The purpose of the present study was to determine the prevalence of mouthbreathing in the cleft population. Percent nasal breathing was assessed in 85 children and adults using a pneumotachograph to measure nasal volumes and an inductive plethysmograph to measure tidal volumes. Breathing mode was defined using the following classifications of percent nasal breathing: 80 to 100 percent, nasal; 60 to 79 percent, predominantly nasal; 40 to 59 percent, mixed oral-nasal; 20 to 39 percent, predominantly oral; 0 to 19 percent, oral. Results demonstrate that 68 percent of the subjects were oral, predominantly oral or mixed oral-nasal breathers, and 32 percent were predominantly nasal or nasal breathers. Adults had the same prevalence of mouthbreathing as children. These findings demonstrate that cleft lip/palate and its treatment frequently compromise nasal respiration.

KEY WORDS: mouthbreathing, pneumotachograph, plethysmograph

The nasal airway is frequently impaired in cleft palate. Maxillary growth deficits constrict the nasal floor and thereby increase nasal airway resistance (Foster, 1962; Drettner, 1960). Similarly, an increased frequency and severity of deviated septum, vomerine spurs, and nasal atresia decrease nasal airway size and increase the work of breathing through the nose (Aduss and Pruzansky, 1967; Warren et al, 1969).

Surgical corrections of nasal deformities and palatal incompetence may further compromise the upper airway and breathing (Kravath et al, 1980; Guilleminault et al, 1976; Warren et al, 1974). Attempts to restore symmetry between nostrils may lead to a reduction in size of the unaffected nostril in a unilateral cleft. Secondary procedures for palatal incompetence significantly reduce nasopharyngeal dimensions as well (Warren et al, 1974).

A restricted nasal airway and high nasal resistance usually result in obligatory mouthbreathing, a mode of respiration considered by some to have potentially harmful effects on dental and facial development (Morrison, 1931; Strang, 1943; Jennes, 1963; Reid and Donaldson, 1970; Linder-Aronson, 1973, 1979; Quinn, 1978). Evidence that the cleft airway is frequently impaired implies that mouthbreathing is common in that population. While clinical impressions support such an assumption, no objective data are presently available.

The primary purpose of the present study was to determine the prevalence of mouthbreathing in the cleft population. Secondary factors considered in this study were (1) whether age relates to the prevalence of mouthbreathing and (2) whether the posterior pharyngeal flap, a frequently used secondary surgical procedure, is associated with the prevalence of mouthbreathing.

METHOD

Eighty-five children and adults with cleft lip and palate were studied. This heterogeneous sample included individuals with primary and secondary repairs of the lip and palate who presented to the Oral-Facial and Communicative Disorders Program at the University of North Carolina at Chapel Hill for diagnostic evaluation between January, 1985 and September, 1986.
(unilateral complete cleft, N = 26; bilateral complete cleft, N = 20; cleft of the secondary palate only, N = 29; submucous cleft, N = 10).

A broad sample was selected in order to provide an estimate of the extent of mouthbreathing in a typical population of individuals with cleft palate.

The methodology involves a recently introduced device which monitors ventilation in a noninvasive way (Warren et al, 1986). The respiratory inductive plethysmograph consists of two transducers that record the relative movements of the abdomen and thoracic cage during respiration (Fig. 1) (Cohn et al., 1978; Watson, 1980; Sackner, 1980). Two teflon coated wires sewn into a lightweight material are fastened around the upper chest and abdomen and attached to frequency oscillators that connect to a calibration system. Each transducer measures changes in inductance that are proportional to changes in thoracic cage and abdominal volumes. Breathing changes the cross-sectional area of the transducer coils and the resulting inductance changes are converted to proportional voltages. The rib cage and abdominal signals are then calibrated against a known volume by having the subjects breathe into a spirometer. The sum of the calibrated signals (i.e., thoracic and abdominal) is equivalent to tidal volume. Separation of the oral and nasal components of total volume is accomplished by placing a small nasal cap over the nose and connecting it through a tube to an integrating pneumotachograph which measures nasal air volume. The ratio of nasal to tidal volume is then multiplied by 100, and a percentage of nasal breathing is thus obtained.

All subjects were examined in the morning. The data were collected for each patient during one visit. Following the establishment of steady-state breathing for at least 4 minutes, a 10 second sample (1,024 data points) was captured by the computer for subsequent analysis.

RESULTS

The data were grouped into five categories of breathing mode. Individuals who demonstrated a percent nasal breathing of 80 or greater were classified as nasal breathers. In fact, some individuals scored slightly above 100 percent. This reflects measurement error associated with this technique. Although we have reported a mean error of about 5 percent, errors as great as 10 percent are not uncommon (Warren et al, 1986).

Mouthbreathing was defined using the following criteria. Individuals scoring between 60 and 79 percent were classified as predominately nasal breathers. Those scoring 40 to 59 percent were considered mixed oral-nasal breathers. Those scoring 20 to 39 percent comprised the predominately oral breathers, and those scoring 0 to 19 percent were considered to be oral breathers. These are arbitrary classifications which, nonetheless, appear to be reasonable.

Figure 2 illustrates the findings according to group. The largest number of subjects (37 percent) were oral breathers. Sixty-eight percent of the sample fell within groups that were more oral than nasal. Only 32 percent of the subjects were either predominately nasal or nasal breathers.

Figure 3 illustrates the findings according to age. The adult group comprised those 15 years and older, and the children’s group consisted of those less than 15 years of age. Justification for these age categories is based on our previous studies, which demonstrated that internal growth of the nose generally ceases by age 15 (Warren et al, 1969). There were 22 subjects in the adult group and 63 subjects in the children’s group.

Statistical analysis (t-test, p >0.5) revealed no difference according to age when percent nasal respiration was the variable tested. Sixty-eight
percent of those over age 15 were oral, predominately oral, or mixed oral and nasal breathers. Sixty-seven percent of those under 15 years of age also fell within these categories.

Figure 4 illustrates the findings for those subjects who had received posterior pharyngeal flaps. A total of 32 belonged to this subgroup. Fifty percent of this subgroup were oral breathers, 22 percent were predominately oral breathers, and 6 percent were mixed oral and nasal breathers. Only 22 percent were nasal or predominately nasal breathers. The data were further analyzed according to age group, and once again no differences were observed.

**DISCUSSION**

Although a high prevalence of mouthbreathing was expected in the cleft population, the extent and severity observed in this population were not anticipated. Published data on the prevalence of mouthbreathing in the normal population indicates that the percentage is approximately 15 percent (Niinimaa, 1981; Saibene, 1978; Uddstromer, 1940). Our own continuing studies suggest that about 30 percent of the normal population breathes through the oral mode to some extent. Differences in the methods used are probably responsible for the differences reported in the literature for the normal population. Most habitual mouth breathers in the normal population are mixed oral-nasal breathers or predominately nasal breathers rather than predominately oral or oral breathers. The cleft population presents an almost complete reversal of normal patterns. About 70 percent of the subjects in this study were oral, predominately oral, or mixed oral-nasal breathers. More worrisome is the finding that 37 percent were found to be oral breathers. Since air flows through the path of least resistance, this implies that there is severe airway impairment in many of the subjects with cleft.

Another unexpected finding was that adults had the same prevalence of mouthbreathing as children. We previously reported that the nasal airway in cleft palate improves somewhat with growth (Warren et al, 1974). Therefore, a lower prevalence of mouthbreathing was expected. Since prevalence of mouthbreathing did not change, we must conclude that the improvement with growth is not sufficient to induce a change in breathing mode. Another possibility is that once the pattern of mouthbreathing is established, change does not rapidly occur even when the airway improves. That is, obligatory mouthbreathing is replaced by habitual mouthbreathing rather than nasal breathing. There is evidence in the literature that mouthbreathing can become a learned behavior (Bouhuys, 1977; Polgar and Kong, 1965).

Since subjects did not receive a nasal or nasopharyngeal examination prior to measurement nor were influencing variables such as history of allergies, vasomotor rhinitis, nasal surgery, condition of tonsils and adenoids, current medications, or onset of menses taken into account, this preliminary study cannot establish an etiology for mouthbreathing, other than to distinguish between the presence or absence of a pharyngeal flap. The findings from this study will be used to investigate in more detail vari-
ables that may have influenced the subjects’ breathing pattern.

Many clinicians believe that mouthbreathing is a harmful behavior often associated with alterations in dentofacial growth (Morrison, 1931, Strang, 1943; Jennes, 1963; Reid and Donaldson, 1970, Linder-Aronson, 1973, 1979; Quinn, 1978). Our own studies (Watson et al., 1968; Vig et al., 1981; Warren et al., 1984; Hinton et al., 1986) suggest otherwise except in instances where the oropharynx is quite small. A long draping velum, large tonsils, or high tongue carriage in combination with obligatory mouth-breathing may lead to a postural response that influences dentofacial growth. In most instances, an individual with nasal airway impairment and normal oropharyngeal morphology would only need to part his lips 2 to 3 mm to reduce airway resistance such that respiration can freely function. Parting of the lips 2 to 3 mm corresponds to an area of 0.4 to 0.5 cm² (Warren et al., 1984).

Harvold 1979, demonstrated the extreme situation very nicely in his study of primates with nasopharyngeal atresia. The primate was not structured to mouthbreathe and an exaggerated postural response to open the oral airway was necessary for survival. This resulted in altered dentofacial growth.

Again, while this is rarely the case in humans, there are circumstances that diminish the oropharyngeal airspace in cleft palate. A constricted maxilla, large tonsils, a posterior pharyngeal flap, or scarring of the pillars are not unusual, and as this study demonstrates, neither is obligatory mouthbreathing. The consequences in terms of dentofacial growth will be explored in future studies.

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REFERENCES


