Nasal Airway Dimensions of Adults With Cleft Lip and Palate: Differences Among Cleft Types

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Objective: **To determine the nasal airway dimensions in adults with repaired cleft lip and palate by rhinomanometry and to analyze the reduction associated with different types of clefts.**

Model: **A prospective analysis comparing three types of previously repaired clefts: bilateral cleft lip and palate (BCLP), unilateral cleft lip and palate (UCLP), and isolated cleft palate (CP) at the 5% level of significance.**

Setting: **Laboratory of Physiology, Hospital for Rehabilitation of Craniofacial Anomalies, University of São Paulo, Bauru, Brazil.**

Participants: **Fifty-three subjects aged 18 to 35 years (17 BCLP, 16 UCLP, 20 CP) and a group of 20 individuals without cleft (N).**

Variables: **Minimum cross-sectional nasal area assessed by posterior (PR) and anterior (AR) rhinomanometry and nasopharyngeal area assessed by modified AR.**

Results: **Mean (± 1 SD) nasal areas obtained by PR were: 0.47 ± 0.16 cm² (BCLP), 0.57 ± 0.19 cm² (UCLP), 0.61 ± 0.13 cm² (CP), and 0.60 ± 0.10 cm² (N). The mean value for the BCLP group was significantly smaller than that for the N and CP groups. The remaining values did not differ from one another. The proportion of subjects with subnormal areas obtained by PR was 41%, 19%, and 0% for groups BCLP, UCLP, and CP, respectively. Similar results were obtained by AR. All subjects presented a nasopharyngeal area larger than 0.80 cm², denoting absence of obstruction in the nasopharynx.**

Conclusions: **In adulthood BCLP is the type of cleft associated with a greater reduction of nasal airway, compared with UCLP and CP, suggesting that adults with BCLP are at a greater risk for nasal obstruction.**

KEY WORDS: *cleft lip and palate, nasal airway, rhinomanometry*

Cleft lip and palate are often associated with nasal deformities such as septal deviation, nostril atresia, turbinate hypertrophy (real or relative), and deficiency of maxillary growth that alter the nasal floor (Drettner, 1960; Warren et al., 1969, 1992b; Hairfield et al., 1988; Hairfield and Warren, 1989). These deformities are due in part to the congenital defect itself and also to the surgeries that are done (Wetmore, 1992; Gubisch, 1995). The nasal deformities tend to reduce the dimensions of the nasal cavity, increase nasal resistance to air flow, and reduce nasal patency, all of which can lead to a high prevalence of compensatory oral respiration in this population (Hairfield et al., 1988; Warren et al., 1992b) and may impair craniofacial growth and development (Linder-Aronson 1979), lower airway function (Trindade et al., 1992), and speech production (Dalston et al., 1992).

The anatomical involvement of oral, nasal, and pharyngeal structures in cleft lip and palate may have a particularly negative effect on speech in terms of resonance. There may be dysfunction of the velopharyngeal mechanism leading to hypernasality; alternatively, nasal obstruction may result in hyponasality. It is also possible that both hypernasality and hyponasality may be present in the speech of the same individual. Paradoxically, nasal obstruction may favor speech by reducing the occurrence of articulatory disorders that usually develop to compensate for velopharyngeal dysfunction. Indeed, the nasal airway is an important regulator of the pressures generated in speech when velopharyngeal function is altered. When nasal patency is normal, the lack of isolation between nasal and oral cavities may lead to speech articulation at points inferior to the velopharyngeal region to maintain the pressure necessary for speech production. On the other hand, when nasal obstruction is present, this compensatory mechanism is no longer nec-

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essary because it is the obstructed nasal cavity itself that compensates for velopharyngeal closure. This was the line of reasoning followed by Warren et al. (1992b) when they stated that ‘‘a good nose for breathing is often a bad nose for speech’’ (p. 511).

In view of the above considerations, it is relevant to study nasal patency in a comparative manner in the three most frequent types of cleft involving the palate (i.e., isolated cleft palate [CP], unilateral cleft lip and palate [UCLP], and bilateral cleft lip and palate [BCLP]). Differences in patency may explain eventual variations in the prevalence of compensatory articulatory disorders in these different cleft types, as previously postulated by Warren et al. (1990a) and Dalston et al. (1992).

Rhinomanometry is the technique most frequently used to estimate nasal patency in a quantitative manner, permitting the measurement of nasal resistance or the minimum cross-sectional nasal area. The latter measurement has the advantage over the former of being flow independent (Warren, 1984). The measurement of minimum nasal cross-sectional area has been used by different investigators to characterize the nasal airways of adults and children under normal conditions and in the presence of nasal obstruction (Warren, 1984; Hinton et al., 1986; Warren et al., 1987a, 1987b; Hairfield and Warren 1989; Liu et al., 1992; Vig and Zajac, 1993; Trindade et al., 1995, 1997; among others). Several studies have demonstrated that the nasal area of adults without cleft ranges from 0.60 to 0.70 cm^2 and that values of less than 0.40 cm^2 should be considered suggestive of nasal obstruction, whereas children show significantly lower values. For individuals with CP, studies by Hairfield and Warren (1989), Warren et al., (1990b), Liu et al. (1992), and Trindade et al. (1995) have confirmed the hypothesis that the minimum cross-sectional area of the nose of adults with cleft lip and palate is considerably smaller than that of adults without cleft and have shown that more than 60% of this population has an inadequate nasal area for normal respiration.

Little is known about the differences in nasal dimensions among the different types of clefts (i.e., between those involving only the palate and those involving lip ± palate unilaterally or bilaterally). Warren et al. (1988) studied 60 children with cleft lip, cleft palate, or both whose average age was 10 years and subdivided them according to the type of cleft. They found the largest nasal airway in the BCLP group and attributed this fact to surgery for columella lengthening to which children with bilateral clefts are submitted early in infancy and often at the time of initial palatoplasty. The procedure is indicated to favor nasal esthetics but also because it is assumed to favor nasal patency. However, in a later study, Warren et al. (1992a) raised the possibility that the differences detected between the airways of children with bilateral and unilateral clefts may tend to decrease or even to disappear with age because they no longer detected the same differences in young people aged up to 17 years.

The objective of the present investigation was to extend the study of the nasal airway to adult individuals with cleft palate with or without cleft lip to determine whether the differences reported for children are also manifested in adulthood or whether they are temporary, as suggested by Drake et al. (1993). Thus, the minimal nasal cross-sectional areas of adults with repaired UCLP, BCLP, and isolated CP was determined using posterior and anterior rhinomanometry. The proportion of subjects presenting subnormal areas in each group and the symmetry between the nasal cavities in subjects with UCLP was also analyzed.

METHOD

Subjects

Fifty-three adults with repaired cleft lip and palate, 32 male subjects and 21 female subjects aged 18 to 35 years who were regularly followed up at the Hospital for the Rehabilitation of Craniofacial Anomalies, University of São Paulo, Bauru, Brazil, were evaluated. The subjects were divided into three groups according to type of cleft: 16 subjects with UCLP, 17 with BCLP, and 20 with CP. A group of 20 adults without cleft palate (N), 10 male subjects and 10 female subjects aged 18 to 33 years, were used as controls. In this group, no sex differences were found for nasal areas; therefore, male and female subjects were considered one group throughout the study.

Inclusion criteria for the noncleft and cleft groups were: (1) age older than 17 years, (2) no previous nasal surgery except for the subjects with bilateral cleft who underwent columella lengthening in infancy (7 of 17), and (3) no previous pharyngeal flap surgery, orthognathic surgery, or surgical or orthodontic expansion of the maxilla. Exclusion criteria included a history of acute or chronic respiratory symptoms, obvious neurological problems, labial incompetence, palatal fistula, and nasopharyngeal area smaller than 0.80 cm^2 on rhinomanometry assessment indicating nasopharyngeal obstruction.

Equipment

The internal dimensions of the nasal airways were determined by rhinomanometry (pressure-flow technique) according to the method proposed by Warren (1984), using the PERCI-SARS computerized system (Microtronics Corp., Carrboro, NC).

Procedures

Posterior Rhinomanometry

Posterior rhinomanometry (PR) permits the determination of the minimum nasal cross-sectional area, usually the nasal valve, by simultaneous measurement of the differential pressure through the constriction and the air flow that crosses through it during resting respiration. The technique provides an estimate of the internal bilateral dimensions of the nasal airways without indicating the exact location of the minimum area (maximum constriction). The area obtained by this technique was referred to as PR nasal area (i.e., nasal area determined by PR). The differential oronasal pressure was measured with two pressure transducers connected to two catheters. One catheter was positioned inside the oral cavity and the other was connected to a mask positioned over the nose. Nasal flow was measured with a heated pneumotachograph connected to the nose mask. The individual was asked to breathe as naturally as possible through the mask, and the resulting pressure and flow signals were transmitted to the PERCI-SARS system for recording and analysis with a specific software. The system was calibrated before each exam to known values of flow (250 ml/second) and pressure (6 cm H_2O), using a rotameter and a water manometer.

Anterior Rhinomanometry

Like PR, anterior rhinomanometry (AR) is performed during resting respiration and provides an estimate of the unilateral internal dimension of the nasal cavity by the simultaneous measurement of the differential transnasal pressure and nasal air flow. This technique has also been used as an alternative to PR to assess the total bilateral area, calculated by adding the unilateral areas. Usually the area determined by AR exceeds the area determined by PR because the former does not incorporate the measurement of eventual constrictions at the nasopharyngeal level. The area obtained by this technique was referred to as AR nasal area (i.e., the nasal area determined by AR). Because only subjects with no nasopharyngeal obstruction were included in the present study, as determined by modified AR (described below), the measurement of the bilateral nasal area determined by AR was used, in principle, to confirm the findings of PR.

Transnasal pressure was measured by positioning a catheter connected to one of the entries of the differential pressure transducer inside one of the nostrils in the vestibule area. The catheter was kept in place with a cork that blocked the nostril, creating a static air column. This permitted an estimate of nasopharyngeal pressure, compared with ambient pressure. Nasal air flow was measured by positioning a plastic tube in the other nostril; this tube was connected to a heated pneumotachograph connected to a second differential transducer. The signals were sent to the system, in which they were recorded and analyzed. The measurements were first made with the flow analysis tube in one nostril and the pressure catheter in the other for the determination of nasal area on the side in which the tube was positioned. The position of the tube and the catheter was then inverted to measure the nasal area of the other nostril. The signals were calibrated in the same manner as described for PR.

Modified AR

To detect the presence of eventual constrictions at the nasopharynx and to select subjects suitable for participation in the study (i.e., subjects without nasal obstruction at the nasopharyngeal level), the so-called nasopharyngeal area was also determined by modified rhinomanometry. For this procedure, the differential pressure through the nasopharyngeal area (oronasal pressure) was measured by positioning a catheter inside the mouth to measure the pressure in the oropharynx and another one in the nostril of lower flow as identified by AR. The catheter was held in position by a cork that blocked the nostril, thus creating a static air column and permitting the measurement of nasopharyngeal pressure. Nasal airflow was measured by positioning a plastic tube in the nostril of greater flow and connecting it to a heated pneumotachograph linked to a third transducer. The transducer signals were recorded by the PERCI-SARS and analyzed. Signal calibration was performed in the same manner described for PR.

Determination of Nasal and Nasopharyngeal Areas

For each of the three techniques, the nasal area and the nasopharyngeal area were determined during resting respiration at the peak of expiratory flow over two to four successive respirations. The area considered for analysis corresponded to the mean of these multiple measurements. The constriction area was calculated using the following equation: $A = V/k\,(2\Delta P/d)^{1/2}$, where A is the area of the orifice in square centimeters; V is the nasal flow in milliliters per second; $k = 0.65$; ΔP is the oral pressure minus nasal pressure in centimeters H_2O; and d is the air density in grams per cubic centimeters. When values higher than 0.80 cm^2 were found, they were fixed at 0.80 cm^2 by the program itself in view of the imprecision of the method in evaluating dimensions beyond this limit, as specified by the manufacturer (Microtronics Corp.).

Normal Limits

To establish the lower normal limit of the variables analyzed (nasal areas determined by PR and AR), the 5% inferior limit was calculated, subtracting from the mean values obtained for the group of normal individuals 1.645 SD (mean − 1.645 SD) as described by Snedecor and Cochran (1980).

Statistical Analysis

The minimum cross-sectional areas obtained are reported as square centimeters. The mean $\pm$ 1 SD value was calculated for each sample group and compared among groups. The differences between the group of individuals without cleft and the cleft group as a whole were determined by the Student's *t* test. The significance of the differences between samples (N, BCLP, UCLP, CP) was then determined by one-way analysis of variance; when a significant difference was observed, the samples were compared pairwise by the Tukey test (Snedecor and Cochran, 1980). The level of significance was set at $p < .05$ in all cases.

Results

All subjects selected for the study, with and without cleft palate, presented a nasopharyngeal area of more than 0.80 cm^2

TABLE 1 Mean Minimum Nasal Cross-Sectional Area Determined by PR and AR in N, and in the Total Cleft Subject Group (C)*

		Nasal Area (cm^2)	
Group	N	PR	AR
N	20	0.60 ± 0.10	0.68 ± 0.09*
C	53	0.55 ± 0.17	0.59 ± 0.20*

* These comparisons reached statistical significance ($p < .05$). For example, for the AR method, nasal area in the cleft group was significantly less than nasal area in the noncleft group.

TABLE 2 Mean Minimum Nasal Cross-Sectional Area Determined by PR and AR in N, CP, UCLP, and BCLP Groups*

		Nasal Area (cm^2)	
Group	n	PR	AR
N	20	0.60 ± 0.10[b]	0.68 ± 0.09[d]
CP	20	0.61 ± 0.13[a]	0.67 ± 0.16[c]
UCLP	16	0.57 ± 0.19	0.57 ± 0.21
BCLP	17	0.47 ± 0.16[ab]	0.51 ± 0.21[cd]

* Same-letter superscripts represent comparisons that reached statistical significance ($p < .05$). For example, for the AR method, nasal area in the BCLP group was significantly less than nasal area in the CP group.

on rhinomanometry assessment, denoting absence of nasopharyngeal obstruction. Therefore, none were excluded from the study.

Analysis of Nasal Area by PR

Table 1 presents the mean PR and AR nasal area values for the N group (n = 20) and the cleft group as a whole (C, n = 53). The mean PR (± 1 SD) area was 0.60 ± 0.10 cm^2 for the N group and 0.55 ± 0.17cm^2 for the C group; values that did not differ significantly from one another.

Table 2 presents the mean PR values obtained for the three subgroups of subjects with cleft analyzed: CP (n = 20), UCLP (n = 16), and BCLP (n = 17), which were 0.61 ± 0.13cm^2, 0.57 ± 0.19 cm^2, and 0.47 ± 0.16 cm^2, respectively. Group comparison by analysis of variance showed a significant difference among them ($F = 3.855$; $df = 3$; $p = .013$). The Tukey test detected statistically significant differences between groups BCLP and N and between groups BCLP and CP. No significant differences were observed for the remaining comparisons.

Analysis of Nasal Area by AR

Table 1 also presents the mean values of the AR nasal area of the noncleft and cleft groups obtained by the algebraic sum of the right and left unilateral areas evaluated by anterior rhinomanometry. The mean value obtained was 0.68 ± 0.09 cm^2 for the N group and 0.59 ± 0.20 cm^2 for the cleft group, values that differ significantly from one another.

Table 2 also shows the AR values obtained for the three cleft subgroups. The mean values obtained were 0.67 ± 0.16 cm^2, 0.57 ± 0.21 cm^2, and 0.51 ± 0.21 cm^2, respectively. Group comparison by analysis of variance showed that the values differed significantly ($F = 4.032$; $df = 3$; $p = .010$). The Tukey test detected once again statistically significant differences between groups BCLP and N and between groups BCLP and CP, whereas the remaining comparisons did not show significant differences.

Analysis of Individual Nasal Area Values

To determine the number of subjects with cleft palate who exhibited reduced nasal areas, we calculated the lower normal limit of nasal area based on the data obtained for the noncleft group, subtracting 1.645 SD from the mean values. This procedure led to a value of 0.44 cm^2 as the lower normal limit for the nasal area determined by PR (0.60 to 1.645 [0.10]). To simplify, the value was approximated to 0.40 cm^2, which is the same value reported by Warren et al. (1987b). When the nasal area was determined by anterior rhinomanometry, the value obtained was 0.53 cm^2, i.e., [0.68 to 1.645 (0.09)]. In this case also, the value was approximated to 0.50 cm^2 for the sake of simplification.

Table 3 shows the percentage of patients in each cleft palate group who exhibited subnormal minimum nasal cross-sectional areas determined by PR and AR. Comparing the individual values of nasal area measured by PR to the normal limit of 0.40 cm^2, we observed that in the N and CP groups, no subject presented a subnormal nasal area; in the UCLP group, the proportion was 3 of 16 (19%) and in the BCLP group, 7 of 17 (41%). In other words, subnormal nasal area values were more common in the BCLP group when the measurement was made by PR, which explains the lower mean values observed in this group, compared with the remaining ones. Similar results were obtained by AR. By comparing the individual nasal areas determined by this technique to the limit of 0.50 cm^2, we observed that in the N group, no subject presented a subnormal nasal area. In the CP group, the proportion was 1 in 20 (5%); in the UCLP group, 5 in 16 (31%), and in the BCLP, 10 in 17 (59%).

Unilateral Analysis of Internal Nasal Dimensions of Subjects With UCLP

Table 4 presents the mean values obtained on the cleft side and the unaffected side in the UCLP group using anterior rhinomanometry. Mean values of 0.19 ± 0.09 cm^2 and 0.39 ± 0.18 cm^2 were observed, respectively. The value on the cleft side was significantly lower than the value observed on the

TABLE 3 Proportion (Percentage) of Patients With Subnormal Minimum Nasal Cross-Sectional Areas Determined by PR and AR in the Isolated CP, UCLP, and BCLP Groups

Group	PR (%)	AR (%)
CP	0/20 (0)	1/20 (5)
UCLP	3/16 (19)	5/16 (31)
BCLP	7/17 (41)	10/17 (59)
Total	10/53 (19)	16/53 (30)

TABLE 4 Comparison of the Mean Minimum Nasal Cross-Sectional Area Between the Cleft and the Noncleft Sides in Subjects With UCLP*

	Cleft Side	*Noncleft Side*
Nasal area (cm^2)	0.19 ± 0.09*	0.39 ± 0.18*

* These comparisons reached statistical significance ($p < .05$).

cleft side. Individually, this was observed in 12 of the 16 subjects analyzed (75%).

Discussion

The present study was carried out to estimate the nasal patency associated with the three types of cleft lip and palate most frequently observed (BCLP, UCLP, and CP) by measuring the smallest cross-sectional nasal area. We opted to use the pressure-flow technique or modified rhinomanometry recommended by Warren (1984) as the method for evaluation. Generally speaking, analysis of the data obtained with both PR and AR demonstrated that the adults with BCLP had a smaller nasal area than adults with UCLP and that the nasal area of subjects with isolated CP was not compromised. Because Warren et al. (1988) observed that children with BCLP present the ''best nose,'' these findings for adults are of significance and require discussion of the results obtained for each group analyzed.

For control purposes, a total of 20 adults without cleft were evaluated by PR, which is used to directly measure the right plus the left areas and obtained a mean value of 0.60 ± 0.10 cm^2. This value is quite close to that reported in the literature. In the study reported by Warren (1984) in which the same technique was used, a mean value of 0.62 ± 0.17 cm^2 was obtained for 18 adults without cleft. Later, Hinton et al. (1986) obtained mean values of 0.58 ± 0.16 cm^2 for 15 adults, Hairfield et al. (1986) obtained values of 0.56 ± 0.14 cm^2 for 15 adults, Warren et al. (1987b) obtained values of 0.60 ± 0.15 cm^2 for 30 adults, and Liu et al. (1992) obtained values of 0.50 ± 0.16 cm^2 for 72 adults. Thus, taken together, these data validate the measurements obtained in the present study.

There is general agreement that the nasal airway of individuals with cleft palate is impaired. However, considering the cleft palate group as a whole, we observed a mean area of 0.55 ± 0.17 cm^2 by PR that did not differ significantly from that observed in the noncleft group (0.60 ± 0.10 cm^2). Sandham and Solow (1987) also found no significant differences in nasal resistance between individuals with and without cleft palate and attributed this fact to the use of a nasal decongestant by all subjects 30 minutes before the evaluation, a procedure that was not used in the present study. In the present study, the difference between the noncleft and cleft groups was statistically significant by AR. Warren et al. (1969) already stated that nasal resistance is greater in subjects with cleft palate, compared with the noncleft population (by about 20% to 30%). In later years, Hairfield and Warren (1989) and Warren et al. (1990b), in a study of minimum cross-sectional nasal area, once again reported lower values for subjects with cleft palate, with a mean of 0.40 ± 0.20 cm^2 for 37 subjects and 0.38 ± 0.20 cm^2 for 50 subjects, respectively. Liu et al. (1992) detected an even lower value of 0.35 ± 0.15 cm^2 in 37 adults with cleft, with 65% of them presenting an area <0.40 cm^2, suggestive of nasal obstruction. In the present study, this proportion was only 19% by PR.

It should be pointed out that the subjects studied by Hairfield and Warren (1989) and Warren et al. (1990b) included individuals with a pharyngeal flap, which reduces the nasopharyngeal area. In a study performed in our laboratory, a value of 0.34 ± 0.17 cm^2 was observed in 21 adults with cleft palate previously submitted to pharyngeal flap who started to have respiratory complaints (oral breathing, snoring, and respiratory difficulty during sleep) after surgery and a value of 0.46 ± 0.18 cm^2 in 37 adults with cleft palate with no respiratory complaints (Yamashita, 2003). The groups studied by Hairfield and Warren (1989), Warren et al. (1990b), and Liu et al. (1992) also involved subjects who previously underwent nasal surgery. In the present study, none of the subjects analyzed had previously undergone any type of secondary surgery, a fact that may explain the higher value obtained. However, this is not the only factor explaining the differences.

It is important to analyze the data obtained for the three groups of clefts. With respect to CP, the data suggest that this type of cleft is not associated with anatomical deformities in the nasal cavity that are measurable by rhinomanometry. In PR, the mean nasal area determined for the 20 adult subjects with CP analyzed was 0.61 ± 0.13 cm^2, a value that did not differ significantly from that observed in the noncleft group. The lack of a difference between the CP group and the noncleft group was confirmed by AR. Curiously, Hairfield and Warren (1989) detected practically half this value (0.32 ± 0.16 cm^2) in their group of nine subjects with cleft palate. As discussed earlier, this difference may be attributed to the fact that these investigators included in their study subjects who had undergone secondary surgeries, which was not the case in the present study. Furthermore, we cannot exclude the possibility that the surgeries performed on subjects analyzed by Hairfield and Warren (1989) had a greater impact on nasal patency than those used in the subjects presently analyzed because of factors such as type of surgery or age of repair, two variables not controlled in both studies.

With respect to subjects with unilateral clefts, the mean nasal area of 16 subjects with UCLP was 0.57 ± 0.19 cm^2 as measured by PR. Using the same technique, Hairfield and Warren (1989) detected a value of 0.41 ± 0.13 cm^2 in 11 adult subjects. In addition to the factors discussed earlier, another explanation for the difference observed is the fact that the nasal deformities typical of unilateral clefts are not always present and their severity varies widely among subjects, as emphasized by Warren and Drake (1993).

Although it was not a primary objective of the present study, the use of AR as a way of validating the evaluations performed by PR permitted an analysis of the effect of a unilateral cleft on the symmetry of nasal airways. In this respect, a smaller nasal area was observed on the cleft side (0.19 ± 0.09 cm^2) than the noncleft side (0.39 ± 0.18 cm^2). These data should be interpreted with caution because the effect of the so-called nasal cycle should be considered in the analysis of unilateral patency. This is an episodic physiological phenomenon characterized by alternate cycles of congestion and decongestion that reciprocally affect the two nasal cavities (Cole, 1993). This means that results suggestive of asymmetry of the dimensions of the two cavities obtained for a given individual by rhinomanometry may be due to the nasal cycle itself rather than to anatomical causes. However, it is known that this reciprocal resistive behavior may be perturbed, for example, by a structural obstruction of the nasal cavities. This must have been the case in the present study because our results confirm previous reports by Sandham and Solow (1987) and Sandham and Murray (1993), who observed greater resistance on the cleft side when measuring nasal resistance by standard rhinomanometry. The same was observed by Warren et al. (1998) with respect to the cross-sectional area; these investigators observed that the dimension of the cleft side of 87 subjects with UCLP was about half the dimension of the unaffected side, but they did not report the values obtained. Also, Kunkel et al. (1997, 1999) obtained smaller nasal areas on the cleft side as measured by acoustic rhinometry in 10 and 34 adult subjects with UCLP, respectively, and also observed a 35% smaller volume on the cleft side.

Finally, with regard to bilateral clefts, in the present study, the mean nasal area of 17 subjects with BCLP was 0.47 ± 0.16 cm^2 as determined by PR. In this subgroup, the value was similar to that reported by Hairfield and Warren (1989) who, in a study considered to be preliminary, detected a mean area of 0.45 ± 0.29 cm^2 in nine adults with this type of cleft. In comparison with what was observed in the group with a unilateral cleft, less pronounced alterations could be expected because the bilateral cleft may lead to anatomical changes more symmetrical than those caused by unilateral clefts. On the other hand, the overall nasal area of the individuals with BCLP could be smaller, given the greater severity of the original defect. In fact, the mean value detected in the BCLP group was clearly lower than the value of the UCLP group (0.57 ± 0.19 cm^2), although the difference was not statistically significant and was even lower (at a statistically significant level) than the value of the CP group (0.61 ± 0.13 cm^2). Thus, these results suggest that in adulthood, BCLP is associated with a smaller nasal airway. That is, individuals with this type of cleft have a greater reduction of nasal airway, in contrast to what Warren et al. (1988) reported for children. In the study by Warren et al., which was carried out on 60 subjects with cleft aged 6 to 15 years and in a noncleft group of 95 children, BCLP was associated with a larger nasal airway than UCLP. The authors attributed this effect to the columella lengthening performed during early infancy and its probable effect on the internal dimension of the nose by widening the nasal valve. A bilateral cleft is associated with typical nasal alterations including a shortened or nonexistent columella, and for this reason subjects with this condition undergo surgery to re-establish the esthetic appearance of the nose.

The opposite results obtained for the two age ranges may indicate the existence of an abnormal pattern of development in the subjects with BCLP. This possibility was anticipated by Warren et al. (1992a), when they compared the nasal area of 16 children with BCLP after columella lengthening with that of 16 adults with the same type of cleft. A group of 95 children without cleft and 15 adults without cleft served as controls. They observed that the difference in nasal area between children without cleft and adults was 0.22 cm^2, as opposed to only 0.09 cm^2 in subjects with cleft. The authors attributed these findings to possible muscular abnormalities in the perialar region induced by the columella lengthening, compatible with denervation-reinnervation that probably impaired nose growth. The same group (Drake et al., 1993) later studied the effect of advancing age on nasal dimensions by analyzing the nasal area of 150 children and youngsters aged 4 to 17 years with different types of clefts. Based on the results obtained for 26 subjects with BCLP and 48 subjects with UCLP, they concluded that the difference in the nasal dimensions of children previously reported by Warren et al. (1988) tended to disappear with time. This effect was confirmed in the present study.

It is possible that the nose of a child with bilateral cleft, which is larger than the nose of a child with unilateral cleft, starts to grow proportionally less. Both effects (i.e., an early positive one and a delayed negative one) may indeed result from columella lengthening, as suggested by Drake et al. (1993). In this case, it is demonstrated that the functional effect of the surgery is transitory. However, other possibilities should be considered, such as the existence of differences in the pattern of craniofacial growth between the two types of cleft that are inherent to the defect itself or secondary to the surgical procedures used for its correction. The proposal of causative factors other than lengthening of the columella is supported by the fact that in the present study, even subjects with BCLP who had not undergone this type of surgery presented subnormal nasal areas when evaluated in adulthood. This topic will be investigated in more depth in future studies from our laboratory.

In summary, it was observed by PR and AR that subjects with BCLP had a significantly smaller mean nasal area than subjects with CP, with subjects with UCLP presenting an intermediate value. The differences among groups were more evident in the analysis of individual results. Using PR, the proportion of subjects with evidence of nasal obstruction (area $<$0.40 cm^2) was 41% for the BCLP group and 19% for the UCLP group. In the CP group as in the noncleft group, no subject presented a subnormal nasal area. The differences with regard to evidence of nasal obstruction were also seen in AR, which revealed proportions of 59% in the BCLP group, 31% in the UCLP group, and 5% in the CP group. This confirms that adults with BCLP are at greater risk for nasal obstruction, compared with those with UCLP or CP only.

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