Mouth Breathing and Malocclusion: Quantitative Technique for Measurement of Oral and Nasal Air-Flow Velocities*

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Orthodontists, by and large, link mouth breathing with malocclusion, particularly, Class II, Division 1 malocclusion. In fact, major orthodontic textbooks[1-6] discuss the subject of mouth breathing under the general heading of etiology of malocclusion. However, it should be recognized that, actually, no sufficient evidence has ever been presented to substantiate a hypothesis that these two conditions are correlated. To the contrary, all existing evidence except that based upon empirical and uncontrolled observations seems to indicate that mouth breathing and malocclusion are independent of each other.[7-10]

The present investigation has been designed to explore the nature of the interrelation existing between mouth breathing and malocclusion by means of carefully standardized quantitative methods.

Material and Methods

The experimental sample consisted of thirty adolescent subjects whose age ranged from 9½ to 15½ years, and four adult subjects whose age ranged from 27 to 36 years. Out of the thirty adolescent subjects fifteen had normal occlusion with a mean overjet of 1.6 mm, while the other fifteen had bilateral Class II, Division 1 malocclusion with an average overjet of 9.3 mm. All four adult subjects had normal occlusion.

Instrumentation

The measuring instrument consisted of three bead thermistors, one for the oral and one for each nasal respiratory passage, mounted on a plexiglas platform which served to separate the nasal from the oral air stream (Fig. 1).

The thermistors employed in this study are semiconductors with inversely proportional temperature and resistance, so that, within certain limits, electrical resistance is almost entirely a function of temperature.[11,12] When voltage is stepped up, the current raises the temperature of the thermistor simultaneously lowering its resistance. When the

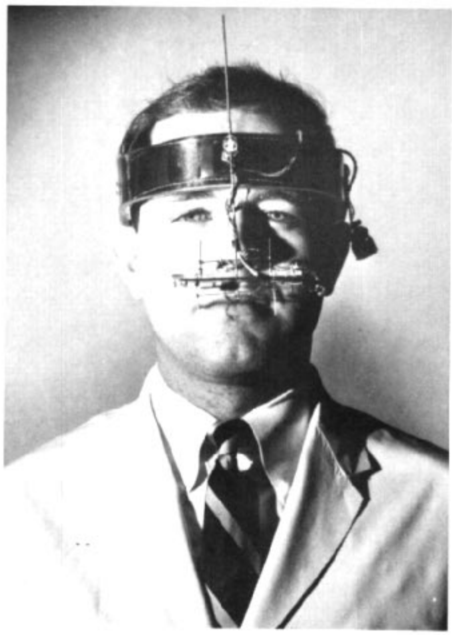

Fig. 1 Frontal view of thermistor assembly *in situ*.

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limit of power available in the circuit is attained, the "self-heating effect" reaches a steady-state condition which remains highly sensitive to all environmental changes that alter the rate of heat dissipation. In this study thermistors were heated to 75°C., *i.e.*, approximately 50°C. above the ambient room temperature. A 22½ volt battery with a Sylvania diode was used as a power source, while a Beckman Dynograph, type R, was employed for registration of the fluctuation of voltage caused by the cooling effects of respiratory air-flow. In order to convert the observed voltages to corresponding air velocities, thermistors were calibrated by means of a spirometer.

Experimental Procedures

The thermistors, bridge circuits and recorder were allowed to warm up for a period of five minutes. The ambient room temperature was measured and then, bridge circuits were balanced by means of bridge-balance potentiometers.

The subject was seated on a straight chair in an upright position and the measuring instrument placed on his head (Fig. 1). Nasal thermistors were adjusted to a distance of ⅛ inch from the center of each nostril, while the oral thermistor was fixed ⅛ inch anteriorly to the most prominent point of the lower lip in the midsagittal plane. Plastic templates were employed for standardized placement of thermistors.

The subject was instructed to relax and remain seated quietly. Then he was left alone in the room and observed through a one-way mirror. Air-flow velocity was recorded for approximately five minutes at a constant paper-drive speed of 0.5 cm/sec, while the subject remained relaxed and relatively motionless.

On ten adolescents, five with normal occlusion and five with malocclusion, a second registration of air-flow velocity was taken after fifteen minutes of rest. During that period the measuring device was removed and subsequently repositioned to test the accuracy of instrument placement. On adult subjects air-flow registration was repeated on five consecutive days at the same time of day.

The breathing habit of each subject was also ascertained subjectively by means of (a) visual observation and (b) cold mirror test,[13] and accordingly, classified as "mouth breathing" (M), "nose breathing" (N), or "nose-and-mouth breathing" (N-M). The patency of nasal passages was tested by closing successively the left and then the right nostril with a vaseline-impregnated cotton roll.[13] Nasal obstruction was scored as: "0"—when test was managed without difficulty, "1"—when test was managed with difficulty and signs of dyspnea, and "2"—when test could not be managed and the child was forced to breathe through the mouth. In some cases an intermediate score of 0-1 or 1-2 was used. In addition, a physical examination of nasal passages and pharyngeal region was performed by means of a nasal speculum, mouth mirror and a tongue blade.

Body weight of each subject was recorded in kilograms on a standard medical scale, while body height was measured in centimeters on an anthropometric board. Surface-area of the body was calculated by means of Dubois body-and-surface chart, modified by Boothby and Sanford.

Analysis of the Recorded Air-Flow Velocities

The following respiratory parameters were identified on oscillographic tracings (Fig. 2) and measured on sixty continuous respiratory cycles recorded on the right-nasal, left-nasal and oral channels:

1. *Peak Inspiratory Velocity* (i), determined by the maximum deflection of

recording stylus during the inspiratory phase of the respiratory cycle.

2. *Peak Expiratory Velocity* (e), determined by the maximum deflection of recording stylus during the expiratory phase of the respiratory cycle.

3. *Duration of the Respiratory Cycle* (R), measured in millimeters and converted to seconds.*

Findings

The mean values of recorded peak respiratory air-flow velocities and the duration of respiratory cycles revealed a considerable between-subject variability and absence of a noticeable intergroup difference (Table 1). In fact, a t-test of group means (Table 1) strongly suggests that, in our sample, breathing pattern observed in Class II subjects does *not differ significantly* from that recorded in normal subjects.

A great number of youngsters in both experimental groups appeared to be "pure" nose breathers but no subject in either group disclosed "pure" mouth breathing. Seven "mouth-and-nose breathers" were identified in the malocclusion group, as compared to four in the normal occlusion group.

* A constant paper-drive speed of 0.5 cm/sec was maintained throughout the experiment.

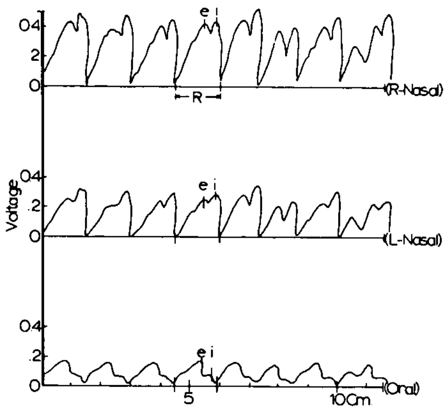

Fig. 2 Tracing of eight respiratory cycles recorded on a "mouth breather": i, peak inspiratory velocity; e, peak expiratory velocity; R, duration of respiratory cycle.

Double determination of the respiratory pattern performed on ten adolescents at fifteen minute intervals, during which the measuring instrument was removed and then repositioned, revealed significant within-subject differences. A similar instability of the prevailing respiratory pattern was observed among adult subjects on whom measurements were repeated on five consecutive days. In this group, the coefficient of within-subject variation of recorded air velocities ranged from 11.9% to 52.7%.

An intercorrelation of the recorded variables was estimated for the total

Table 1

Comparison of the respiratory pattern recorded in the two experimental groups.

Variable	Normal Group (n=15) Mean	S.D.	Class II Group (n=15) Mean	S.D.	t*
Peak Insp. R.N. (cm/sec)	181.6	71.4	168.2	97.5	0.41
Peak Exp. R.N. (cm/sec)	130.5	56.9	129.7	59.0	0.04
Peak Insp. L.N. (cm/sec)	196.9	65.2	273.7	169.8	1.58
Peak Exp. L.N. (cm/sec)	181.6	59.5	196.0	70.5	0.59
Peak Insp. Oral (cm/sec)	3.4	7.2	6.3	11.1	0.81
Peak Exp. Oral (cm/sec)	6.7	14.8	16.4	27.0	1.17
Duration Resp. Cycle (sec)	3.1	0.5	3.1	0.6	0.16

* All t-values non-significant at 0.05 level

sample and for the two subgroups. Strong positive coefficients of correlation were obtained only between the inspiratory and expiratory air velocities registered in the same nostril. In general, correlations seemed to be of a higher magnitude in the malocclusion group than in the normal group.

A clinical inventory of the breathing habits and the nasopharyngeal structural characteristics observed in our sample (Tables 2 and 3) disclosed no consistent positive correlation with the corresponding oral and nasal air-flow velocities recorded on these subjects.

Discussion

The observed within-subject variation of peak air-flow velocities, both within-day and between-day, could be derived from two distinct sources: (1) the inaccuracy of the instrument positioning, and (2) normal physiologic respiratory fluctuation. Further research is needed to determine the relative contribution of these two factors to the general instability of recorded respiratory patterns. It must be recognized, of course, that the within-subject and between-subject variability, brought about by our instrumentation, could actually be responsible for the lack of statistically significant respiratory differences between the normal occlusion group and the malocclusion group. However, it should be mentioned that other laboratories have obtained quite similar results by means of different rhinometric techniques which employ a nasal mask with a pressure transducer[14] instead of thermistors.

It is noteworthy that subjective clinical observations (Tables 2 and 3) inferred a greater prevalence of mouth breathers in the malocclusion group than has been actually determined by means of recording of air-flow pattern on these subjects. We would like to propose, therefore, that a subjective evaluation of the patient based upon (1) visual observation, (2) clinical examination of nasopharyngeal passages and (3) "cold mirror test" cannot be relied upon for positive identification of his breathing habits. For example, subject No. 20 has been classified as a mouth breather on the basis of his physical appearance and "cold mirror test" (Table 3); however, according to the recorded air-flow pattern, this subject was a "pure" nose breather.

Summary

1. Mouth breathing does not seem to be significantly correlated with the dental occlusion.
2. Further research is needed to determine: (a) the reliability of "thermistor technique," as well as other rhinometric methods, for measuring of respiratory air-flow, and (b) the magnitude of normal physiologic fluctuation of air-flow velocities.
3. A patient's facial appearance and various subjective breathing tests cannot be viewed as valid indicators of respiratory pattern, since many subjects classified as "mouth breathers" actually reveal no discernible oral air-flow.
4. There seems to be no correlation between the duration of respiratory cycle and the peak respiratory air velocity.

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Acknowledgments

The authors wish to acknowledge, with thanks, the assistance of: Prof. Harold W. Shipton, Bioengineering Research Facility; Prof. Paul E. Leaverton, Preventive Medicine and Environmental Health Dept.; and Mr. Donald E. Laughlin, Internal Medicine Dept.

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Table 2

Summary of clinical observations recorded on subjects with normal occlusion.

Subject	Sex	Deviated Septum*	Enlarged Palatine Tonsils	Enlarged Pharyn. Tonsil	Enlarged Turbinates Right	Enlarged Turbinates Left	Breathing Habit** Visual Observation	Breathing Habit** Cold mirror test	Nasal obstruction test*** Right	Nasal obstruction test*** Left
1	F		+	+		+	N	N	0	1
2	F		+	+		+	N	N	0	0
3	M	R	+	+			N	N	0	0-1
4	F		+		+	+	N	N	0	0-1
5	F		+	+			N	N	0	0-1
6	F			+		+	N	N	0	0-1
7	M	R				+	N	N	0	0-1
8	F				+		N	N	0	0
9	M		+	+			N	N	0	0
10	M		+	+	+	+	N	N	0-1	1
11	F				+	+	M	N	2	1
12	M						N	N	0	0
13	F		+	+	+		N	N	0	0
14	F	L			+		N	N	1	0
15	M		+	+	+		N	N	0	0

* To the Right (R) or to the Left (L)

** N = nose breathing; M = mouth breathing; N-M = nose-and-mouth breathing

*** After Linder-Aronson and Backstrom (1960)

Table 3

Summary of clinical observations recorded on subjects with Class II malocclusion.

Subject	Sex	Deviated Septum*	Enlarged Palatine Tonsils	Enlarged Pharyn. Tonsil	Enlarged Turbinates Right	Enlarged Turbinates Left	Breathing Habit** Visual Observation	Breathing Habit** Cold mirror test	Nasal obstruction test*** Right	Nasal obstruction test*** Left
16	F	R	+	+			M	M	1	0
17	M	R					NM	M	0	0-1
18	F		+			+	NM	N	0	0
19	F	R				+	NM	N	0	0-1
20	F		+	+			M	M	0	0
21	F	R	+	+			N	N	0	0
22	M	R	+	+	+	+	N	N	0-1	1
23	M	L			+		M	N	0-1	0
24	M						N	N	0	0
25	F	R	+		+	+	M	N	0	1
26	F				+	+	NM	NM	0	0
27	M		+	+	+		NM	M	0	0
28	F	R	+	+	+	+	M	N	0-1	0
29	F	R	+	+	+	+	M	N	0	0
30	M		+	+	+	+	NM	•NM	1	1

* To the Right (R) or to the Left (L)

** N = nose breathing; M = mouth breathing; N-M = nose-and-mouth breathing

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