

Original Paper

Concha Bullosa: A Shield against Allergens?

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Key Words

Allergic rhinitis · Allergens · Chronic rhinosinusitis · Nasal airflow · Nasal turbinate · Concha bullosa · Computed tomography · Radiology

Abstract

Purpose: Concha bullosa (CB) alters the intranasal anatomy and may influence the buffering of inhaled allergens and the inflammatory microenvironment central to chronic rhinosinusitis (CRS). By investigating the link between allergies and CB, we can examine this theoretical benefit, which has implications on the extent of resection in endoscopic sinus surgery. **Methods:** Forty-three adults treated between 2010 and March 2014 with chronic sinonasal symptoms were retrospectively analyzed by skin prick allergy testing, maxillofacial computed tomography scan, and Lund-Mackay score. χ^2 analysis and t tests were employed to determine statistical significance. **Results:** Subjects were divided into 30 positive cases and 13 pan-negative allergy controls. No difference in CB prevalence was observed between those with positive (70%) and those with negative (69.2%) allergy tests ($p = 0.93$). Furthermore, no association between CB and Lund-Mackay score was identified ($p = 0.69$). Overall, 83.3% of CB were located in the middle turbinate, 16.7% in the superior turbinate, and 20% occurred in the middle turbinate bilaterally. **Conclusions:** Although an enlarged, pneumatized turbinate could function as a physical barrier to inhaled allergens, documented allergies demonstrate no association with CB formation. Furthermore, this study finds no correlation between CB and radiographic evidence of CRS.

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Introduction

Concha bullosa (CB) is an air-filled cavity within the nasal turbinates. Considered a variant of intranasal anatomy, CB commonly occurs within the middle turbinate [1] and is rarely seen in the superior or inferior turbinate. An overly large CB causes increased contact between the turbinate and the adjacent nasal structures, which may drive nasal obstruction and impair sinus drainage [2, 3]. However, the association between chronic rhinosinusitis (CRS) and CB remains controversial [3–9]. While several hypotheses describe the aberrant formation of this anatomic variant, ranging from expansive sinus pneumatization and abnormal chondral lamella fusion in utero [10] to conchal microfractures and mucosal invagination in late puberty [11, 12], it is unclear if CB imparts any physiologic benefit. The turbinates assist with humidification, filtration, and climatization of inhaled air. An alteration in turbinate form, via pneumatization, may influence its function. A prime phylogenetic example is the camel, with its specialized, highly pneumatized and complex nasal turbinates, presumably to maximize surface area for humidification and to induce rapid changes in air pressure and flow for reduction of inhaled dust and sand [13]. We postulate that while overly large CB can cause nasal obstruction and may predispose to CRS, this pneumatization of the turbinates may serve a beneficial role. Although thought to initially form in utero or during late puberty, expansion of CB in the setting of atopy could serve as an adaptive defense mechanism, limiting the penetration of inhalant allergens within the intranasal cavity in patients with allergic rhinitis.

Materials and Methods

Seventy-two subjects seen in our clinic with chronic sinonasal symptoms and allergy skin testing by ICD-9 code between 2010 and March 2014 were retrospectively evaluated. The subjects were screened for documented allergy testing results, and 5 additional subjects were removed. Multiprick allergy testing was done by standard protocol with commercial test solutions and measurement of wheal size. Each subject was screened for sensitivity to 29 common allergens. Twenty-two patients were removed because no maxillofacial computed tomography (CT) scan was available; 2 cases were removed because CT scans followed endoscopic sinus surgery with middle turbinectomies, prohibiting assessment for CB.

The remaining 43 patients' allergy test results were blinded, and CT scans evaluated for the presence of CB including its location and relative size – divided into small, moderate, and large (fig. 1). CT scans were reviewed by a second surgeon to establish interobserver validity. Finally, CT scans were evaluated using the Lund-Mackay (L-M) scoring system [14] to establish radiographic CRS severity.

Statistical Analysis

The prevalence of CB was calculated amongst those with pan-negative allergy testing results and compared to those with positive allergy results. Allergies were further subdivided as moderately atopic (2–9 positive allergies) or severely atopic (≥ 10 positive allergies). A χ^2 test was utilized to examine the relationship between CB and atopy. Two-sided t tests assuming unequal variances were utilized to evaluate L-M scores and CB. Ipsilateral and contralateral L-M scores were compared in cases of unilateral CB, in addition to investigating the association between L-M scores and atopy.

Results

Of the 43 subjects evaluated, 13 tested negative to all 29 multiprick allergens. The remaining 30 subjects tested positive for allergies to some degree, with a median of 6 positive responses and a range of 2–17 positive wheals.

The prevalence of CB in the entire study population was 69.8% (30/43). Among those testing positive for allergies, 70% (21/30) had CB on CT scan evaluation, compared to 69.2%

Table 1. CB prevalence among subjects with varying degrees of atopy

	CB present	No CB	CB prevalence
Positive allergy testing (n = 30)	21	9	70.0%
Moderate atopy (n = 21)	15	6	71.4%
Severe atopy (n = 9)	6	3	66.7%
Negative allergy testing (n = 13)	9	4	69.2%

Moderate and severe atopy defined as 2–9 and ≥ 10 positive allergens on multiprick testing, respectively.

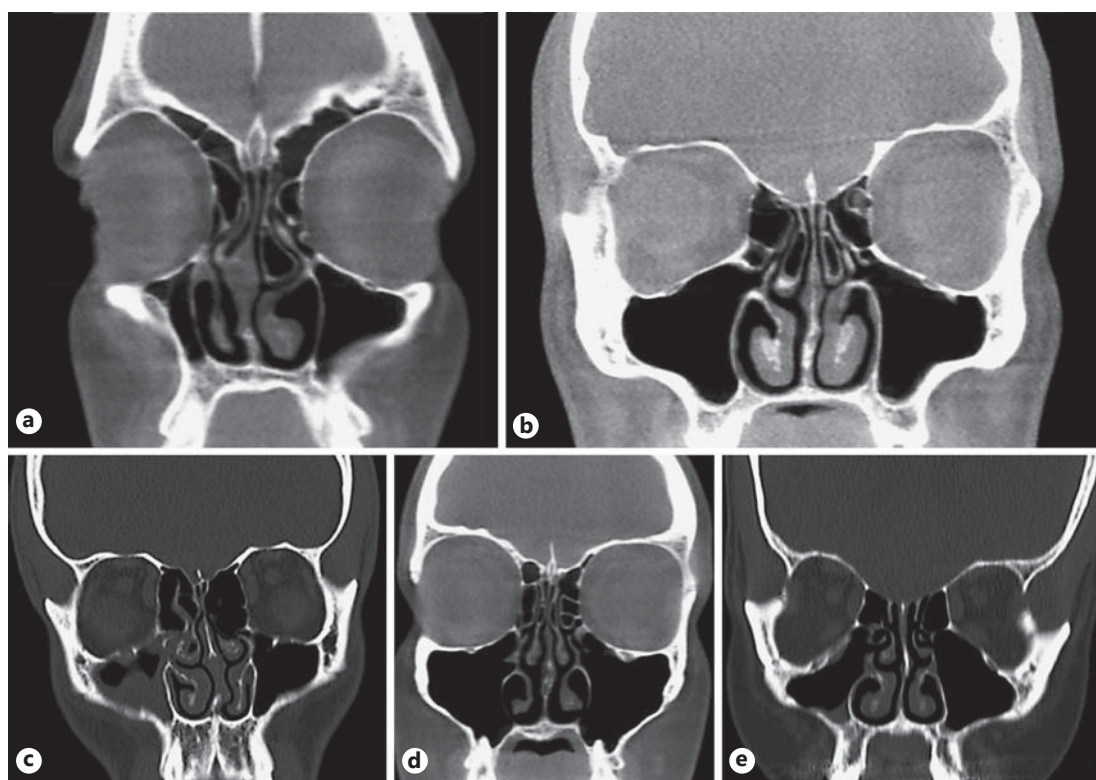


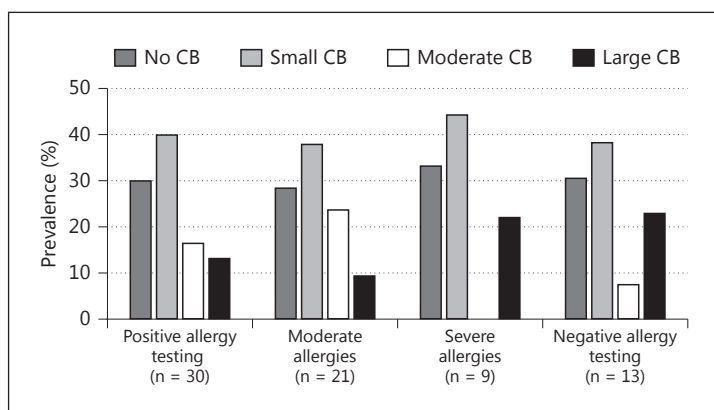
Fig. 1. Qualification of CB on coronal maxillofacial CT scans. **a** Large CB in the left middle turbinate. **b** Moderate CB in the middle turbinates bilaterally. **c** Small CB in the right middle turbinate. **d** Small CB in the roots of the middle turbinate bilaterally. **e** No CB present in the inferior, middle, and superior turbinate or their respective roots for comparison.

(9/13) of negative controls (table 1). χ^2 analysis demonstrated no difference in the prevalence of CB between those with and those without allergies ($p = 0.93$, odds ratio = 1.03, 95% confidence interval 0.37–2.87). Furthermore, there was no association between the degree of atopy and the size of the CB observed on CT scan (fig. 2). The majority (83.3%) of CB were located in the middle turbinate, 16.7% in the superior turbinate, and 20% were bilateral in the middle turbinates.

The L-M scoring system [14] was used to establish the radiographic severity of CRS. Overall, the L-M score ranged from 0 to 23 with an average of 2.6 and a standard deviation of

Table 2. Comparison of atopy to CB and mean L-M score

	Atopy (n = 30)	No atopy (n = 13)	p value
CB present (patients)	21	9	0.93
Mean L-M score	2.8	2.0	0.56

Fig. 2. Prevalence of CB size with-in each atopic subpopulation. Moderate atopy defined as 2–9 positive allergens and severe atopy defined as ≥ 10 positive allergens by multipricket allergy testing.

4.4. The mean L-M score was not different between subjects with CB and those without (2.3 vs. 3.1, respectively, $p = 0.69$). Similarly, atopy did not appear to affect the mean L-M scores (table 2). In cases of unilateral CB, the ipsilateral and contralateral L-M scores were not statistically different for CB of any size.

Discussion

CB is an anatomic variant of intranasal anatomy with unclear origins and with no clear physiologic benefit in the human population. The pathophysiology behind CRS remains incompletely understood. Multiple infectious, inflammatory, and anatomic factors may contribute singly or jointly to triggering and sustaining the persistent inflammation in CRS [15]. However, while one study has shown an association between CB and CRS [3], others have observed a connection only when CB is bilateral [4], and a large number of studies have found no association [5–9]. Similarly, this study found no association between CB and CRS. L-M scores served as a validated, objective marker of mucosal disease severity in CRS [14, 16]. Scores did not differ between subjects with and without CB, even when divided into ipsilateral and contralateral scores and stratified based on relative CB size. However, L-M scores do not correlate to symptom severity [16, 17]; thus, CB may contribute to sinonasal symptoms and not impact the radiographic severity of CRS, explaining the significant symptom improvement observed following endoscopic resection of the lateral portion of the CB compared to medical management alone [18, 19]. Other sinonasal anatomic variants, namely infraorbital and frontal intersinus cells, have an association with the development of CRS in patients with allergic rhinitis [20, 21], but our understanding of the effects of CB in the nasal cavity is limited.

CB alters intranasal anatomy and was proposed to play a protective role against inhaled allergens in allergic rhinitis. Previous studies have shown a strong association between

middle turbinate polypoid edema and atopic disease [22]. However, this pilot investigation identifies no clear link between the presence of CB detected on CT scan and atopy by skin prick allergy testing. Based on our investigation, CB formation does not appear to correlate to documented environmental allergies.

As a retrospective case-control study, there are several inherent limitations and biases. Data retrieval and CT scan analysis was strictly designed to mitigate much of this bias. Allergen skin prick testing results were blinded prior to CT scan review. CB assessment was established by two independent evaluators. Skin prick testing accurately quantifies atopy but is not a clinical marker of allergy severity. This study is limited by the absence of an allergy symptom questionnaire. Furthermore, false negatives are possible if the inciting allergen was not among the 29 allergens tested. However, despite these limitations, the results demonstrate no difference in CB prevalence between those with and those without atopy, nor an association with CRS.

Conclusion

The turbinates function to humidify, filter, and warm inhaled air, and it remains unclear whether pneumatization of the turbinates affords any physiologic benefits. Massive enlargement of a CB could theoretically be detrimental to the sinuses, impairing drainage and contributing to sinonasal symptoms; however, in our study, CB did not influence the radiographic severity of CRS. In this pilot investigation, those individuals with atopy do not have an increased prevalence of CB, suggesting that allergies do not play a role in the formation or growth of pneumatized cavities in the turbinates.

Disclosure Statement

No funding was received for this project, and the authors have no financial disclosures or conflicts of interest to report.

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