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Academy of Pedodontics / Vol. 1, No. 1 / Printed in U.S.A.

Prediction of dental and skeletal relationships from facial profiles in preschool children

Henry W. Fields, D.D.S., M.S., M.S.D.
William F. Vann, Jr., D.M.D., M.S.

Abstract

This paper reviews the rationale for assessing the facial profile of the patient with a developing dentofacial complex. The purpose of the study was to assess one method of profile analysis utilizing 4-year-old children. Sixteen orthodontists and 16 pedodontists were asked to classify the existing skeletal or dental relationships solely from a soft tissue profile tracing or from a lateral facial photograph. The analysis of the data indicated that for this age group neither the orthodontists nor the pedodontists could predict accurately the existing skeletal or dental pattern solely from the soft tissue profile tracing or the lateral facial photograph. No significant differences were found between the predictions of the orthodontists and the pedodontists. This investigation notes that even with highly similar dental relationships, much variability in skeletal and soft tissue relationships may occur in preschool children.

Introduction

Practitioners involved with the child whose dentofacial complex is developing should find it necessary to observe the facial profile. Analysis of the profile is valuable in both diagnosis and treatment. First, the face of the child in profile is one method of evaluating the child's overall facial esthetics. Second, a clinical facial profile analysis has been suggested as a method of assessing the skeletal pattern of the patient when a cephalogram is not available.[1,2] Third, to perform an accurate space analysis, the lip posture and incisor position must be appraised if the available space is to be properly managed. Finally, when a malocclusion appears to be developing and treatment decisions need to be made, the facial profile often influences the preferred course of therapy.

Since the advent of cephalometry, many approaches to analysis of facial profiles and esthetics have been proposed. Most of these analyses have dealt with the adolescent patient.[3-5] The facial skeletal profile (Na-A-Pg) is generally regarded to become less convex (straighter) with maturity.[6,7] The soft tissue profile (Na'- SN', Pg'), which excludes the nose, remains reasonably stable from 3–18 years according to Subtelney.[8] Although the soft tissue profile is related to the underlying skeletal pattern, apical bases, and incisor position,[9] there is evidence that it does not always mirror the skeletal pattern.[8]

A common method of assessing facial profiles was introduced by Cheney[1] and popularized by Moyers.[2] This method requires the plotting of selected hard tissue landmarks relative to a plane through hard tissue Nasion, perpendicular to the Frankfort horizontal plane (Fig. 1). Recently, a modification of this technique has been introduced.[10] This modification uses a plotting of soft tissue landmarks relative to the same reference lines (Fig. 2). This step-by-step method can be employed routinely in a clinical setting, or used to train dentists to assess facial profiles.

Since the hard and soft tissue profiles are not necessarily synonymous, several questions may be posed regarding the use of a clinical facial profile analysis for young children. Can clinicians assess the skeletal pattern and infer the molar relationships from the facial profile drawing of young children? Is a facial photograph equally or more valuable when judging profiles than the line drawing? Finally, do pedodontists and

FACIAL FORM ANALYSIS

I. Lateral View

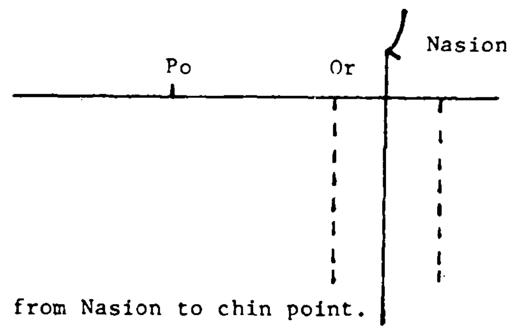
Frankfort

Midfacial

Maxillary alveolar

Mandibular alveolar

Chin point



Draw in the profile from Nasion to chin point.

1. What molar relationship is indicated by facial skeleton?

2. a. What is the overjet?______ b. What is the overbite?______

3. What is the significance of the incisor relationship?

4. What is molar relationship?______ What is the cuspid relationship?__________

5. Is mandible shifted in A-P on closure? Yes No

6. Angle between Frankfort horizontal and occlusal plane; flat, normal, steep

7. Obtusity of gonial angle, less than normal, normal, greater than normal

8. Inclination of maxillary central incisors, relative to nasion plane; anteriorly inclined, normal, vertical, posteriorly inclined.

9. Inclination of mandibular central incisors relative to nasion plane; anteriorly inclined, normal, vertical, posteriorly inclined.

SUMMARY:

Fig. 1. The Facial Form Analysis worksheet used to plot hard tissue landmarks and assess the profile. (From Moyers, R.E.: *Handbook of Orthodontics*, 2nd ed., Chicago: Year Book Medical Publishers, Inc., 1975.)

orthodontists assess the profiles of young children with similar results?

Materials and methods

Sixteen pedodontists and sixteen orthodontists participated as raters in this study. Raters were selected to reflect a variety of training experiences, years in practice, and geographical location. Ninety-five percent of the raters were engaged in full time private practice; the remainder were academicians who spend a portion of their time engaged in an intramural private practice.

The raters were randomly assigned to one of four groups such that each of the four groups consisted of four pedodontists and four orthodontists. Each of the four groups was asked to make a different judgment:

Group One was asked to categorize primary molar occlusion from a *soft tissue profile tracing* as mesial step, flush, or distal step;

Group Two was asked to categorize primary occlusion from a *facial profile photograph* as mesial step, flush, or distal step;

Group Three was asked to categorize skeletal patterns from a *facial profile photograph* as greater than average convexity, average convexity, straight or concave;

Group Four was asked to categorize skeletal patterns from a *soft tissue profile tracing* as greater than average convexity, average convexity, straight, or concave.

Choices of the primary molar relationships were diagrammed for the raters. The skeletal relationships were also defined as *greater than average convexity*—what you consider to be greater than average convexity for a child of this age; *average convexity*—what you consider to be average convexity for a child of this age; *straight*—what you consider to be equal contributions of the mandible and maxilla; *concave*—what you consider to be greater mandibular than maxillary prominence.

Ten children, all between the ages of 4 and 5, provided the diagnostic data that were used in this study. The children were selected from a larger sample of subjects utilized in a previous study.[11] Each child met the following criteria:

1. All children were North American Caucasians of Northern European ancestry;
2. A lateral facial photograph was available with the soft tissue at rest;
3. A lateral cephalometric radiograph was available with the soft tissue at rest and the teeth in occlusion;

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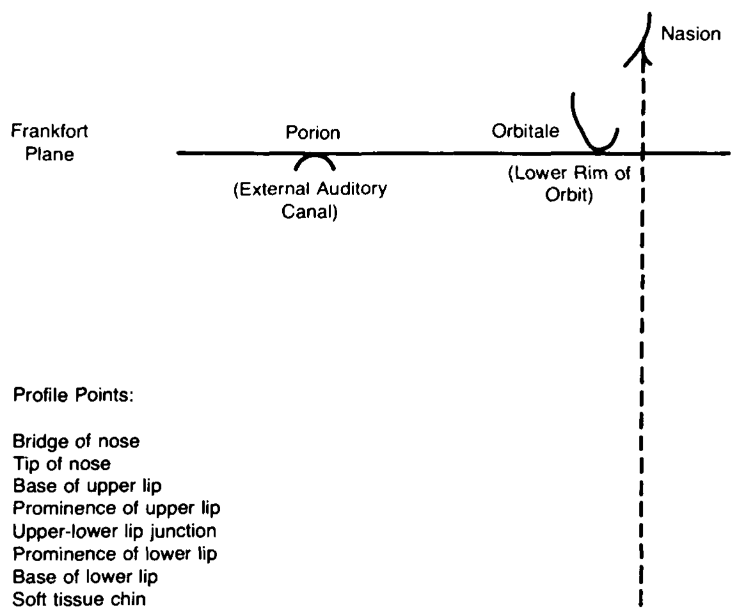
FACIAL PROFILE ANALYSIS

Draw the patient's profile. Mark the position of each profile point relative to the imaginary vertical reference line, which is perpendicular to the visual axis or Frankfort plane; then connect your points to complete the profile drawing.

For the drawing, the patient should be in, or very near, the terminal hinge position.



What molar relationship is suggested by the profile?____________________

Is the Mandibular plane steep, moderate, or low in relation to the Frankfort plane?__________

Summarize the skeletal jaw relationship in the antero-posterior *and* vertical planes, and degree of lip support.

Fig. 2. A Facial Profile Analysis worksheet utilizing soft tissue landmarks. This is a modification of the method illustrated in Fig. 1.

4. All subjects exhibited a full complement of primary teeth with no evidence of first permanent molar emergence into the oral cavity;
5. Accurately trimmed diagnostic casts (centric occlusion) demonstrated a flush or mesial step primary second molar relationship;
6. The primary canines were in an Angle Class I relationship;
7. The overbite and overjet were judged acceptable, and no anterior crowding or posterior crossbite was present.

These 10 subjects were selected in order to provide a variety of skeletal relationships for the raters to evaluate. Eight subjects were male; two were female.

Using complete cephalometric tracings, five of the subjects were classified as exhibiting average skeletal convexity (Fig. 3) since they displayed ANB angles within 1 standard deviation of the mean (4.85) for this

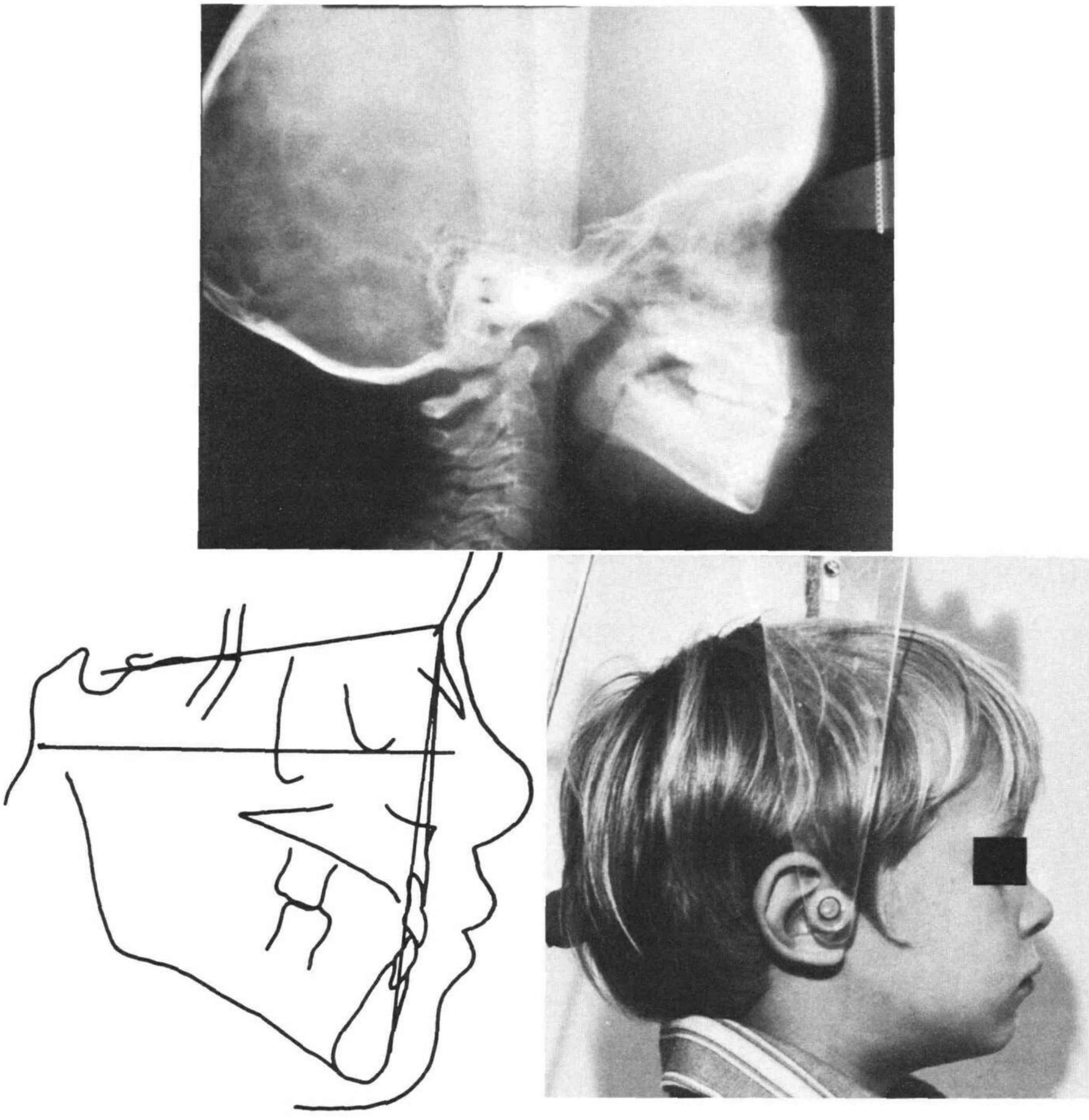


Fig. 3. A cephalometric headfilm, tracing of hard and soft tissue, and facial profile photograph of a patient with an ANB angle of 4.00°. This patient has a mesial step primary molar occlusion.

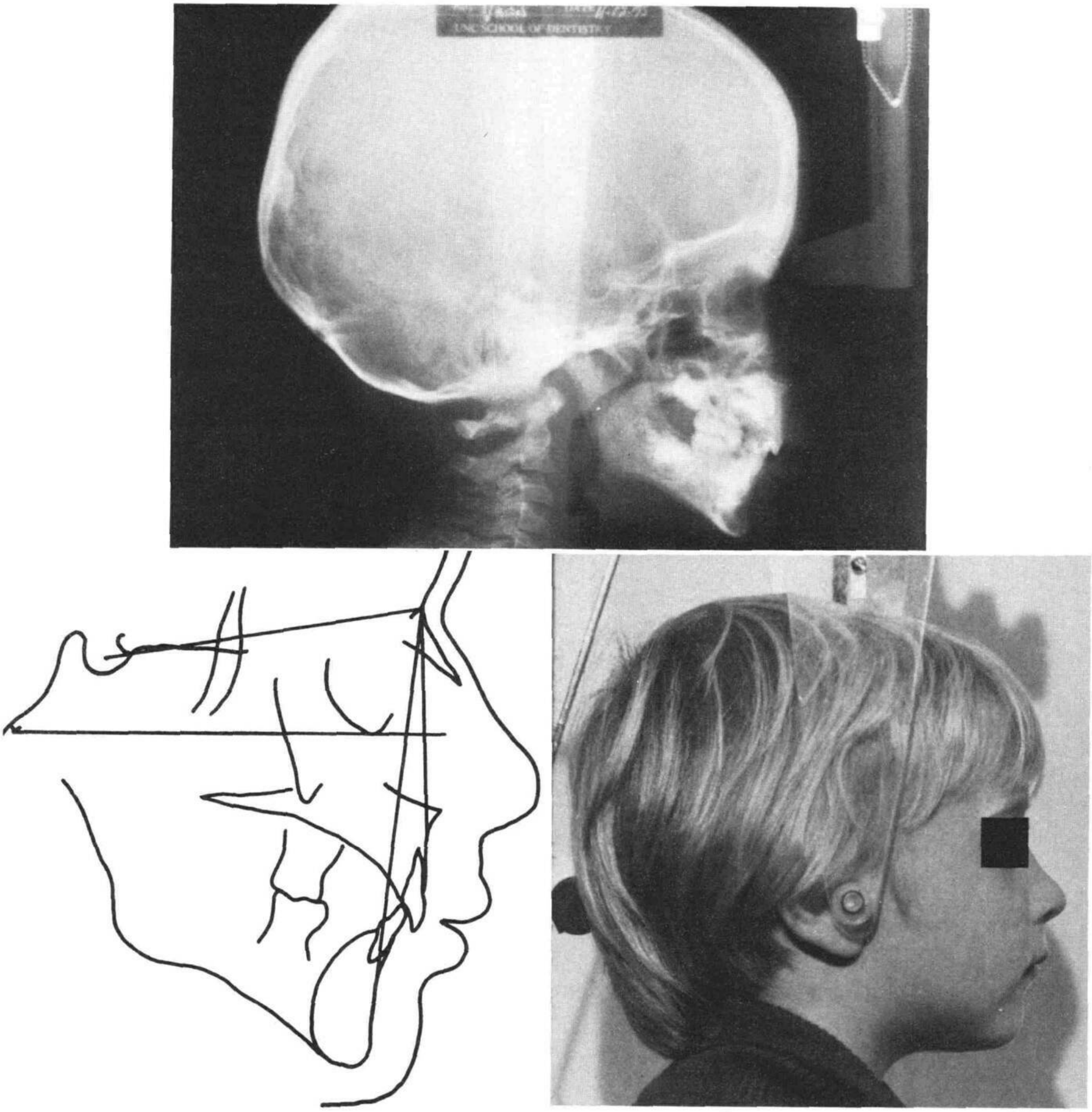


Fig. 4. A cephalometric headfilm, tracing of hard and soft tissue, and facial profile photograph of a patient with an ANB angle of 7.75°. This patient has a mesial step primary molar occlusion.

age group as determined by Vann *et al.*[11] Two subjects had greater than average skeletal convexity (Fig. 4) and ANB angles 1 standard deviation greater than the mean (greater than 6.8). The three remaining subjects had less skeletal convexity than average (Fig. 5) and ANB angles 1 standard deviation less than the mean (less than 2.9). The mean overbite for the group was 2.0 (SD = 0.53) and the mean overjet was 1.8 mm (SD = 0.86). Eight of the primary molar relationships were mesial step and two were flush terminal planes.

The soft tissue tracings (Fig. 6) used for this study were obtained by tracing the soft tissue outline from the lateral cephalometric radiographs.[11] This technique of obtaining the profile tracings was preferable to performing an actual clinical soft tissue profile drawing because it reduced the possibility for introducing variability.

Data analysis focused on the accuracy with which the four groups of orthodontists and pedodontists could predict dental and skeletal relationships from

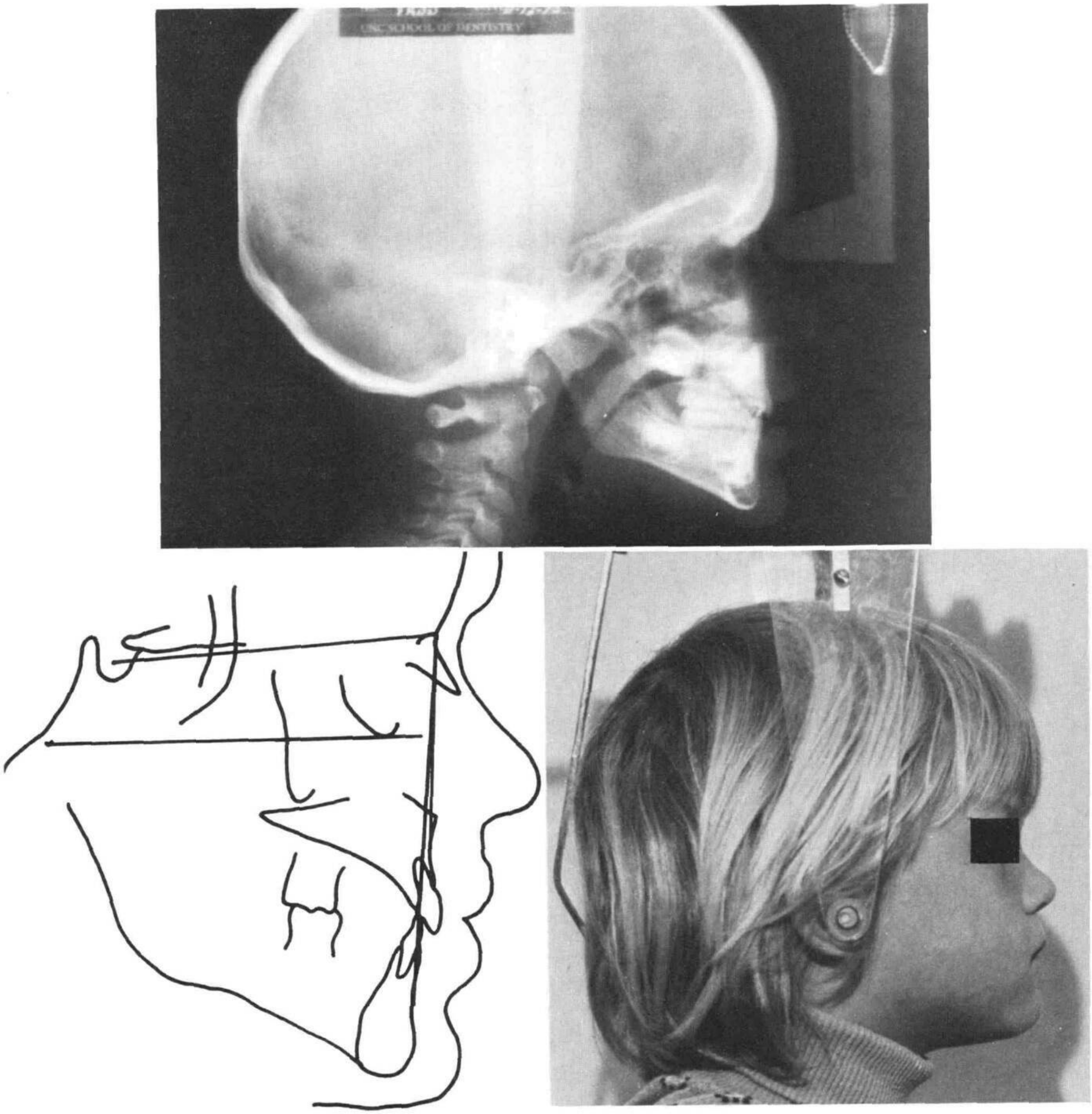


Fig. 5. A cephalometric headfilm, tracing of hard and soft tissue, and facial profile photograph of a patient with an ANB angle of 1.75°. This patient has a mesial step primary molar occlusion.

facial profiles and photographs. The degree of accuracy was determined using the weighted kappa statistic.[12] Weighted kappa values range from −1.0 to +1.0 with 0 indicating chance prediction; 1.0 indicates perfect prediction and −1.0 indicates totally inaccurate prediction. Weighted kappa is more appropriate than traditional correlation coefficients for this study because first, it assesses agreement above the chance level. Second, it allows disagreements to be differentially weighted. Since the categories in this study are ordered, a one category disagreement (*e.g.*, average *vs.* straight skeletal pattern) is weighted as less disagreement than a two category difference (*e.g.*, average *vs.* concave skeletal pattern). Finally, weighted kappa is known to be nearly normally distributed, thereby allowing further statistical analysis. Further discussion of this statistic is reported elsewhere.[12-15]

A two factor analysis of variance was used to determine whether there were differences in prediction between orthodontists and pedodontists and whether there were differences in accuracy using the photographs or the profiles. This analysis was completed for skeletal and for dental prediction.

The following hypotheses were formulated.

Hypothesis 1: The occlusion of *preschool* children *cannot* accurately be determined from a facial profile photograph.

Hypothesis 2: The occlusion of *preschool* children *cannot* accurately be determined by a soft tissue profile tracing.

Hypothesis 3: The skeletal relationship of *preschool* children *cannot* accurately be determined by a facial profile photograph.

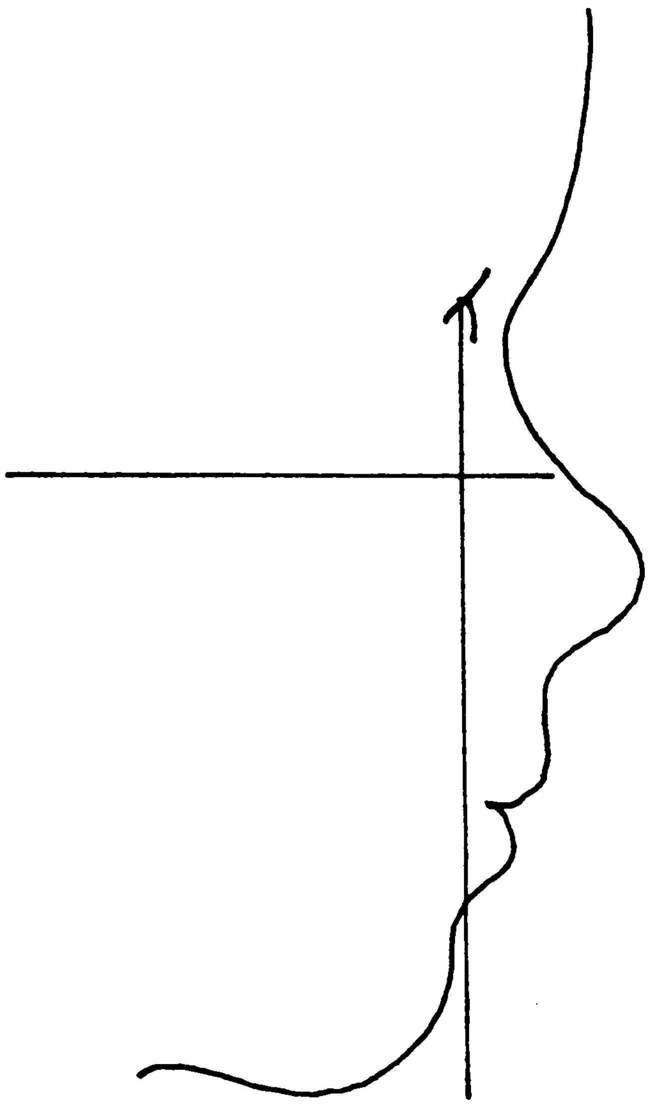


Fig. 6. A soft tissue tracing taken from a cephalometric tracing used to simulate a Facial Profile Analysis for this study. The reference lines are Frankfort Horizontal and a perpendicular to Frankfort through hard tissue Nasion.

Table 1. Summary of the kappa (κ) results by group

Rater	Mean κ	SD
Group I: Dental prediction from tracing		
Ortho	0.0588	0.1132
Pedo	0.0880	0.0597
Group II: Dental prediction from photograph		
Ortho	0.0913	0.0370
Pedo	0.0753	0.1419
Group III: Skeletal prediction from photograph		
Ortho	0.2915	0.0813
Pedo	0.2460	0.1700
Group IV: Skeletal prediction from tracing		
Ortho	0.2772	0.1380
Pedo	0.0643	0.2781

Hypothesis 4: The skeletal relationship of *preschool* children *can* be accurately determined by a soft tissue profile tracing.

Hypothesis 5: Orthodontists and pedodontists *do not* differ in their abilities to predict accurately occlusal or skeletal relationships in *preschool* children using either facial profile photographs or soft tissue profile tracings to make predictions.

Results

Kappa statistics for dental and skeletal predictions by group are reported in Table 1. The resulting kappa statistics for the skeletal prediction are shown in Table 1 and values range from 0.2915 to 0.0643, a range of poor to only slightly better than chance agreement, respectively. The orthodontists and pedodontists were comparable in performance except when skeletal patterns were predicted from the soft tissue tracings. For this task the orthodontists were somewhat more accurate. When predicting dental relationships the kappa statistic ranged from 0.0913 to 0.0588. Again, the accuracy of the predictions was very poor and hardly better than chance. The orthodontists and pedodontists were comparable.

The second step in the analysis of these data was to determine whether: 1) there was any difference between prediction with photographs and prediction with profile tracings; 2) there was any difference between pedodontists and orthodontists; and 3) there were any interactions between the material and the training. This was accomplished by two standard analysis of variance routines which were run on the resulting kappas—one for the skeletal predictions and one for the dental predictions. In both cases there were two factor orthagonal designs with the two factors being A) photographs *vs.* profile tracings and B) orthodontists *vs.* pedodontists. The results, presented in tables 2 and 3, show no significant differences in either prediction for either factor or their interactions. It must be remembered, however, when interpreting

Table 2. ANOVA summary table: Skeletal prediction

Source	df	SS	MS	F	P value
A (material)	1	0.038	0.038	0.876	0.368
B (training)	1	0.067	0.067	1.521	0.241
AB	1	0.028	0.028	0.638	0.440
Error	12	0.527	0.044		

Table 3. ANOVA summary table: Dental prediction

Source	df	SS	MS	F	P value
A (material)	1	0.001	0.001	0.064	0.805
B (training)	1	0.000+	0.000+	0.036	0.853
AB	1	0.003	0.003	0.250	0.626
Error	12	0.127	0.011		

these results that the sample sizes per cell were very small ($n = 4$) and that the variances of the kappa were rather large.

Discussion

The results of this study indicate that the ability of the raters to predict the skeletal and dental relationships from the photographs or the soft tissue tracings was very poor. Since an arbitrary K-value of +0.5 would indicate the ability of the raters to predict the relationship with high accuracy, the performances in this study were only slightly better than chance. These results allow one to accept Hypothesis 1: the occlusion of *preschool* children *cannot* accurately be determined from a profile photograph; Hypothesis 2: the occlusion of preschool children *cannot* accurately be determined by a soft tissue profile tracing; and Hypothesis 3: the skeletal relationship of *preschool* children *cannot* accurately be determined by a profile photograph. However, we were *not* able to accept Hypothesis 4, which stated that skeletal relationships of the *preschool* children *can* accurately be predicted from the soft tissue tracing.

These results raise the question of the usefulness of this type of facial profile analysis for this age group. There are several possible explanations for the inability to use this analysis in this context. First, the practitioners may not have been educated to use this tool as a diagnostic aid. Second, the practitioners may not be as familiar with this age group as with adolescents. This is a tenable explanation for the orthodontists, but may indicate that the pedodontists do not evaluate the soft tissue profile or skeletal relationship of the patients they examine in this age group. Third, since the soft tissue does not accurately reflect the underlying skeletal structure, the lack of opportunity to palpate the soft tissue of these children and assess its thickness may have made the task more difficult. In this regard, the variability in soft tissue thickness may disguise skeletal variation. This is evident when the soft tissue profile and skeletal patterns of Figs. 3 and 4 are compared. Fourth, another method of clinical assessment may have to be devised. Finally, it may not be possible to evaluate the skeletal relationships without an analysis of a celphalometric headfilm.

Some practitioners may not be aware that wide skeletal and profile variability accompany quite similar dental relationships. Figures 3, 4, and 5 illustrate patients with similar mesial step dental relationships, but highly dissimilar skeletal and soft tissue relationships.

This is an important fact to recognize because when the dentition is mutilated or a malocclusion exists, the facial profile may heavily influence the direction of treatment. It may be necessary to treat similar malocclusions in contrasting manners due to the soft tissue profile. Potentially aberrant skeletal patterns may also go unrecognized if only the dentition is evaluated. These skeletal growth patterns will be reflected in dental compensation which may result in highly dissimilar malocclusions. Therefore, skeletal and dental interactions must be continuously assessed.

The analysis of variance revealed no statistical difference at the 0.05 level in prediction with the photographs or the soft tracings. Again, this is probably because the soft tissue profile does not reflect the skeletal or dental patterns.

Although the orthodontists tended to be somewhat better at prediction of the skeletal pattern from the soft tissue tracing, the analysis of variance revealed no significant difference at the 0.05 level between the two groups of specialists. Thus, Hypothesis 5: orthodontists and pedodontists do *not* differ in their ability to predict accurately occlusal or skeletal relationships in *preschool* children is supported. One may speculate that orthodontists are not significantly better because of their lack of familiarity with assessment of preschool children; one may speculate that pedodontists are not significantly better because their concerns with these children are more dentally oriented and the profile is not a focus of great attention.

It is important for the practioner to be conscious of the great variability of profile relationships in this age group as well as the lack of skill possessed by most in analyzing these relationships short of using a cephalometric headfilm. Either a better method of skeletal assessment needs to be devised, or the existing method needs to be redefined and carefully taught to students.

Conclusions

1. The results of this study indicate that soft tissue profile tracings and facial photographs alone were not useful in predicting the existing skeletal or dental relationships in this age group, probably due to soft tissue thickness variability.

2. Pedodontists and orthodontists were not signifi-

cantly different in their abilities to predict the skeletal and dental relationships.

3. Photographs and soft tissue profile tracings were of similar value in predicting skeletal and dental relationships in this age group.

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Dr. Henry W. Fields (left) is assistant professor of pedodontics and orthodontics, and **Dr. William F. Vann, Jr.** (right) is assistant professor of pedodontics, School of Dentistry, University of North Carolina at Chapel Hill. Requests for reprints should be addressed to Dr. H. Fields, School of Dentistry, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina 27514.