Section 1

Mouth Breathing

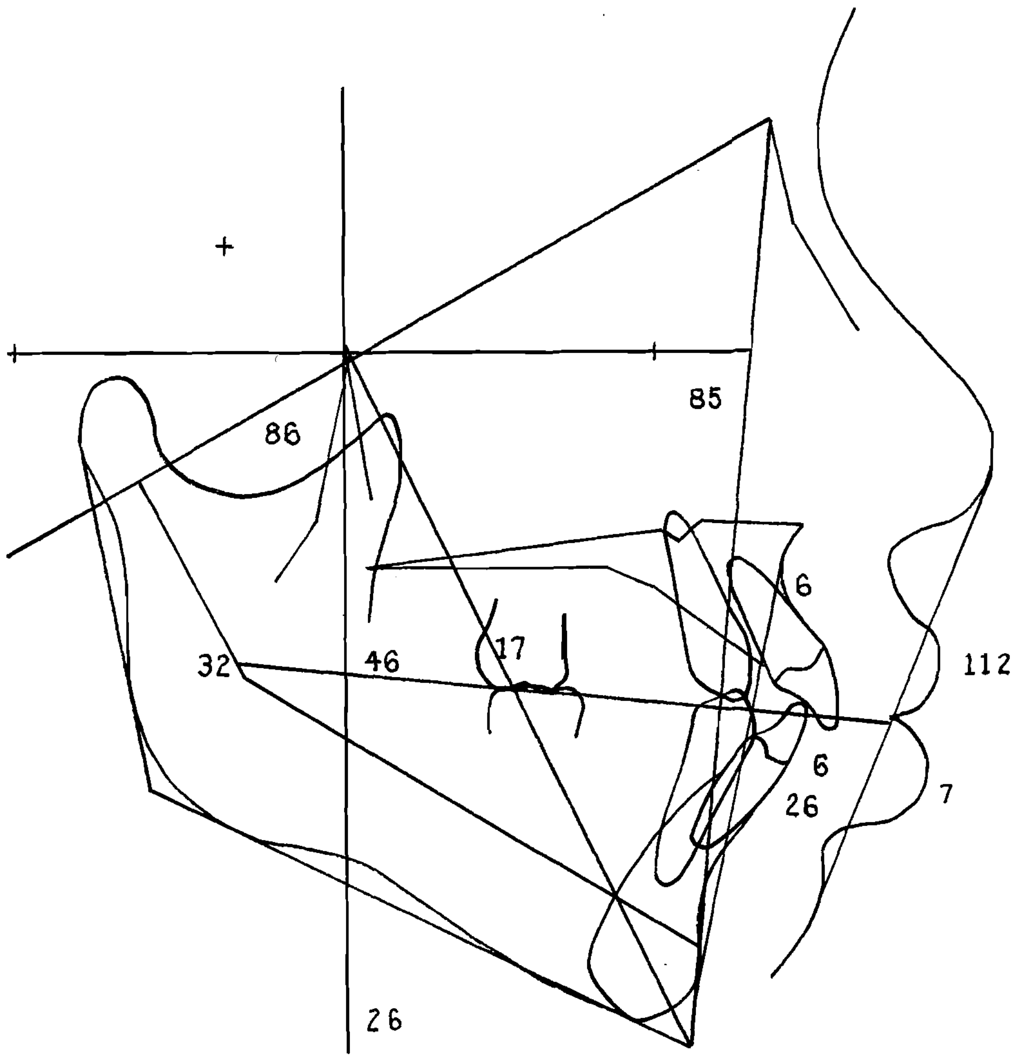


Fig. 323 Male patient, M.M., age 12 years, has a submucous cleft palate. Repair by a pharyngeal flap resulted in a complete closure of the airway. The outcome: The patient became a mouth breather.

The following case is a dramatic demonstration of the importance of nasopharyngeal competence in the growing child.[1] Illustrated in Fig. 323 is a tracing of a male who, at age 12.5 years, had a submucous cleft palate, which was repaired by a pharyngeal flap. An unfortunate result was a complete closure of the nasopharyngeal airway system, resulting in the patient becoming a mouth breather. Five years later, a complete open bite had developed, with a 6° opening of the facial axis (Fig. 324). The chance of such an occurrence at random is less than one in a million. However, abnormal growth in patients who are mouth breathers as a result of nasopharyngeal airway blockage is relatively common.

The relationship between mouth breathing and unusual growth is well-documented in orthodontic literature.[2,3] A continuance of untreated mouth breathing can cause abnormal growth of the face, as exhibited by a vertical (long, narrow) facial pattern. Conversely, a person with this type of facial structure would tend to be more prone to airway blockage leading to mouth breathing tendencies.[4] Mouth breathing also causes a weakening of the muscles in the facial structure

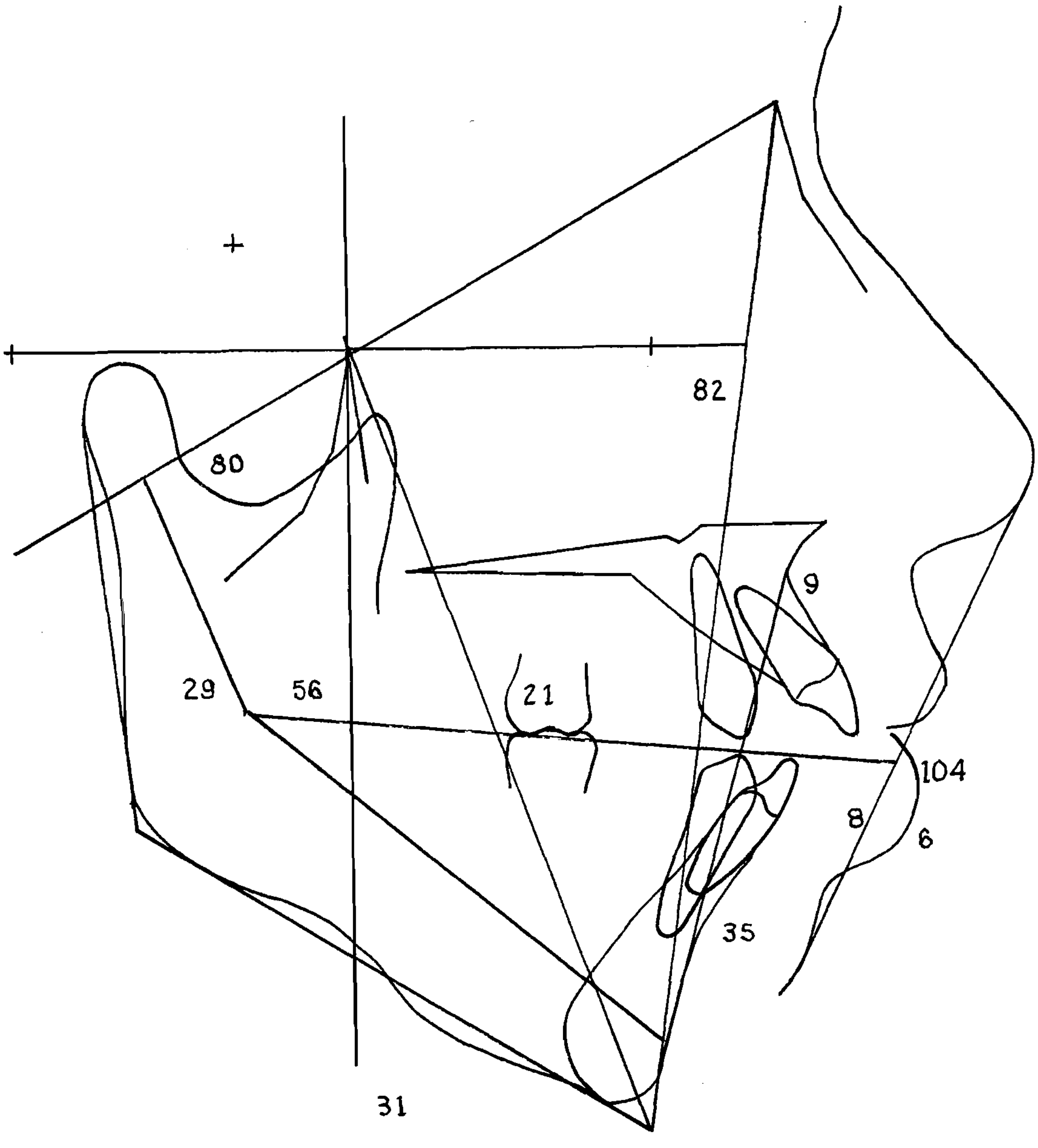


Fig. 324 Patient M.M., age 17 years, had developed a complete open bite with a 6° opening of the facial axis.

leading to various orthodontic problems including Class II malocclusion, buccal crossbite, open bite, and low tongue position, which, if untreated, can produce temporomandibular joint (TMJ) difficulties. In turn, temporomandibular joint dysfunction can create headaches, earaches (not surprising, since the TMJ is within 2-3mm of the ear canal), hearing problems, neurosis, and associated trauma. Mouth breathing has also been regarded as an obstacle to successful orthodontic treatment, and is likely to result eventually in orthodontic relapse. Therefore, it is important that the existence of mouth breathing in a child be recognized as soon as possible, and certainly before orthodontic treatment is attempted.

Analyzing the cephalometric characteristics of a case from a static standpoint, it can be seen

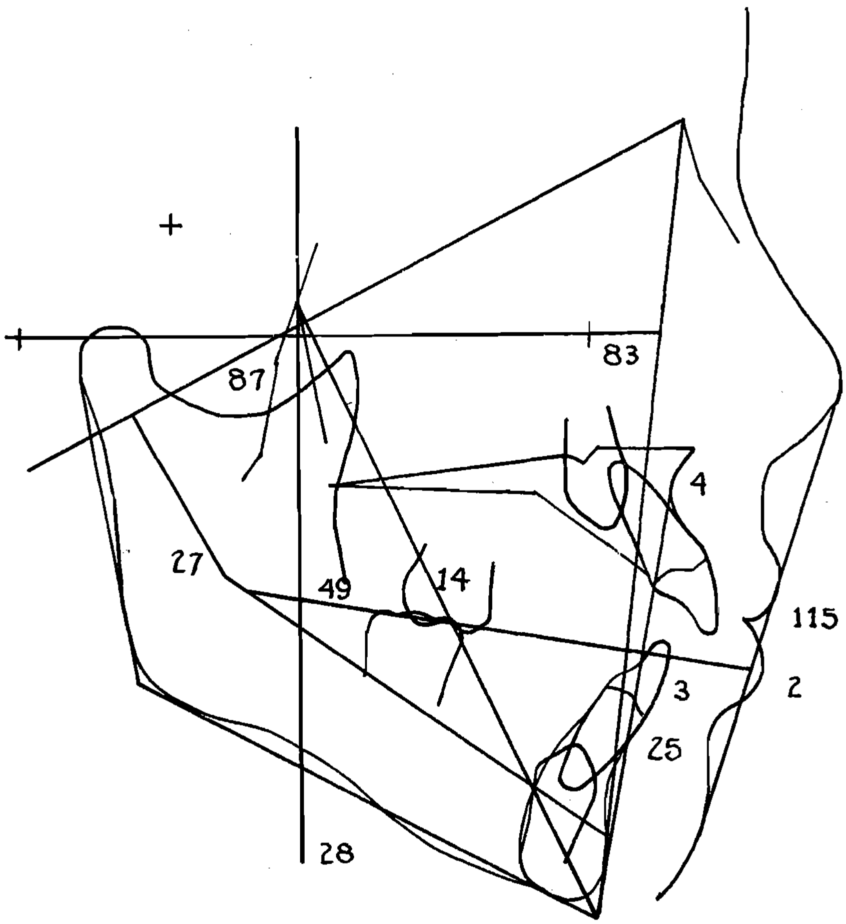
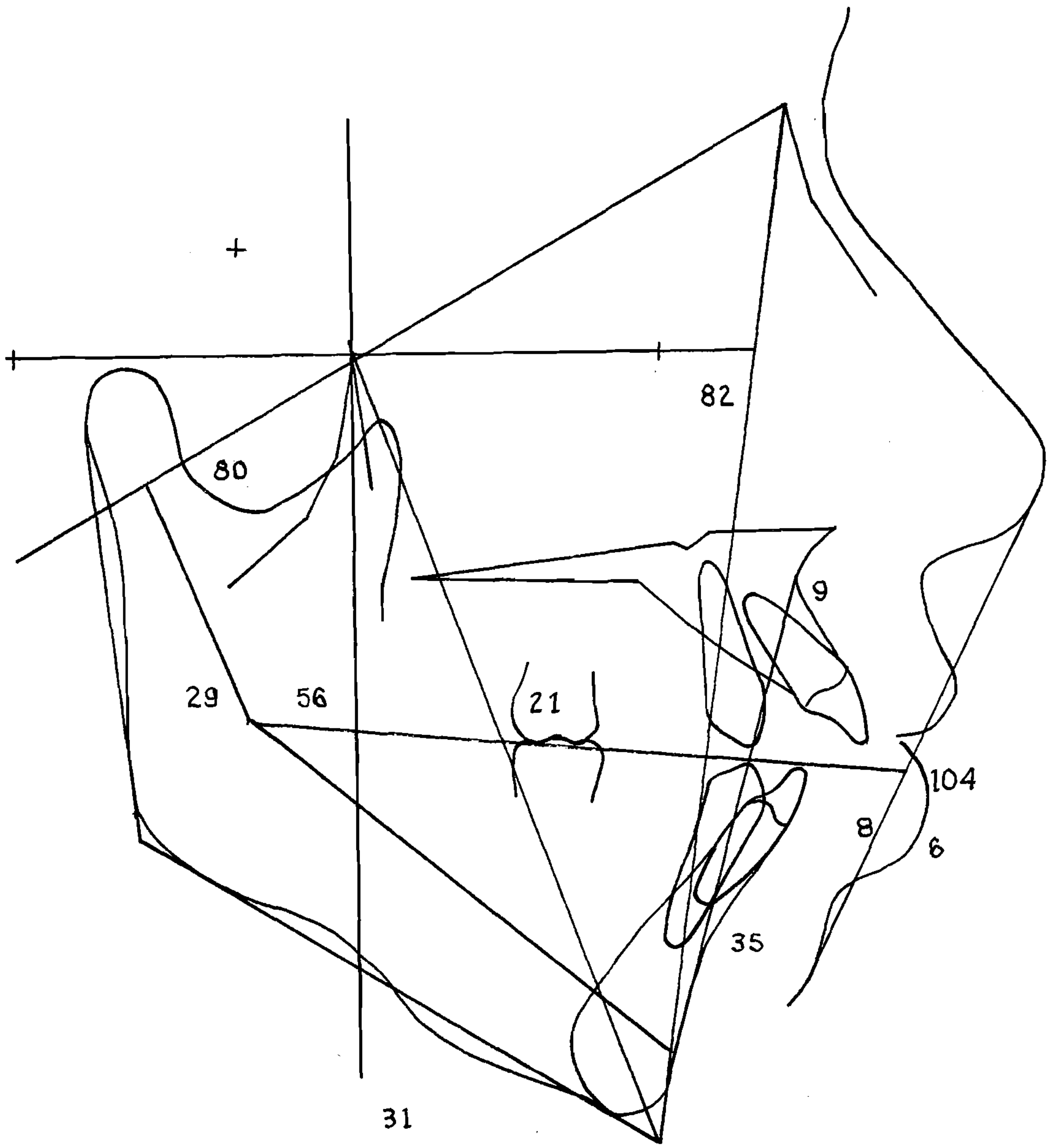


Fig. 325 Typical mouth breathing patient, S.T. Note vertical facial pattern, excessive lower face height, a retruded mandible, and an open bite malocclusion.

on the lateral tracing of Fig. 325 that this typical mouth breathing patient tends to exhibit a vertical face, as evidenced by excessive lower facial height, a retruded mandible, and an open bite malocclusion. In the frontal headfilm, a narrow maxilla is noted as compared to the mandible as well as a cross-bite malocclusion, and a narrow nasal cavity (Fig. 326). Observing the functional/behavioral dynamic description, it can be noted that, with growth, lower face height tends to increase and the facial axis opens, producing an increased long, narrow face for a patient with an already existing dolichofacial pattern (Fig. 327).



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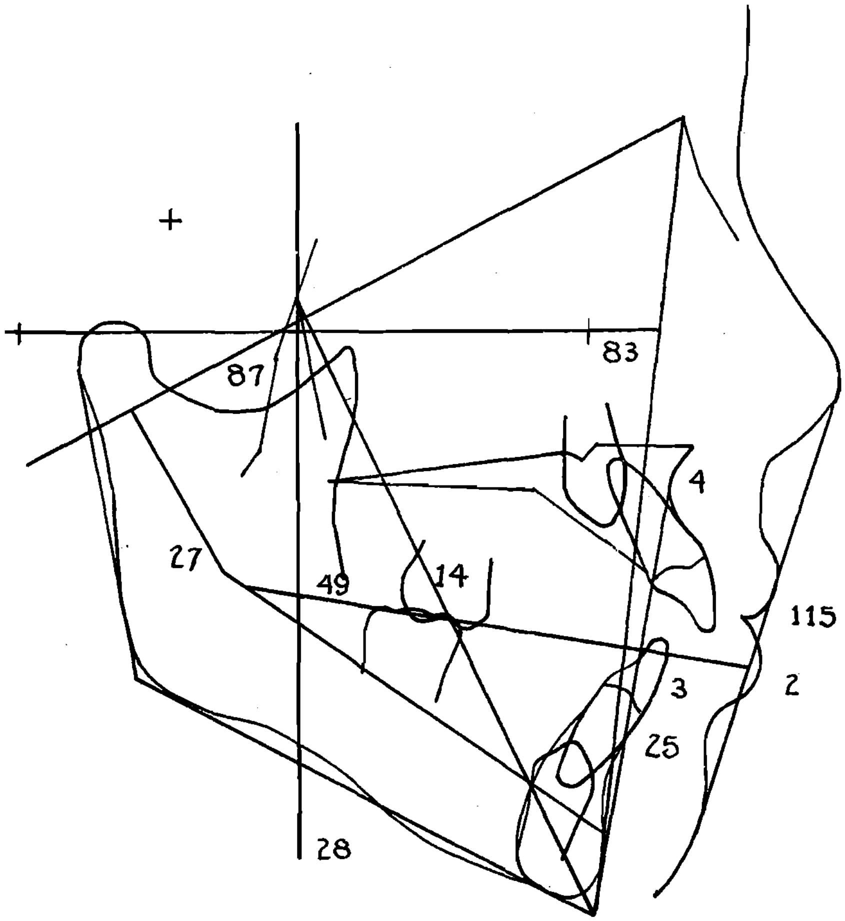

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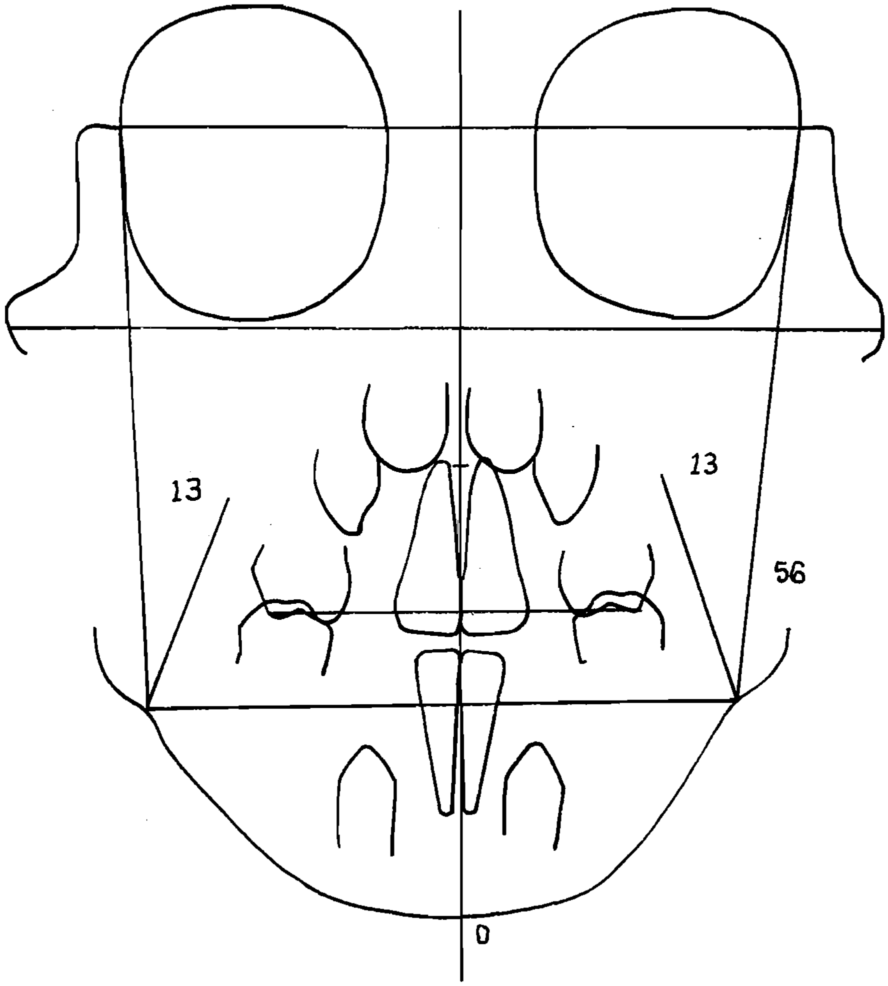

Fig. 326 Frontal tracing of patient S.T. Note narrow maxilla as compared to the mandible, a crossbite malocclusion and a narrow nasal cavity.

Thus, it is seen that the existence of mouth breathing must be detected as soon as possible. Point of entry for discovery of mouth breathing could be a visit to the office of the pedodontist, allergist, ear-nose-throat specialist, speech pathologist, or orthodontist. For this reason, both physical and cephalometric manifestations of mouth breathing are of interest to a number of health professions. Three basic concerns of breathing evaluation are adenoids, palatal width (cephalometrically analyzed) and non-cephalometric clinical factors.

Adenoid Considerations

According to the international medical health literature[5], the tonsil- and adenoidectomy is the most frequently performed surgical procedure. Tonsillo-adenoidectomies (T and A) are performed for the following classic indications[6]. (1) chronic nasopharyngeal obstruction, (2) pulmonary hypertension, (3) severe and chronic tonsillitis, (4) peritonsillar abscess, (5) otitis media, (6) rhinitis, and (7) sinusitis.

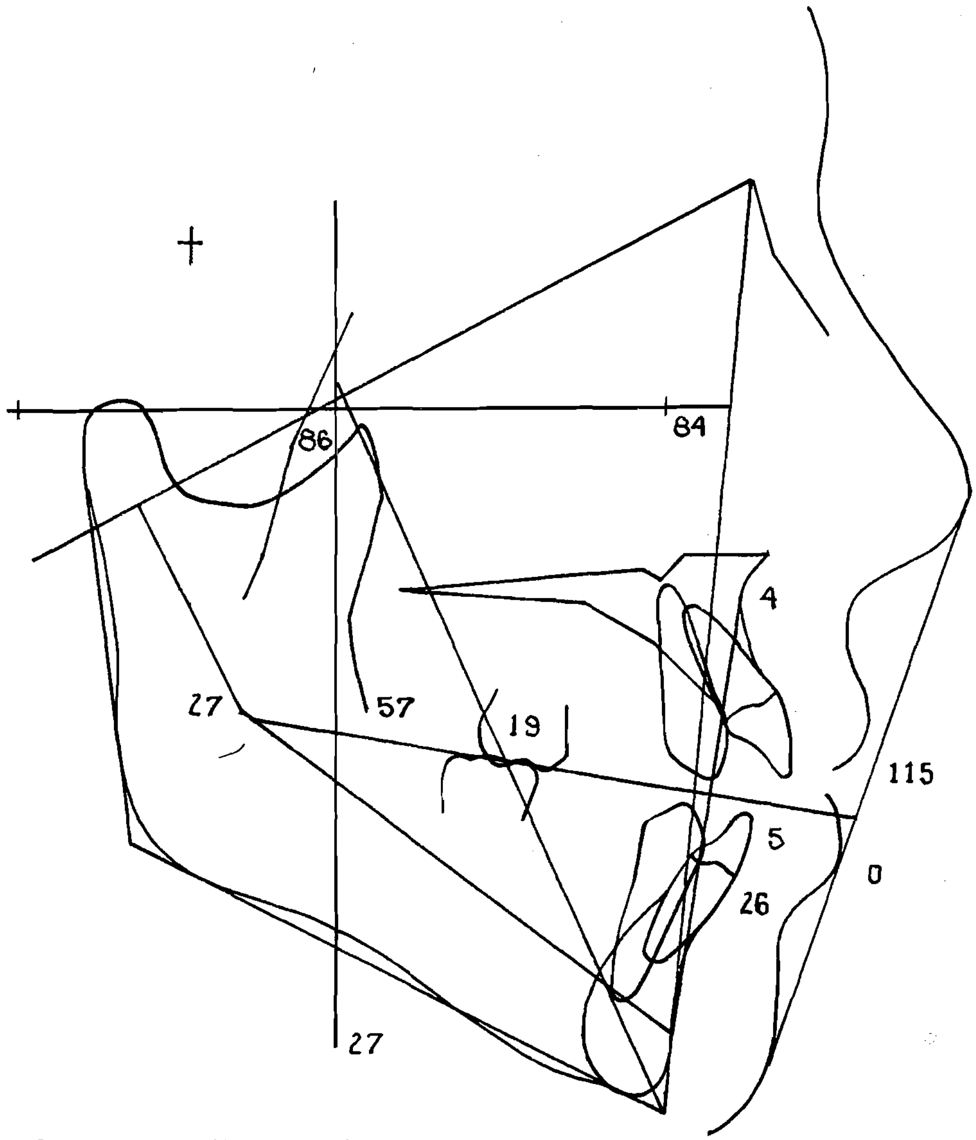

Fig. 327 Patient S.T. 5 years later. Note that, with growth, the *lower face height increased and the facial axis opened, worsening* the long, narrow face already evident in the patient with a dolichofacial pattern.

Chronic nasopharyngeal "inflammation" or obstruction is far too often used as the subjective criterion to justify the performance of a T and A. However, the incidence of craniofacial osseous anomalies (for example, submucous cleft palate) cannot be determined without quantifying radiologic information (profiles). Analysis of the nasopharyngeal cephalometric profile will reduce the probability and incidence of the danger of postoperative velopharyngeal incompetence in T and A surgery. It has been reported that occurrence of temporary hypernasality following T and A operations is at least 7.2 percent[7].

The nasopharyngeal cephalometric profile presents areas of anatomic displacement or distortion which are not easily recognized during the routine subjective clinical head and neck evaluation. The results of this analysis should be

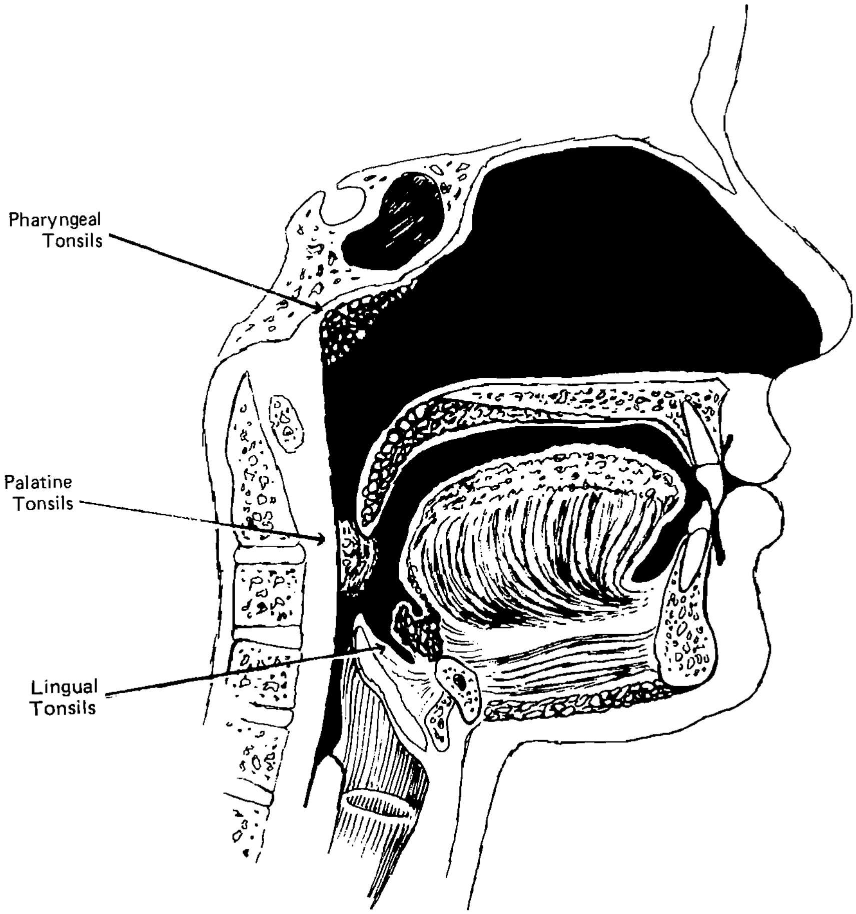

Fig. 328 Location of the adenoid tissue.

used to complement the pathologic profile (chronic tonsillitis) so that multidisciplinary clinicians can manage the patient through a clinical growth period (9 to 13 years).

Previous Studies

The nasopharyngeal tonsil, pharyngeal tonsil, or adenoid is a component of a ring of several lymphoid tissue masses known as Waldeyer's ring. The remaining components include the palatine or faucial tonsils, the lingual tonsils, and a scattered collection of lymphoid follicles within the mucous membranes of the pharyngeal wall.[8] (Fig. 328).

Although its function is not completely understood, the adenoid has been studied extensively in order to clarify its role in relation to the development of the nasopharynx and its accompanying airway.

In 1930, Scammon[9] pointed out that lymphatic tissue, such as that of intestinal lymphoid masses and thymus, shows rapid growth in infancy and early childhood and continues to grow, though at a slower rate, until puberty, with a gradual decline thereafter.

A subsequent study of adenoid configuration in the midsagittal plane by Subtelny and Koepp-Baker[10] has confirmed that adenoids follow Scammon's lymphatic cycle. The study indicated that the adenoids are apparent on x-ray at 6 months of age and attain their maximum mass between the ages of 9 and 15 years.

In a study by Pruzansky and Handelman, [11] the relative size of the adenoid was compared to the area occupied in the nasopharynx. It was found that adenoids judged to be large relative to their nasopharyngeal housing are most frequently observed between the ages of 4 and 6 years and become less frequently observed in the older groups.

It has also been found that a number of seemingly unrelated medical problems can be the result of an imbalance between the sizes of the adenoids and the nasopharynx. Cases of hypoventilation and cor pulmonale due to chronic upper airway obstruction have been reported in the literature by Menashe, Ferrehi, and Miller.[12] When such cases were treated by tonsillectomy and adenoid-

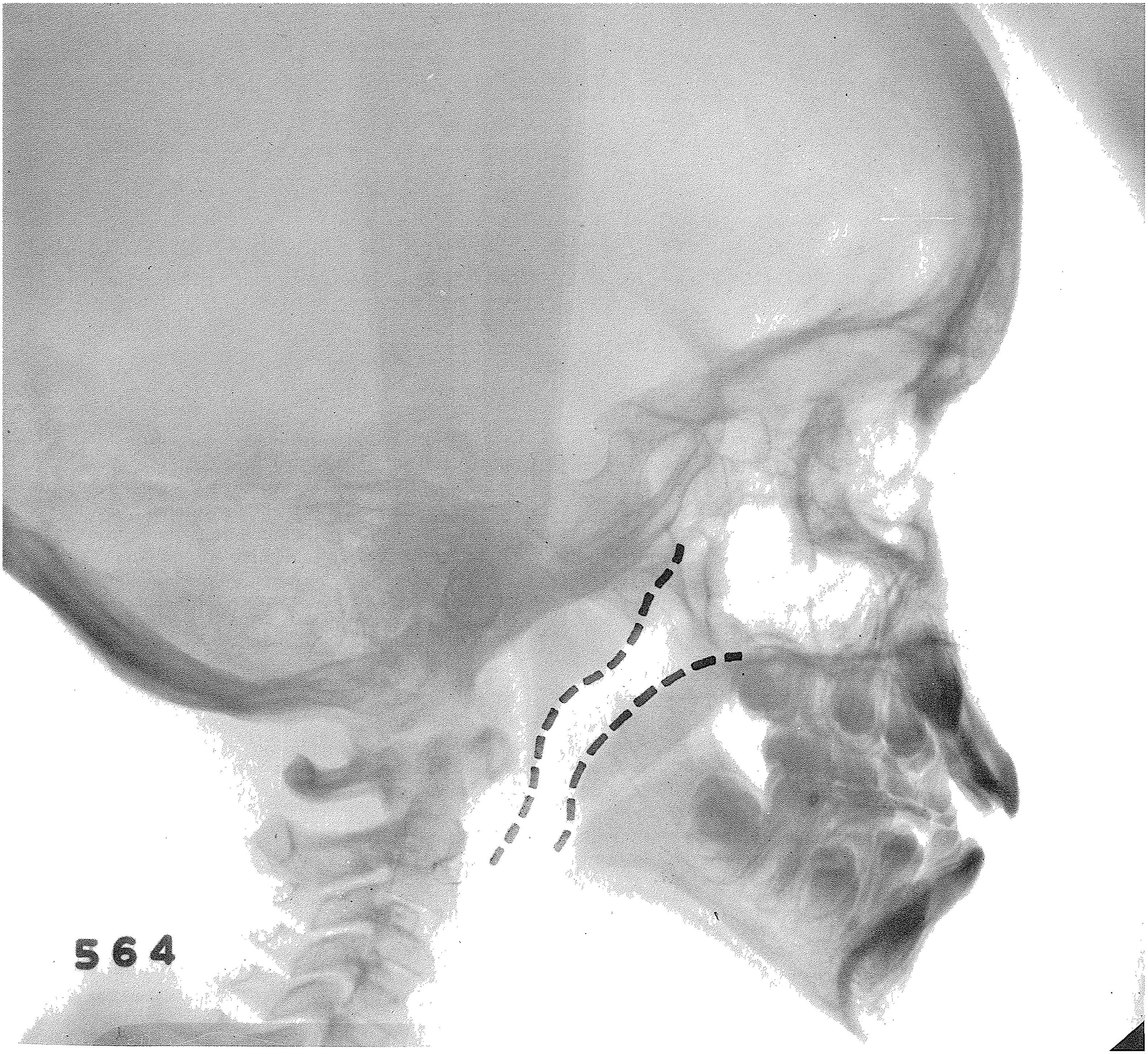

Fig. 329 The adenoid tissue outline can be easily seen on the lateral cephalogram.

ectomy, dramatic improvement was shown in respiration, cyanosis disappeared, right ventricular hypertrophy receded, and normal activity was resumed.

Levy and associates [13] reported a case of hypertrophied adenoids causing pulmonary hypertension and severe congestive heart failure. An adenoidectomy was performed because it was believed that this alone might be sufficient to relieve the obstructed airway. Afterward, the patient progressively improved.

Balanced against the medical problems that occur with enlarged adenoids are the possible detrimental effects to the human body caused by the removal of adenoid tissue. One problem that may be encountered is a decrease in the body's immunity to illness and disease.

The production of immunoglobulins by the body's lymphoid tissue, including the adenoids, has been found to be important in preserving immunity. In fact, according to Steele and colleagues, [14] the lymphoid follicles in the spleen and in the tonsillar tissue, as well as the other lymphatic tissues in the body, are the main sources of immunoglobulins.

Lateral cephalometric roentgenograms have been used to study the growth of the nasopharynx and the adenoid tissue.[15] Since both soft and hard tissue can be viewed on such roentgenogram, the soft tissue of the nasopharynx can be easily related to bony landmarks of the face and cranium. (Fig. 329).

The frontal or posteroanterior radiographic view has also been used occasionally in the study of the bony airway, especially in order to gain a three-dimensional perspective of the nasal and pharyngeal airway.

Linder-Aronson[16,17] of Sweden, in a study of the effect of adenoids on airflow, facial skeleton, and dentition, used forty-five linear, angular, and two-dimensional measurements from lateral cephalometric and posteroanterior radiographs to classify skeletal changes in mouth breathers. He stated that, according to his measurements, the skeletal variable of greatest importance for mouth breathing appears to be the size of the nasopharynx.

A nasopharyngeal area was derived mathematically by Handelman and Osborne[18], using nasopharyngeal depth, nasopharyngeal height, and the angle of the basion-nasion line to the palatal plane. With these measurements, the relative areas occupied by airway and soft tissue were calculated for a number of cases.

A measurement of nasopharyngeal depth to determine adenoid blockage of the nasopharynx was advanced by Ricketts[18,19]. He recommended a measurement from pterygoid vertical (PTV) to the adenoid tissue, 5mm superior to the palatal plane (ANS-PNS), which he found to be an excellent discriminator between mouth breathers and non-mouth breathers.

In his masters' thesis, Bushey[20] studied the alterations in anatomic relations accompanying the change from oral to nasal breathing, and vice versa. He used over a dozen lateral cephalometric measurements to measure these changes in bony landmarks as well as soft-tissue changes.

The nasopharyngeal cephalometric procedures described have been used to create a system which will aid in determining the need for adenoidectomy.

Recent Study

An effective method of using the lateral cephalogram to evaluate nasopharyngeal incompetence was derived by Poole[21]. More than 200 measurements were used to analyze the frontal and lateral tracings. These measurements included not only standard cephalometric lateral and frontal measurements[19] but also many measurements used in previous studies[8,16,20] or those hypothesized to be useful in measuring adenoid development.

Tests of the 200 measurements revealed four statistically significant measurements related to adenoid hypertrophy and/or nasopharyngeal dimensions. These measurements are illustrated in Fig. 330 and are described as follows:

1. Adenoid percentage: Percentage of nasopharynx occupied by adenoid tissue (shown in Fig. 330 as the ratio of striped area to trapezoid area). This measurement is a modification of Handelman's and Osborne's[8] nasopharyngeal area measured in the study of adenoid development as published in July, 1976.

2. D-AD1:PNS: Distance from PNS to the nearest adenoid tissue measured along a line through PNS in the direction of BA (Fig. 330).

3. D-AD2:PNS: Distance from PNS to the nearest adenoid tissue measured along a line through PNS perpendicular to S-BA (Fig. 1.8). Linder-Aronson[17] used these two measurements in his study of anteroposterior nasopharyngeal dimensions of "mouth breathers" and "nose breathers."

4. D-PTV:AD: Distance to the nearest adenoid tissue from a point on PTV 5mm superior to PNS (Fig. 330). Ricketts[14,18] used this measurement in his analysis of the nasopharyngeal "airway."

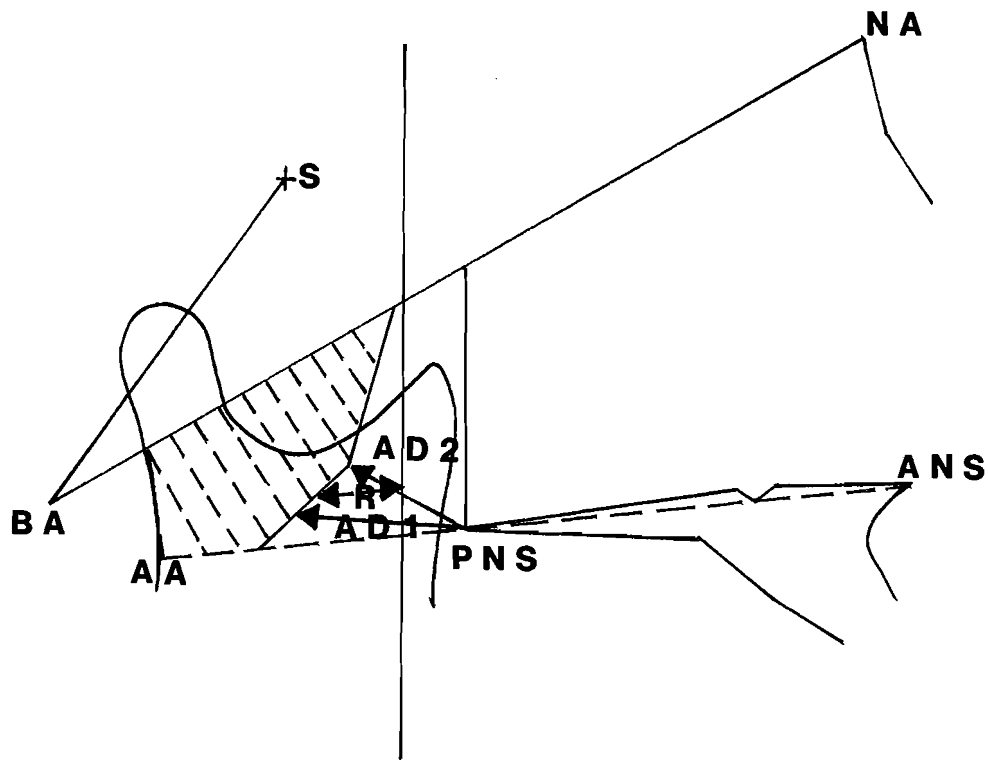

Fig. 330 Lateral cephalometric angular and linear measurements used to determine amount of adenoid tissue and potency of the nasopharyngeal airway.

Norms have been calculated for each of these four variables. Norms and standard deviations at the ages of 6 and 16 for both sexes are shown in Table 17. Norms and standard deviations for any age in between can be estimated by linear interpolation. Great variation can be seen in the mean values with respect to age, but little difference is noted between sexes.

It has been noted that no single measurement consistently reflects nasopharyngeal blockage. In some cases, one or two measurements are more than one standard deviation below normal, while in other cases three or all of the four measurements can be significantly below normal. In still other cases exhibiting mouth breathing, none of the variable are significantly below the norm.

A procedure was developed to determine when an enlarged adenoid problem exists. The technique is a follows:

For each case to be classified, the four variables (adenoid percentage, D-AD1:PNS, D-AD2:PNS and D-PTV:AD) are measured and compared to the norms derived from the sample data and listed in Table 17. For each individual, the number of measurements falling more than one standard deviation below the norm is counted and the classification scheme used is shown in Table 18.

The exactness of this scheme has been tested by classifying patients with known adenoid problems, as well as patients with no adenoid problems. It was shown that fewer than 5 percent of the patients with no adenoid obstruction will be classified incorrectly as having possible adenoid problems, and fewer than 0.5 percent will be classified as having probable or certain adenoid problems.

NORMS FOR AIRWAY MEASUREMENTS

Measurement		Male 6 yr.	Male 16 yr.	Female 6 yr.	Female 16 yr.
Airway percent	$\bar{X}$	50.55	63.96	50.99	62.68
	S	15.85	12.80	13.49	16.09
D-AD1:PNS	$\bar{X}$	20.66	26.48	14.74	26.32
	S	5.50	5.45	5.69	4.28
D-AD2:PNS	$\bar{X}$	15.89	22.44	14.93	21.78
	S	3.53	4.26	3.52	4.67
D-PTV:AD	$\bar{X}$	7.07	14.59	7.02	14.56
	S	3.84	6.10	3.87	4.70

$\bar{X}$ - Mean

S - Standard deviation

Table 17 Norms for airway measurements.

CLASSIFICATIONS: DEGREE OF ADENOID PROBLEM

No. of Measurements More Than One Standard Deviation Below Norm	Classification
0-1	No adenoid problem
2	Possible adenoid problem
3	Probable adenoid problem
4	Definite adenoid problem

Table 18 Classification scheme for degree of adenoid impingement upon the nasopharyngeal airway.

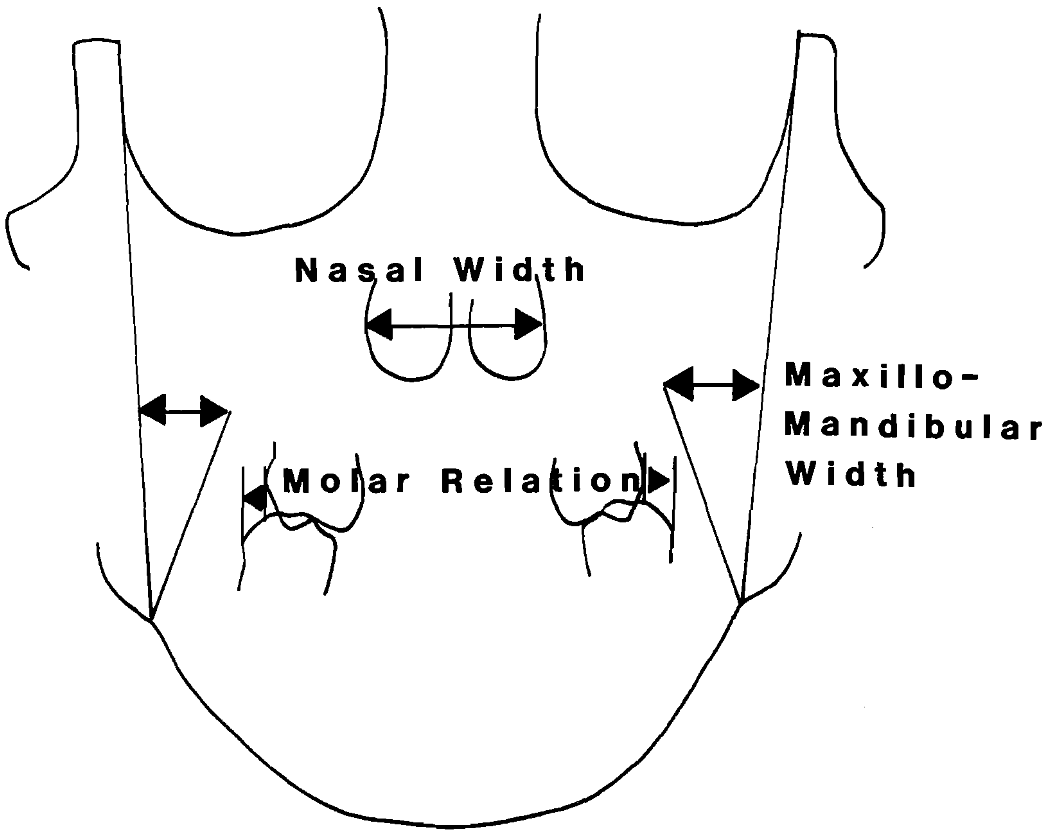

Fig. 331 Need for palate separation can be determined cephalometrically by evaluating the width of the maxilla compared to the mandible, the width of the nasal cavity, and the buccal molar relation.

Other Considerations

Inadequate airway due to nasal resistance can also be improved through palate separation.[22,23] If the patient exhibits a crossbite malocclusion, the maxilla is usually narrow. Orthopedic palate separation could significantly increase the airway, particularly if the nasal cavity is already narrow. Studies at the University of North Carolina[24] reported a 45% average improvement in nasal resistance through palate separation, **provided adenoid obstruction was not present.**

To determine cephalometrically if palate separation is indicated to correct an airway deficiency, one must evaluate the buccal molar relation, the width of the maxilla compared to the mandible, and the width of the nasal cavity (Fig. 331). If the molar relation shows a lingual crossbite and the maxilla is narrow compared to the mandible, palate separation may improve nasal breathing.

A third important factor in establishing nasal breathing is the clinical examination and patient health record. Inadequate nasal respiration can be caused by allergy, nasal inflammation, nasal polyps, deviated septum, and other non-cephalometric factors. Bushey[26] found that a combination of the four factor nasopharyngeal analysis described above and cephalometric evaluation of the need for palate separation was less than 70% accurate in prescribing all proper procedures for eliminating dependence on oral respiration. However, when the results of clinical examinations were combined with the cephalometric factors, he was able to predict prior to treatment, which courses of action would facilitate nasal respiration with approximately 90% accuracy.

PATIENT HISTORY SHEET

PATIENT NAME ______________________ NO. __________ DATE __________

I. PREVIOUS ORTHODONTIC TREATMENT

☐ 0. None ☐ 1. Some ☐ 2. Considerable

II. HEREDITARY FACTORS

A. Growth Potential
1. Father's height
Inches ________
2. Mother's height
Inches ________
B. General development resembles:
☐ 0. Neither Parent ☐ 1. Father ☐ 2. Mother
C. Congenital Abnormalities
☐ 0. None ☐ 1. Cleft Palate

III. DEVELOPMENTAL FACTORS

A. Chronologic Age (Yrs/Mos) ________
B. Height (Inches) ________
C. Weight (Pounds) ________
D. Somatotype
☐ 0. Mesomorph
☐ 1. Ectomorph
☐ 2. Endomorph
E. Growth - Last 6 Mos. (Inches) ________
F. Skeletal Age (Yrs/Mos) ________
1. Sesamoid Bone ?
☐ 0. No ☐ 1. Yes
2. Epiphyses Fused? ☐ 0. No ☐ 1. Yes
G. Dental Age (Yrs) ________
Last erupted tooth ________
H. Sexual Development Stage
☐ 1. Pre-pubertal ________
☐ 2. Pubertal ________
☐ 3. Post-pubertal ________
J. Neonatal Period
☐ 0. Normal
☐ 1. Head-moulding
☐ 2. Severe Infections
K. Nursing ☐ 1. Breast ☐ 2. Bottle

IV. GENERAL MEDICAL HISTORY

☐ 0. Normal
☐ 1. Endocrine Disorder
☐ 2. Orthopedic Disorder
☐ 3. Dermal Allergies
☐ 4. Poor Nutrition

V. RESPIRATORY HISTORY

☐ 0. Normal
☐ 1. Rhinitis
☐ 2. Asthma
☐ 3. Tonsilitis
☐ 4. Adenitis
☐ 5. Upper Respiratory Infection
☐ 6. Lower Respiratory Infection
☐ 7. Mouth Breather
☐ 8. Respiratory Allergies

VI. ORAL HABITS

☐ 1. Thumb-sucking-past
☐ 2. Present
☐ 3. Tongue-thrust (corrected)
☐ 4. Tongue-thrust (present)
☐ 5. Lip-sucking
☐ 6. Bruxism
☐ 7. Clenching
☐ 8. Nail-biting
☐ 9. Pacifier

VII. DENTAL HISTORY

☐ 0. Normal
☐ 1. Late Eruption
☐ 2. Early Eruption
☐ 3. Late Exfoliation
☐ 4. Early Exfoliation
☐ 5. Poor Oral Hygiene
☐ 6. Poor Dental Care
☐ 7. Caries
☐ 8. Extensive Treatment

☐ 9. Damaged Teeth (List, E.G. A1L, B6R.)
____

☐ 10. Missing Teeth (List)
____

☐ 11. Supernumerary Teeth (List)
____

VIII. OTHER DESCRIPTIVE FACTORS

A. Musculature
☐ 0. Normal
☐ 1. Hypotonic Perioral Musculature
☐ 2. Hypertonic Perioral Musculature
☐ 3. Poorly Developed Buccal Musculature
☐ 4. Overdeveloped Buccal Musculature
B. Mastication
☐ 0. Adequate ☐ 1. Weak ☐ 2. Heavy
C. Lips
☐ 0. Normal
☐ 1. Thin Upper
☐ 2. Thick Upper
☐ 3. Thin Lower
☐ 4. Thick Lower
☐ 5. Lip Strain
☐ 6. Sublabial Contraction
☐ 7. Mentalis Habit
D. Swallowing
☐ 0. Normal
☐ 1. Small Tongue
☐ 2. Large Tongue
☐ 3. Low Tongue Position
☐ 4. High Tongue Position
☐ 5. Tonsil/Adenoid Complex
☐ 6. Hypotonic Tongue Musculature
☐ 7. Hypertonic Tongue Musculature
☐ 8. Reverse Swallowing
E. Speech
☐ 0. Normal
☐ 1. Affected by Tongue Function
☐ 2. Affected by Malocclusion
F. T-M-J Function
☐ 0. Normal
☐ 1. Clicking/Popping
☐ 2. Crepitus
☐ 3. Subluxation
☐ 4. Pain on Opening
☐ 5. Pain on Closing
☐ 6. Abnormal Closure Path
G. Freeway Space (MM) ________

IX. OTHER ABNORMALITIES/COMMENTS

____
____
____

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Fig. 332 A patient history record should be obtained for any patient undergoing nasopharyngeal examination.

The clinical respiratory examination should encompass six basic areas:

1. Patient history
2. Respiration
3. Lip competence
4. Deglutition
5. Facial form
6. Intraoral examination

The importance of the patient history sheet has been stated above (Fig. 332). The key is to check for any illness that could have a cause and effect relationship with mouth breathing.

Nasal respiration can be checked using various methods ranging from holding a cold piece of glass near the patient's nostrils and examining the amount of condensation to employing an elaborate nasal airflow measuring apparatus (Fig. 333). Various methods of testing nasal respiration are described in detail throughout the literature.[20]

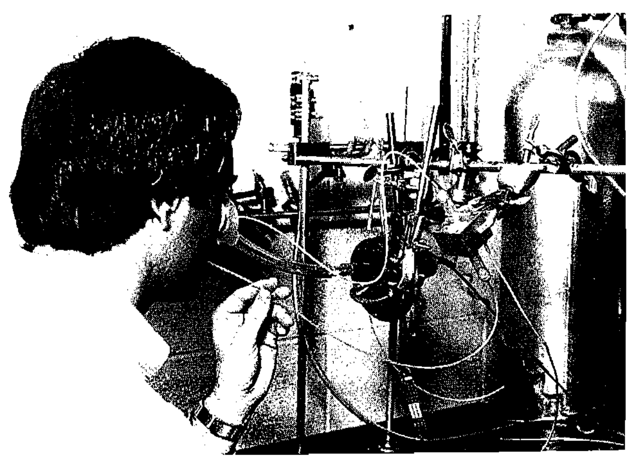

Fig. 333 Nasal airflow apparatus provides a fairly accurate measure of nasal breathing vs. oral breathing.

The typical mouth breather frequently exhibits inadequate lip competence. This status can be seen in the photo of Fig. 334.

The clinical examination, however, is the main source of verification for this fact. Lack of lip competence can be detected by simple examination. However, more specific measurements can be obtained using pressure sensitive devices which measure tonicity [25] (Fig. 335).

Fig. 334 Typical mouth breathing patient exhibiting weak musculature surrounding the lips.

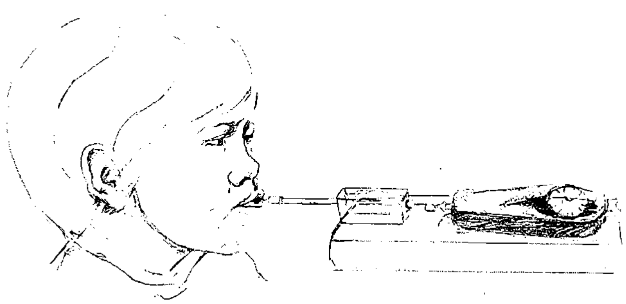

Fig. 335 This device is used clinically to assess lip tonicity.

Improper deglutition may also affect breathing. Observation of patient swallowing patterns can provide valuable information. A cinefluorographic analysis, however, will provide a more complete insight into patient problems [16,15].

Determination of facial form and the intraoral examination are primarily another check on cephalometric findings.

Summary

Inadequate nasal breathing can be related to a variety of medical problems including abnormal craniofacial growth, allergies, orthodontic treatment stability, cardiopulmonary disease, and alteration of the immunological system. Possible treatment to improve the method of respiration can include adenoidectomy, palate separation, medication, speech therapy, formation of new habit patterns, etc., etc. In order to determine the proper treatment plan for any particular patient, a thorough frontal and lateral cephalometric analysis must be performed, as well as a clinical examination and a patient history review. Armed with this information, the doctor or doctors treating the mouth breathing problem can maximize the probability of a successful result.