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Frequency of Nasal Septum Deviation and Concha Bullosa: Forensic Anthropological Implications

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Abstract. Concha bullosa (CB) and nasal septum deviation (NSD) can be a congenital trait or be linked to respiratory pathologies. Symptoms include snoring, sleep apnea, and other respiratory disorders that can be easily recognized by relatives and partners. CB and NSD are easy to identify and can be very applicable in the human identification process during routine forensic anthropological investigations. A physical-anthropological analysis was carried out by observing the presence of NSD and CB in 57 skulls from a Brazilian skull collection. Of the 57 skulls, 14 (24.6%) showed septal deviation, 19.3% to the right side and 5.3% to the left side. Regarding CB, this trait was observed in 16 skulls (34.8%) unilaterally and bilaterally in 9 skulls (19.6%). Our results are compatible with the literature and we suggest that CB influences contralateral NSD. The frequency and clinical aspects of these traits may be considered in a forensic investigation.

Keywords: Forensic Anthropology; Nasal septum deviation; Concha bullosa; Turbinates; Nasal obstruction; Skull collection.

1. Introduction

Human remains often garner the attention of the families of the missing, which leads to multiple attempts at positive identification using forensic anthropological analysis, DNA, ante mortem medical and dental records. It is a challenging job to provide

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answers as to the manner of death, the individual environment, and estimations of age at death, ancestry, sex and height from human remains. According to the American Board of Forensic Anthropology: “Forensic anthropology is the application of the science of physical or biological anthropology to the legal process. Physical or biological anthropologists who specialize in forensics primarily focus their studies on the human skeleton.” (http://www.theafba.org/)

The recognition of pathological process in bone remains and an appropriate osteopathological diagnosis can support the human identification process, as well as the epidemiological data that can strengthen vulnerable anthropological estimations.

The nasal cavity presents some of most common bony variations[1]. Anatomically, this cavity is divided by a nasal septum and on its lateral wall can be seen a curved bony structure called the nasal concha (superior, middle and inferior); between them there are the respective meatus where the nasal cavity has communications with the nasal sinuses and lacrimonasal duct[2]. Bony changes in the nasal cavity such as nasal septum deviation (NSD) and concha bullosa are easy to identify and can be very applicable to forensic anthropology. NSD is a variance of the nasal septum that can occur due to different etiologies such as irregular osseous development, trauma, or overgrowth of the nasal concha; this contributes to nasal obstruction and may lead to some level of facial deformity[3-5].

Pneumatization of the nasal concha is also called concha bullosa (CB); it has a similar etiology to NSD and can also be a result of respiratory pathology. However, the exact mechanisms of CB formation remain unclear; some authors suggest that the airflow pattern has an important influence. CB alters the nasal cavity space, its size and shape, blocking the nasal sinus apertures and leading to an obstructive respiratory disorder with clinical relevance[4-9].

Symptoms of nasal obstruction include snoring, sleep apnea and other respiratory disorders[8,10]; that can be easily recognized by relatives and partners, helping with the identification process. In addition, chronic nasal obstruction can affect facial and whole skeletal development, resulting in an undeveloped maxilla, abnormal tooth positioning, lips that do not seal properly and induce functional changes in process as chewing, swallowing, suction and speech[10-12]. The symptoms and skeletal variations due to NSD and CB are applicable and useful in the forensic context.

These traits are common and have a complex pattern, as the literature reports a strong association between nasal concha hypertrophy and the side to which the nasal septum is diverted[4,11,13,14]. This research also aimed to verify and correlate the presence of CB and the possible correlation with NSD.

Some osteopathological disorders may afford information concerning medicolegal significance[15]. The identification of NSD and CB can be very useful in forensic anthropology. The main purpose of this work was to document their frequency and correlation.

2. Methods

A physical-anthropological analysis was carried out by observing bony variations in the nasal cavity in a sample of 89 modern human skulls from of skull collection at the laboratory of forensic anthropology at medicolegal institute *Nina Rodrigues*, in Salvador, Brazil. The nasal cavity non-metric traits were NSD and CB, evaluated from a modern human skeletal collection, see Figure 1. The data were collected by two trained researches in a blind data analysis.

From a total of 89 skulls, 32 were excluded from the sample due to exclusion criteria such as fractures and/or malformations. The final sample consisted of 57 skulls with an intact nasal cavity. For the visual analysis, the following parameters were adopted: (1) present, (2) absent and (3) non-evaluable which was excluded. The moderate and intense expression of NSD and CB was used to classify the trait presence; see Figure 1.

For the descriptive statistical analysis, the categorical variables were presented as proportions and for the univariate inferential statistical analysis, categorical variables were compared using the chi-squared test or Fisher's exact test. The data were tabulated in SPSS software (Statistics Package for Social Sciences for Windows 17.0).

The present study was approved by the Brazilian platform for the ethical committee "Plataforma Brasil" registered under the number CAAE11276413.0.0000.5577.

3. Results

From a total of 57 skulls evaluated, 14 (24.6%) showed NSD with 11 (19.3%) nasal septum presenting a deviation to the right side; only 3 (5.3%) skulls showed a deviation to the left side. In total, 75.4% of the skulls did not present this variation.

Evaluating the presence of CB, of 57 skulls only 46 could be evaluated bilaterally. This trait was observed in 16 skulls (34.8%) unilaterally and bilaterally in 9 skulls (19.6%), while 21 skulls (45.7%) did not present this trait, see Table 1.

As some nasal cavities could be evaluated only unilaterally, the results of unilateral analysis with statistically valid percentages follow. Considering the presence of CB only for the right side, a total of 51 nasal cavities were intact and evaluated. Of them, 37 (72.5%) skulls did not present nasal concha aeration and 14 (27.4%) of the cavities presented a concha bullosa in the right nasal cavity. When just the left side was analyzed, a total of 48 nasal cavities were evaluated; of these, 25 (52.1%) did not present a concha bullosa and 23 (47.9%) left nasal cavities presented this variation.

Table 1. Frequency and valid percentage for concha bullosa for the right and left side.

		Frequency	Valid percentage
Concha bullosa (right)			
	Absent	37	72.5
	Present	14	27.4
	Total	51	100.0
Concha bullosa (left)			
	Absent	25	52.1
	Present	23	47.9
	Total	48	100.0

The correlation between the CB and NSD analysis using chi-squared tests, showed that, from 14 nasal cavities with CB on the right side (CBD), 10 skulls showed no septum deviation, 3 skulls showed NSD to the right side and only 1 skull presented NSD to the left side, with no statistical significance. Interestingly, the left side presented statistical significance ($p = 0.023$) for the correlation between the presence of CB on the left side (CBE) and contralateral nasal deviation. Of the 23

nasal cavities with CBE, 12 nasal septa were normal, 9 skulls showed NSD to the right side and only 2 skulls presented this deviation to the left side, see Table 2.

Statistical analysis was also performed to determine if there was a correlation between the unilateral or bilateral expression of CB and NSD. For this correlation, we obtained the following results: of the 16 skulls with unilateral CB, 10 did not present deviations of the septum and 6 skulls showed a deviation to the right side. Interestingly, of the 9 skulls with bilateral CB, the pattern of NSD was similar. Five skulls did not present NSD, 3 skulls showed deviation to the right side and only 1 showed such a deviation to the left side. This suggests that NSD is more likely to occur to the right side, as it was statistically significant for the presence of contralateral CB.

Table 2. Correlation between concha bullosa side and nasal septum deviation.

		Nasal septum deviation		
		Absent	Right side	Left side
Concha bullosa	Unilateral	10 (62.5%)	6 (37.5%)	0 (0%)
	Bilateral	5 (55.5%)	3(33.3%)	1(11.1%)
	Absent	19 (90.4%)	1 (4.6%)	1 (4.6%)

Figure 1. Nasal septum deviation (NSD) on the left and the concha bullosa (CB) the right side into nasal cavities. Source: IMLNR

4. Discussion

The present study showed the presence of septum deviation in 24.6% of cases; in the literature, frequencies of septum deviation varying from 9% to 80% have been

presented, depending on the population and methodology[4,5,13,14,16-19]. Some authors mention septum deviation as the most common anatomical alteration in the nasal cavity[18]. Despite this wide range, most studies report a high frequency of NSD, so we suggest that such differences can be explained due to the methodology used. Most studies analyses image data from CT images of patients presenting clinical problems related to the nasal cavity[5,8,10,13,14].

The side of the nasal septum deviation in our results demonstrated a clear tendency to deviate to the right side, i.e. 19.3% overall, compared to 5.3% for a left NSD. Studies using Brazilian samples show the same tendency: Nogueira[19] demonstrated a frequency of 67% for NSD (37% on the right side and 30% on the left side), Tucunduva[17] reported a nasal septum deviation rate of 39.4% to the right and 16.5% to the left, and Keles and colleagues[4] found a distribution of 51.1% to the right side, 42.2% to the left and 6.7% for a biconvex NSD. A similar pattern was found by Stallman and colleagues[13], describing a total NSD rate of 65% in which 51% occurred to the right side and 49% to the left.

Concerning the frequency of CB, we found a notable percentage of 54.4%. Regarding the side prevalence of this trait, 34.8% of the total sample present unilateral expression, while 19.6% showed CB bilaterally. Other studies present a variable frequency: Carneiro[18] described a CB rate 35.2% in their total sample, of which 17.2% were expressed unilaterally and 17.9% bilaterally. Nogueira[19] observed a rate of 41% for CB with similar a unilateral and bilateral distribution, i.e. 19% and 22%, respectively. Using a different methodology, Tucunduva[17] showed that pneumatization of the total middle concha varied to the right side (4.6%), left side (7.3%) and bilaterally (11%). Kinsui and colleagues[16] described an incidence of 33.3% of CB and Stallman and colleagues[13] report a frequency of 44%; of these, 81% were unilateral and 19% were expressed bilaterally. Bolger and colleagues[1] observed pneumatization of middle turbinate at a rate of 53%; however, in their study, an extensive pneumatization of the entire middle turbinate was classified as “true” CB, and was observed in 15.7% of cases. The same high rate was found by Balikci and colleagues[14], in which 44.6% of their sample exhibited pneumatization of at least one concha.

Such extensive divergence in the frequency of this trait may be due to factors such as differences in the criteria for pneumatization classification, methodology and

populations studied, as for studies on NSD. The present study classified as "*present*" the moderate and severe middle turbinate pneumatization and NSD.

The literature also reports a robust association between nasal concha hypertrophy and the side to which the nasal septum is diverted[1,4,11,13,14]. In the present research, we found statistically significant results for a left CB and NSD to the right side, strengthening the findings reported in various studies on nasal cavity alterations. Stallman and colleagues[13] showed that, in patients with unilateral CB or CB dominant on the left side, 70% had contralateral NSD. Naji[20] also described statistically significant results for the correlation between CB and contralateral NSD. In addition, Prado[21] found that the majority (24 of 30 patients) presented NSD associated with nasal concha hypertrophy. Tucunduva[17] also reported this correlation with statistical significance.

5. Conclusion

After a physical-anthropological evaluation of the nasal cavities of a skull collection, we found a mean frequency of these alterations compatible with Brazilian epidemiology. CB presented a significantly higher frequency in relation to NSD. We also suggest that CB influences the appearance and side of the NSD, reinforcing the data present in the literature. This is the first study to relate the presence of NSD and CB to forensic anthropological purposes using a Brazilian sample. These may be useful additional characteristics to consider during a forensic investigation.

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Conflicts of interest

We declare no conflicts of interest.