lip and palate, *Cleft Palate J.* 11:374-393, 1974.
9. Boyne, P. J.: Use of marrow-cancellous bone grafts in maxillary alveolar and palatal clefts, *J. Dent. Res.* 53:821-824, 1974.
10. Rosenstein, S. W.: In *Symposium on Management of Cleft Lip and Palate and Associated Deformities,* Edited by N. Georgiade, C. V. Mosby Co., St. Louis, 1974, pp. 43-46, 118-122.
11. Rosenstein, S. W. and Jacobson, B. N.: Early maxillary orthopedics: A sequence of events, *Cleft Palate J.* 4:197, 1967.
12. Wachs, R.: A comparative cephalometric study of cleft lip and palate patients with and without bone grafts to the maxilla, Masters Thesis, Chicago, *Northwestern University Dental School,* 1972.
13. Dickson, D. R., et al.: Status of research in cleft palate anatomy and physiology, July 1973, Part 1, *Cleft Palate J.* 11:486-492, 1974.
14. Broadbent, B. H. Jr.: Personal communication, 1973.