Anterior Malocclusion and Soft Tissue Profile Related to Sound Production and Self-Concept

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Significant correlations were found between upper lip, lower lip and skeletal convexity at Point A. Convexity at Point A related to a somewhat lower self concept and errors in production of "s," "z," and the unvoiced "th" sounds.

The significance of facial expression in human relations becomes of crucial concern to those whose features appear different. The facial contours and lip movements which relate to the dentition often serve to reflect attitude and emotion.

Movements of the oral structures are used in the production of speech sounds as well as the functions of mastication and respiration. The relationships of teeth, movement of the tongue, and changes in the oropharynx all contribute to articulation of the distinct features of sounds.

Development of speech and oral morphology are interdependent.

Dental malocclusion is observed in 50% of the child population,[18] while deviant speech has been found in less than 10% of school age children. National surveys have reported the incidence of articulation errors among children 6 to 18 years of age to be 5.7%, and among elementary age children who are receiving speech therapy it was found to be 6.1%

The prevalence of speech problems identified by parents has been reported as 6.2% at age 11 and 4% at 15,[19] which is the age group considered in this study.

Deviations from normal relationships of maxilla, mandible and dental arches, as well as in postural positions of the mandible and lips, can deleteriously affect articulatory performance even though the underlying neuromuscular control may be adequate for speech. Bloomer's[6] comprehensive review of the literature and discussion of speech and dental malocclusion concludes that the incidence of malocclusion is higher in children with defective speech than in those with normal speech.

The research objectives for this study were (1) to relate hard tissue profile and anterior malocclusion to normal and abnormal speech production, (2) to relate soft tissue profiles to normal and abnormal speech production, and (3) to relate self concept to the normal and abnormal occlusions.

Review of Literature

As early as 1907, Angle incorporated the concept of a good face into his treatment goal as something to be attained in orthodontic treatment. He said, "The study of orthodontia is indissolvably connected with that of art as related to the human face. The mouth is a most potent factor in making or marring the beauty and character of the face."[3]

Harmony, balance and symmetry should be considered in orthodontic diagnosis. As Angle stated, "We should be able to detect not whether the lines of the face conform to some certain standard, but whether the features of each individual—that is the forehead, the nose, the chin, the lips, etc.—balance, harmonize, or whether they are out of balance, out of harmony, and what concerns us most as orthodontists: whether the mouth is in harmonious relations with the other features, and if not, what is necessary to establish its proper balance."[3]

Broadbent[7] introduced cephalometric radiography to record the cranium and face in life-size images in 1931. Elsasser[14] introduced the facial orthometer to measure the profile in 1951. He marked several places on the midline and took measurements perpendicular to the Frankfort horizontal plane, but paid little attention to the lips.

Riedel,[25] in 1950, addressed the relationship of esthetics to orthodontics. He made several discoveries by examining the soft tissue of normal occlusion and abnormal occlusion cases. He found that a pleasing soft tissue profile was supported by skeletal parts arranged in a straight line, with little or no protrusion. Points A and B, and the upper and lower incisors, were well related to each other in the patients with good profiles, with the A-N-B angle 2½° or less. He believed that in a straight profile the upper incisors could be more protrusive than in a convex profile.

In a cephalometric appraisal of thirty candidates in the 1957 Sea Queen Beauty Contest in Seattle, Washington, he found that about half of the contestants had upper lip, lower lip, and the chin aligned in a straight line. Riedel[26] concluded that the soft tissue profile is closely related to the skeletal and dental structures which make up the bony profile, and that the lower incisors do not directly alter facial esthetics.

Ricketts,[24] in the same year, described the "E" line as a line drawn

from the tip of the nose to the chin, and its relationship to the upper and lower lips.

The Herron sample was used by Burstone[8] in 1958 to establish cephalometric standards for relating the profile components to each other and to the skull. In the following year, Burstone[9] presented another study in which he established similar standards for an adolescent sample between ages 13 and 16, using reference points projected to the nasal floor. This demonstrated exaggeration of soft tissue disharmony in some cases of malocclusion, while in others the soft tissue helped to mask the dental and skeletal disharmonies. Burstone found in this study that lines from hard tissue landmarks to the supposedly corresponding soft tissue landmarks may not represent the true thickness of the soft tissue.

In 1959, Subtelny[29] studied growth changes of the soft tissue facial structures by describing in detail how the lips, chin, nose, and the "total facial cosmesis" grew and developed in thirty selected subjects from three months to eighteen years. This study corroborated other findings that some parts of the soft tissue profile did not directly follow the dentoskeletal profile.

Also using the Herron sample, Toro[30] in 1960, analyzed the lips by establishing a total facial line that connected the frontal point and pogonion. The extension of a line drawn from sella turcica to nasion forward through the facial line formed the total facial angle. Subnasion and pogonion points were joined to form the lower facial line, which formed the lower facial angle with the total facial line. He concluded that there was a definite relationship between the skeletal facial angle and soft tissue facial angle.

Toro also measured lip points to the lower facial line, because he believed that the middle portion of the face contributed significantly to the appearance of the mouth. He believed that the lips related well to the lower facial line in straight, convex or concave profiles, harmonizing with other structures.

MacGregor[21] reported that in an interdisciplinary study of facially disfigured patients conducted at New York University College of Medicine, it was found that there was an exceedingly great psychological impact on those whose deformities evoked ridicule, bordered on caricature, stimulated jokes, or were sources of amusement. They found that many patients with such deviations had more serious psychological problems, more behavioral disorders, and were more maladjusted than those with the kinds of deformities that we consider distressing to look at or that tend to elicit such emotional reactions as pity or revulsion.

A simple profile-simulation device was used by Hershon and Giddon,[17] in the study of forty-two orthodontic patients and an equal number of nonorthodontic patients. The objective was to determine how they thought they appeared and how they would like to appear in comparison with actual cephalometrically determined profiles. Consistent with other studies of the self-perception of body parts, both the orthodontic and nonorthodontic groups underestimated the protrusiveness of their lips. The psycho logical measures showed the actual and perceived magnitudes of protrusiveness correlated significantly with anxiety and dissatisfaction with their profiles.

Kreit, Burstone and Delman[18] attempted to develop a personality inventory to identify cooperative orthodontic patients. They concluded that the most salient feature of uncooperative patients was a poor relationship with their parents. Cooperative patients seemed to be conventional and conforming. These findings tend to agree with those of Baldwin that found parental motivation to be the primary basis for treatment.

Allen and Hodgson[2] found age of the patient to be the one variable in twenty-nine to show a statistically significant correlation with cooperativeness. The cooperative patient was under fourteen years of age, enthusiastic, and trusting. The typical uncooperative patient was over fourteen years of age, independent, and temperamental.

Stricker states that "The situation that emerges is one in which the parents make the decision and bring the child for treatment, but the characteristics of the child determine how well he will react in the treatment setting."[28] Psychological and functional aspects can have a profound influence on the future of the patient.

A survey by the National Opinion Research Center at The University of Chicago[20] showed that the great majority of people believed dentofacial appearance important in making friends, seeking public office, getting a job, and gaining the companionship of the opposite sex.

A National Institute of Dental Research study directed by Albino[1] found that a lay person's evaluation of attractiveness correlates reasonably well with a professional index of severity of malocclusion. Children's perceptions of their own malocclusion, however, are not correlated with professional evaluations. If the general public equates dental appearance with success in a variety of pursuits, there should be a better understanding of these conditions.

Parents and close friends of the patient needing orthodontic correction have been found to be psychologically involved. Baldwin and Barnes[4,5] explored the motivation of families seeking orthodontic treatment. Such motives as the resolution of parental problems through treatment of the child predominated, with "status seeking" present in a substantial proportion of families. The most important motivation for treatment was improvement of appearance, due to the conviction that increased social and occupational opportunities would result. Children tended to view treatment as desirable for immediate benefits, while parents were more concerned with long-term adult goals.[11,12,20,23,27]

When New York State health authorities made orthodontic treatment available to school children, it was found that existing professional concepts obstructed development of a satisfactory basis for selection of patients for orthodontic care. Bushel and Ast[10] concluded that they could not define handicapping malocclusions with sufficient precision. There has yet to be developed a list of criteria including both the psychological and the physical handicapping aspects of this condition.

Draker[13] presented an index of handicapping dental labiolingual deviations to augment clinical judgment for public health purposes. Biometric, esthetic, functional and anatomical standards should be related. When the malocclusion results in actual pain or severe malfunction as in the temporomandibular joint syndrome, the correction is a more obvious necessity. In the absence of disability, an ideal occlusion for functional as

well as esthetic purposes should be the objective of orthodontic treatment.

Moorrees[22] concluded that new research should involve active collaboration of investigators from various disciplines. He particularly notes dentofacial disfigurement and its relationship to mental health, with specific attention to self image, personality, social acceptance and behavior.

The research reported here was a cooperative effort of the faculties in the Speech and Hearing Science Section of the Department of Communication, the Department of Psychology and the College of Dentistry at The Ohio State University. The objective was to relate dentofacial malformation, malocclusion, speech and self image.

Methods and Materials

Numerous descriptions involving the assessment of static intercuspation of the teeth, radiographic interpretation of teeth and skeletal structures, and soft tissue profiles have been presented in the literature. The teeth and soft tissue profile were best suited for appraisal in this study because their assessment could be made in an expedient and accurate manner with little discomfort to the subject. The assessments were:

1. Hard tissue profile (anterior skeletal and dental structures).
2. Soft tissue profile.
3. Self concept related to normal and abnormal hard and soft tissue profiles.
4. Articulation related to self concept and abnormal hard and soft tissue profiles.

Speech pathologists with clinical certification (C.C.C. standards established by the American Speech-Language-Hearing Association) evaluated the articulation or sound production of all subjects. The Templin Darley Articulation test was administered and a sample of conversational speech was taped for each subject. Each patient received a pure tone audiometric threshold test. Subjects presenting a hearing loss greater than 10dB in either ear were excluded from the study.

Self concept was evaluated by paper and pencil procedures using the Coopersmith Self-Esteem Inventory. This inventory included a parental evaluation of the behavior of each patient in a variety of different situations.

There was no opportunity for parent and patient to exchange ideas or influence each other's responses.

A supplementary scale presenting questions directly related to appearance, dental status, and speech was developed. These questions permitted graded responses based on the semantic differential technique. Questions were designed to obtain responses related to negative experiences such as name calling due to appearance, dental status, or speech errors.

Two groups of subjects were selected. One consisted of seven females and four males with no anterior malocclusion who presented for general dental care at the College of Dentistry of Ohio State University. The second consisted of nineteen females and seventeen males with malocclusion who were seeking orthodontic care in the Department of Orthodontics at the College of Dentistry. Both groups were between the ages of eleven and fifteen. These persons, accompanied by one or both parents, came to the orthodontic clinic where the study was explained and permissions completed.

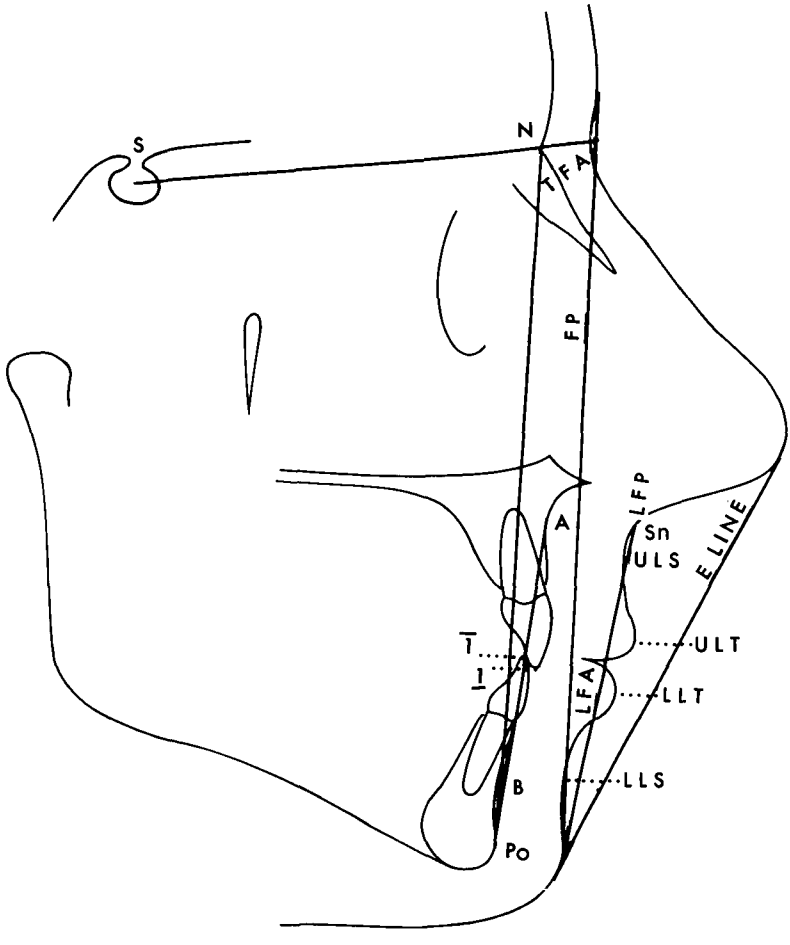

Fig. 1

Cephalometric radiographs of all subjects were exposed so that both hard and soft tissues were discernible.

The films were traced to show the usual skeletal structures and the soft tissue profiles. The following landmarks were located on each tracing (Fig. 1): sella (S), nasion (N), Point A, Point B, pogonion (Po), upper central incisor (U1), lower central incisor (L1), frontal point (Front), subnasion (Sn), upper lip concavity (ULS), upper lip tip (ULT), lower lip tip (LLT), and lower lip concavity (LLS).

Methods of Evaluation and Results

The following angles were measured: S-N-A, S-N-B, A-N-B, FP to A-Po, Ui to A-Po, total facial angle (TFA) and lower facial angle (LFA). Metric measurements were made of the convexity from point A to FP, lower lip to E line, and U1, L1, ULS, ULT, LLT and LLS to A-Po.

All measurements were recorded as positive or negative depending on location of the reference points. Table 1 compares the anatomical measure-

TABLE 1
Anatomical Measurements for the Normal and Malocclusion Groups.

	Mean Normal	*Mean Malocclusion*	*t*	*P*
SNA	81.5	81.7	.1	.12
SE	1.1	.5		
SNB	79.5	78.1	.9	.35
SE	1.3	.6		
ANB	2.1	3.6	1.9	.08
SE	.6	.5		
FAC. PL.	89.0	87.8	1.3	.20
SE	.7	.5		
CONV. PT. A	.9	2.9	2.4	.03*
SE	.7	.5		
$\bar{1}$ APO mm	2.6	.6	2.0	.06
SE	.9	.4		
$\bar{1}$ APO°	27.0	23.8	1.9	.09
SE	1.5	.8		
LLE PL.	.4	− 1.3	.9	.30
SE	1.1	.6		
$\underline{1}$ APO mm	6.5	5.8	.7	.50
SE	.9	.6		
TFA	81.4	81.1	.2	.09
SE	1.3	.1		
LFA	8.9	9.3	.4	.01*
SE	.8	.6		
ULS	− 1.0	− 1.3	1.0	.30
SE	.3	.1		
ULT	3.8	3.6	.2	.84
SE	.7	.3		
LLT	3.5	1.6	1.3	.20
SE	.9	.5		
LLS	− 3.2	− 5.3	3.7	.01*
SE	.5	.3		

* Significant

ments of the malocclusion group with those of the normal group of subjects. Means and standard error (SE) are presented, and the 't' values and the probability of statistical significance are recorded.

Table 2 presents mean values for the nonanatomical measurements. Speech sounds misarticulated most frequently were strident continuant consonants such as "s" and "z" and friction sounds, both voiced and nonvoiced. The sounds requiring higher tongue placement, "sh," "ch" and the unvoiced "th" were influenced.

Mean values for other sounds misarticulated by the malocclusion group were not significantly different from

TABLE 2
Speech and Behavior Scores for the Normal and Malocclusion Groups.

	Mean Normal	*Mean Malocclusion*	*t*	*P*
Behavior Rating	54.6	53.1	—	>.10
SE	.8	1.0		
Semantic	32.8	32.9	—	>.10
SE	1.6	1.7		
Self Esteem	41.8	43.7	—	>.10
SE	1.0	1.1		
Behavior (Habits)	0	1.3	4.4	.01*
SE	0	.3		
S	0	.47	5.6	.01*
SE	0	.08		
Z	0	.19	3.0	.01*
SE	0	.07		
SH	0	.14	2.4	.04*
SE	0	.06		
ZH	0	.08	1.8	.10
SE	0	.05		
DZ	0	.06	1.4	>.10
SE	0	.04		
CH	0	.08	1.8	.10
SE	0	.05		
Unvoiced TH	0	.14	2.4	.04*
SE	0	.06		
Voiced TH	0	.03	1.0	>.10
SE	0	.03		
R	0	.06	1.4	>.10
SE	0	.04		
L	0	.03	1.0	>.10
SE	0	.03		
All Sound	0	.11	2.1	.05*
SE	0	.05		
Lisp	0	.25	3.4	.01*
SE	0	.07		
Mand. Movement	0	.03	1.0	>.10
SE	0	.03		
Nasality	0	.11	2.1	.05*
SE	0	.05		
Volume	0	.11	2.1	.05*
SE	0	.05		

* Significant

the normal group. Correct sound production was recorded as zero misarticulation.

Incorrect production of the "s," "z," "sh" and unvoiced "th" in the malocclusion group was significant at the $P < .05$ level. The familiar distortions in "s" production termed "lisping," approaching the substitution of "th" for "s," were particularly evident in the connected speech of the malocclusion subjects.

The speech pathologist and psychologist applied the semantic differential technique for the self esteem inventory and the behavior rating questionnaires. The self concept data obtained from the Coopersmith Self Esteem Inventory, parental behavior rating scale, questionnaire using the semantic differential technique, as well as articulatory errors were analyzed statistically in relation to the facial measurements of the nonmalocclusion and malocclusion groups.

The mean convexity at Point A was 0.9mm in the normal group and 2.9mm in the malocclusion group, which is significant at the .05 level.

The mean for the lower facial angle was 8.9° in the normal occlusion group and 9.3° in the malocclusions.

The lower lip concavity averaged 3.2mm in the normal group and 5.3mm in the malocclusion group, with $P < .01$.

Deviant movements of the mandible in speech were observed in several subjects in both the normal and malocclusion groups, but there was not a significant difference between the two groups. Variations in mandibular movement were individual to the patient. Speech mannerisms which interfered or distracted the listener were also noticed among the malocclusion group. These included speech avoidance behaviors such as looking down with eyes directed away from the listener, shoulder shrugging to avoid responding verbally and facial expressions conveying doubt or unwillingness to respond. Almost none of these behaviors were exhibited by the normal occlusal group.

Increased nasality of voice was shown by some of the malocclusion subjects. Some of this may be related to reluctance to open the mouth and reveal the dentition. Reduced volume of voice was also exhibited by certain of the malocclusion patients, suggesting lack of confidence.

Correlations were computed using thirty-six variables. Seven anatomical measurements were found to be consistently correlated at a statistically significant level with all anatomical and nonanatomical measurements. These were A-N-B, convexity at Point A, lower central incisor to A-Po line in both mm and degrees, total facial angle, lower facial angle and lower lip concavity. Two other measurements which correlated significantly with malocclusion were the upper and lower lip tip ($P < .03$, .04 respectively).

Discussion

The mean age of the malocclusion group was older by more than one year. A larger normal occlusion sample and age matching could have provided a more nearly equal mean age for the two groups.

The anatomical factors found to be significant between the normal occlusion and malocclusion groups were convexity at Point A, lower facial angle, and lower lip concavity measurements (Table 1). Greater convexity, lower facial angle and lower lip concavity were found in the malocclusion group. No other anatomical factors showed significantly different measurements between the normal occlusion group and the malocclusion group.

The nonanatomical measurements indicated that malocclusion subjects evidenced defective articulation of the sounds "s," "z," "sh," and unvoiced "th." These subjects, approaching "lisping" behavior, had varying degrees of increased nasal quality and reduced voice volume. These subjects also presented behaviors suggesting speech avoidance.

The seven anatomical measurements found to have significant correlation coefficients were used to determine correlation with the nonanatomic parameters. The A-N-B angle was shown to be the best indicator of anterior malocclusion, reduced self concept and defective speech ($P < .05$). With an increase of A-N-B in the malocclusion group the production of the sounds "s," "z" and unvoiced "th" were even more defective ($P < .04, .02, .01$ respectively).

At higher convexities at Point A, it was noted that the A-N-B angle was also higher and there was a higher incidence of speech errors in production of "z," "ch," and unvoiced "th" sounds ($P < .04, .02, .01$ respectively).

The total facial angle also correlated negatively with "lisping-like" articulation and abnormalities in mandibular movement during speech. The presence or absence of abnormal mandibular movement during speech activity was also assessed. This was found in malocclusion subjects with high A-N-B, convexity at Point A and low total facial angle. This type of subject presented relative retrognathia and was probably using mandibular movement to compensate in order to produce more acoustically correct sounds.

There was a significantly higher incidence of speech errors in the subjects presenting a high A-N-B, convexity at Point A and low total facial angle. These are not newly detected relationships in orthodontics; they have long been considered by many to be cause and effect relationships.

The anatomical and nonanatomical measurements with most promise for future investigation are those shown to correlate statistically. These measurements are A-N-B, convexity at Point A, lower central incisor to A-Po in mm and degrees, total facial angle, lower facial angle, lower lip convexity, upper lip tip and lower lip tip. Consideration of a larger number of cases and the use of a different self concept instrument or procedure could provide more information on the relationships among malocclusion, self concept and speech. Future research is also needed to evaluate relationships between various orthodontic considerations and intraoral and extraoral habits.

Summary and Conclusions

The objective of this study was to relate self concept and sound production to skeletal malocclusion and soft tissue facial profiles.

The sample group consisted of forty-seven subjects divided into two groups. One group of eleven was selected on the basis of not having malocclusions from patients seeking general dental care. The other group of thirty-six subjects was selected on the basis of presenting a malocclusion and was chosen from patients seeking orthodontic care. Both groups were between the ages of eleven and fifteen. The findings indicate a high degree of correlation for the following:

1. Upper lip tip and the lower lip tip with skeletal convexity at Point A.
2. Convexity at Point A and abnormalities in self concept and speech production.

Based upon these findings the following conclusions are presented:

1. There is a high correlation of

the upper and lower lip tip to anterior malocclusion due to the correlation of convexity at Point A and lower central incisor to A-Po line.

2. There is a high correlation of the upper and lower lip tip with errors in sound production due to skeletal and soft tissue position.

3. There is a correlation between malocclusion and speech production.

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