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Original Article

The analysis of intranasal anatomic variations of Korean patients with malocclusion

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ABSTRACT

Introduction: There are two important aspects in a relationship between malocclusion and the area of rhinology. First, there is the negative impact of nasal obstruction on normal facial growth. Second, surgical treatment of malocclusion under general anesthesia is chiefly done through nasotracheal intubation.

The aim of this study is to investigate the prevalence of nasal septal deviation and concha bullosa among patients with malocclusion as common anatomical variations that can affect nasotracheal intubation in comparision with previous studies.

Materials and Methods: This study was carried out on the subjects of 634 patients who underwent surgery for malocclusion. High resolution computed tomography (CT) taken preoperatively was analyzed and we measured position and angle of septal deviation and classified degree and position of pneumatization of middle concha.

Results: Septal deviation was found in 402 patients (63.4%). Concha bullosa was found in 328 patients (51.7%). Both of them were found in 238 patients. Three hundred twenty-five patients had the middle concha bullosa, sorted by type into true (182), lamella (80) and bulbous type (33), while for 30 patients, combination of two or more types were observed.

Discussion: This study showed that the frequency of anatomical variations affecting nasotracheal intubation was high in Korean patients with malocclusion. We emphasize that more closely preoperative evaluation is necessary for patients with malocclusion planning on surgery using nasotracheal intubation.

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1. Introduction

Recently, as people pay more attention to the shape of teeth from relatively young ages with larger therapeutic and cosmetic desire, surgical treatment is being carried out in numbers on patients with malocclusion.[1,2]

There are two important aspects in a relationship between malocclusion and the area of rhinology. First, there is the negative impact of nasal obstruction on normal facial growth. It has been reported by many researches that large dependence on mouth breathing due to nasal obstruction caused by hypertrophy of adenoids, allergic rhinitis or nasal septal deviation makes difference in dental and facial growth, compared to nasal cavity breathing.[3–5] Patients with nasal obstruction have a long face, large mandibular angles, significant mandibular retraction, and mostly type II malocclusion, compared to those who breathe through the nasal cavity. The same study revealed that in patients with mouth breathing, distance between upper jaw and molar was narrow, cross-bite was frequent, and height of palate and degree of overjet were significantly serious.[3–5]

Second, surgical treatment of malocclusion under general anesthesia is chiefly done through nasotracheal intubation. However, nasotracheal intubation may cause many complications including injury in nasal mucosa and nasopharyngeal mucosa, laceration in adenoids and tonsils, injury in glottis, serious nasal hemorrhage caused by vascular injury such as sphenopalatine artery, bleeding and airway obstruction caused by nasal polyp or movement of intranasal foreign substance, nasal necrosis and laceration caused by excessive strain or flexion, obstruction of nasotracheal tube caused by conchoidal mucosal laceration, and unexpected nasotracheal excision.[6–9] The most common complication of nasotracheal intubation is epistaxis, which occurs with an incidence of 18–60%.[7,10] So, careful assessment of patients prior to nasotracheal intubation is essential. Aberrations of nasal anatomy are common; nasal septal deviations and septal spurs together with hypertrophy of the turbinates.[11] Based on these aspects, the authors analyzed intranasal anatomical structures causing nasal obstruction or difficulties of nasotracheal intubation in patients with surgical treatment after diagnosis with malocclusion in order to elucidate whether patients with malocclusion have more anatomical problems within nasal cavity.

2. Materials and methods

This study was carried out on 634 patients who had two-jaw surgery under general anesthesia through nasotracheal intubation after diagnosis with malocclusion at the department of oral and maxillofacial surgery in our hospital. Preoperative high resolution dental CT images were analyzed retrospectively to check the presence or absence of nasal septal deviation and concha bullosa (middle concha, inferior concha) and sort their positions, shapes and degrees. Due to the retrospective nature of this study, it was granted an exemption in writing by the Institutional Review Board of our institute.

Patients who experienced maxillofacial trauma including nasal bone fracture or who had the history of intranasal surgery such as septoplasty, submucosal turbinectomy, endoscopic sinus surgery and rhinoplasty, were excluded from the study subjects. For nasal septal deviation, two experienced rhinologists measured the angle made by crista galli and area of the severest curvature by PACS (Picture Archiving and Communication System; Maroview, Marotech, Seoul, Korea) in blinded manner. If the angle was 5° or more in both of two measurements, we classified as significant deviation (Fig. 1).[12] For concha bullosa, superior concha was excluded because it is small in size, because it is hard to judge through CT whether there is pneumatization with neighboring structures, and because it doesn't affect nasotracheal intubation, which is the core of this study. So analysis was focused on the position and shape of concha bullosa that exists in middle concha and inferior concha. Pneumatization at vertical basal lamella was classified into lamellar type, at bulbous segment of nasal concha into bulbous type, and at the whole nasal concha including basal lamella and bulbous segment into true type (Fig. 2A–C).[13] In the same manner, two experienced rhinologists checked the presence of concha bullosa using PACS.

Hypertrophied inferior concha is an important factor that can have effect on nasotracheal intubation. However, its mucosal hypertrophy and bony hypertrophy can have different sections to practically affect, with unclear criterion to determine degree of hypertrophy, which is likely to bring up different views on how to measure and evaluate, so hypertrophy of inferior concha was not considered in this study.

3. Results

3.1. Distribution of patients

Two hundred thirty-seven patients were males with average age 24.1 (age group from 15 to 55) while three hundred ninety-

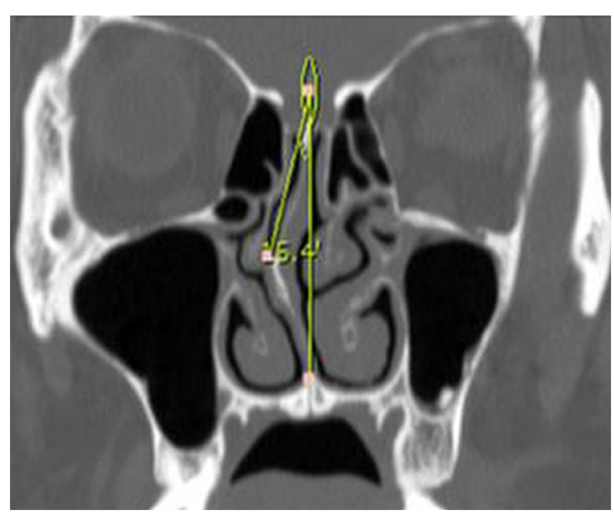

Fig. 1 – Method of septal deviation measurement with computer-based photo program. The angle between crista galli and the most prominent point of the deviation was accepted as the angle of deviation.

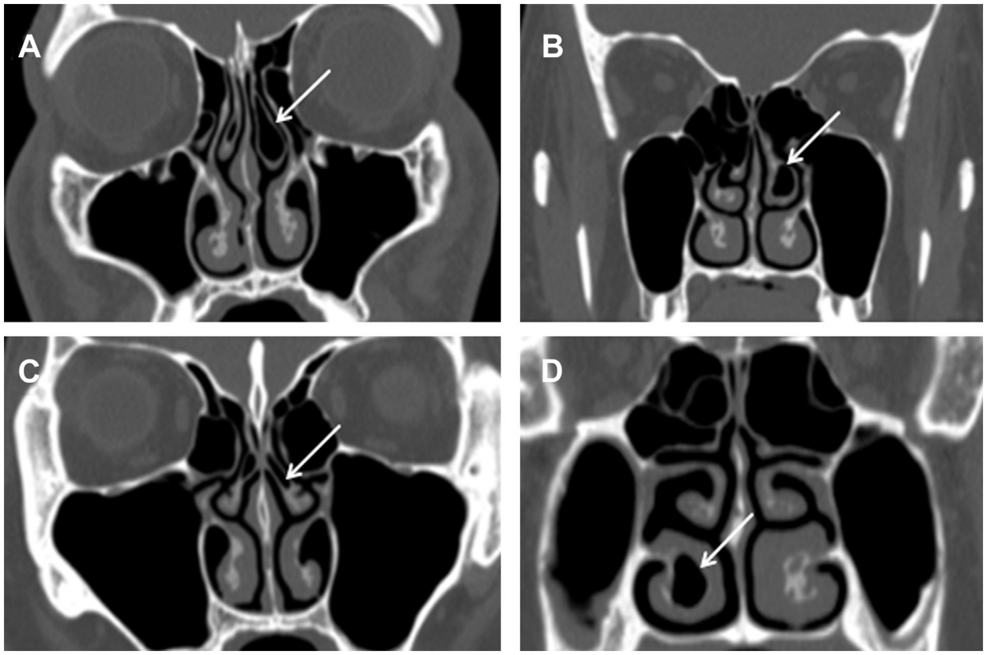

Fig. 2 – Coronal scans of preoperative dental CT. (A) True type (arrow). (B) Bulbous type (arrow). (C) Lamella type (arrow). (D) Right inferior concha bullosa (arrow).

seven patients were females with average age 24 (age group from 15 to 59). By age, ratio was similar between male and female. The portion of the 20's for all age group took up 68.8% and 71.3%, respectively, and the 40's and the 50's were around 1%, respectively, meaning that patients were focally distributed on particular age group (Table 1).

3.2. *General data*

Patients with only nasal septal deviation, only concha bullosa and both of them were 164, 90, and 238, respectively. Patients with pneumatization of inferior concha were 5.

3.3. *Nasal septal deviation*

Patients with nasal septal deviation were 402, showing a prevalence of 63.4%. Patients with right-sided deviation were 182 (45.3%) and patients with left-sided deviation were 220 patients (54.7%), showing no significant difference between in two sides.

Table 1 – Demographic data.

Age (years old)	Male	Female	Number of patients
10–19	44 (18.6%)	70 (17.6%)	114 (18%)
20–29	163 (68.8%)	283 (71.3%)	446 (70.3%)
30–39	24 (10.1%)	38 (9.6%)	62 (9.8%)
40–49	4 (1.7%)	5 (1.2%)	9 (1.4%)
50–59	2 (0.8%)	1 (0.3%)	3 (0.5%)
Mean (range)	24.13 (15–55)	24.07 (15–59)	24.10 (15–59)
Number of patients	237	397	634

3.4. *Middle concha bullosa*

Patients with concha bullosa were 328, showing a prevalence of 51.7%. Except 3 patients restricted to inferior concha, the rest 325 patients had middle concha bullosa (True type, 182; Lamella type, 80; Bulbous type; 33, respectively). For the rest 30 patients, combination of two or more types was observed.

3.5. *Inferior concha bullosa*

All five patients had inferior concha bullosa (Fig. 2D). In patients without nasal septal deviation, inferior concha bullosa was found in 3 patients, of whom two had only unilateral inferior concha bullosa and one had both inferior and middle concha bullosa. In patients with nasal septal deviation, inferior concha bullosa was found in 2 patients, of whom one had only bilateral inferior concha bullosa and one had both inferior and middle concha bullosa.

3.6. *Correlation between concha bullosa and nasal septal deviation*

The ratio of patients with concha bullosa against patients with nasal septal deviation was 59.2% (238 patients out of 402) and the ratio of patients with concha bullosa against patients without nasal septal deviation accounted for 38.8% (90 patients out of 232). On the contrary, the ratio of patients with nasal septal deviation against patients with concha bullosa was 72.6% (238 patients out of 328) and the ratio of nasal septal deviation against patients without concha bullosa, was 53.6% (164 patients out of 306) (Fig. 3). There were 90 patients who had concha bullosa without nasal septal deviation (two patients had only inferior concha bullosa). Only middle concha

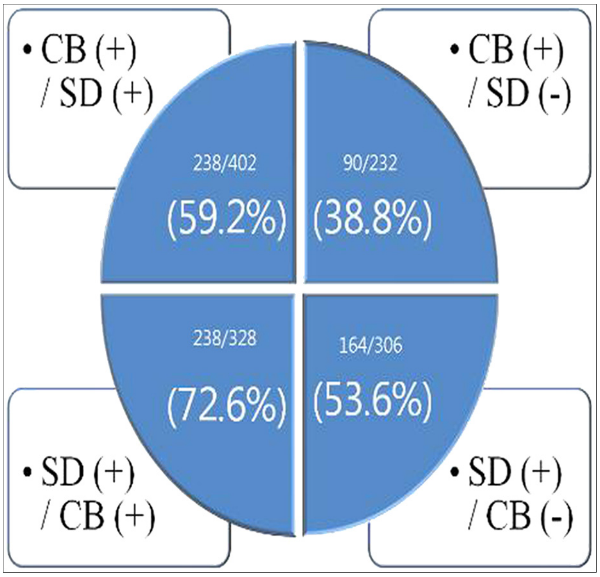

Fig. 3 – The ratio between septal deviation and concha bullosa. Abbreviation: SD, Septal deviation; CB, Concha bullosa.

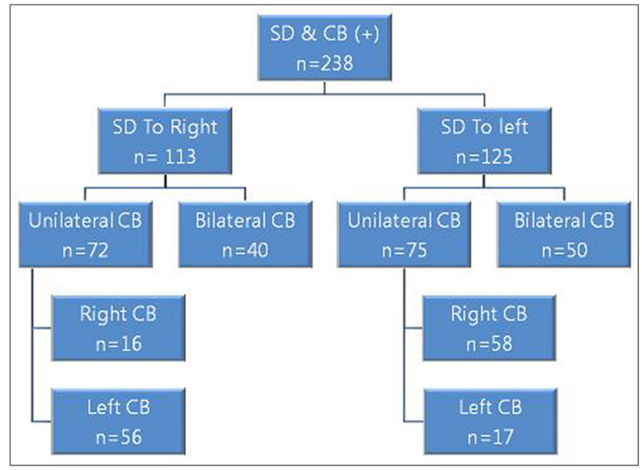

Fig. 4 – The directional relation between septal deviation and concha bullosa. Abbreviation: SD, Septal deviation; CB, Concha bullosa; *n*, Number of patients.

bullosa was found in 88 patients. In a more detailed analysis of middle concha bullosa, unilateral concha bullosa and bilateral concha bullosa were found in 51 patients (right side 27, left side 24) and 37 patients, respectively.

Concha bullosa accompanied by nasal septal deviation was observed in 238 patients, including 1 for inferior concha bullosa. Right-sided nasal septal deviation was found in 113 patients and left-sided nasal septal deviation was found in 125 patients. Compared by position, of 113 patients with right-sided nasal septal deviation, unilateral concha bullosa was found in 72 patients (left side 56, right side 16), while of 125 patients with left-sided nasal septal deviation, unilateral concha bullosa was found in 75 patients (right side 58, left side 17). This means there is a strong association between the existence of concha bullosa and septal deviation in the opposite directions (contralateral convexity). In patients with bilateral concha bullosa, right-sided nasal septal deviation was found in 40 patients and left-sided nasal septal deviation was found in 50, showing no big difference between in two sides (Fig. 4).

4. Discussion

Common anatomic variations associated with nasal obstruction in the nasal cavity have been observed, including deviated nasal septum, inferior turbinate hypertrophy, pneumatization of the inferior or middle turbinate (concha bullosa). Also, since when intubated in nasal cavity, nasotracheal tube is positioned between middle concha, inferior concha and nasal septum, we focused on the analysis of nasal septal deviation and concha bullosa.

Prevalence of nasal septal deviation is known to be 40–46% and that of concha bullosa 13–53.6%, while existence of both in combination reaches upto 44%.[10,12,13] Prevalence of nasal septal deviation for Koreans has been only reported by Min et al[14] as 22.38% (male 24.24%, female 19.8%), but there is no report on prevalence of concha bullosa of middle turbinate in normal person. In this study, prevalence of nasal septal deviation and concha bullosa turned out to be 63.4% and 51.7%, respectively. Compared to other researches mentioned earlier, nasal septal deviation showed a higher prevalence and that of concha bullosa belonged rather high approaching the top limit. Reports on prevalence of concha bullosa at 14–53% over a considerably wide scope can be ascribed to different definitions of pneumatization from researcher to researcher. According to researcher, some case requires pneumatization of even bulbous portion of middle concha while other case only part of middle concha for inclusion in the study, which leads to difference in the result.[12] By classifying the degree and position of pneumatization in progress at middle concha and inferior concha, the authors tried to obtain reliable data excluding omission of data or intervention of subjective opinions through reviewing the CT by two experienced rhinologists.

From analysis of the results above, we may well think that patients with malocclusion, unlike normal persons, have a high prevalence of nasal septal deviation and concha bullosa, which is considered associated to the common pathophysiology shared by many other diseases that bring on nasal obstruction. Why do chronic nasal obstruction and craniofacial change occur is not clearly known yet, but there can be two possible reasons. For the first element, absence of airflow in nasal cavity itself may affect the growth of maxillofacial skeleton.[15–17] For the second element, there is a theory that continued mouth breathing leads to take a new form of posture toward a lower position of lower jaw and anterior descending of the tongue in order to compensate for reduced airflow in nasal cavity and keep up breathing, the result of which reduces oral-facial muscle tone.[18–21] Such positional change of the face affects harmony between tongue, facial muscles and soft tissue, which affects development of cranial bone. As a result, it is probable that upper jaw becomes narrow, palate gets higher, mandibular angle widens, anterior teeth protrude, and these finally brings on malocclusion.

In this study, prevalence of concha bullosa was 59.2% in presence of nasal septal deviation and 38.8% without it, respectively. This result was higher in values for both cases than with (45.34%) or without (18.95%) nasal septal deviation reported by Yigit O et al[10] showing the common aspect that prevalence of concha bullosa is relatively higher when accompanied by nasal septal deviation than not. Besides, analyzing the positions of nasal septal deviation and unilateral concha bullosa revealed that more concha bullosa exists on the opposite side of deviation in this study. Likewise, concha bullosa of the middle turbinate exists on the opposite side of serious nasal septal deviation with statistical significance.[22]

Stammberger explained the connection between nasal septal deviation and concha bullosa with two hypotheses.[23] First is 'e vacuo theory', which suggests that when there is a remarkable decrease in airflow in naval cavity with curvature of nasal septum, pnuematization of the opposite side nasal concha is reinforced. Second is that concha and nasal septal deviation are separate anatomical variation and they are casually found to be accompanied together. Thus, the result of this study is considered a basis to support the first hypothesis Stammberger presented.

Inferior concha bullosa is known as a very rare variation with only a few case reports.[24] In this study, inferior concha bullosa was found in 5 patients, of which one case was bilateral. We emphasize inferior concha bullosa can be a factor to interrupt nasotracheal intubation or cause injury in inferior concha at the time of intubation.

4.1. *Limitations*

Certain limitations of this study should be recognized. Firstly, this study is based on indirect comparisons (compared with previous studies). Secondly, this is a retrospective study. We will perform the analysis of the intubation related complication in malocclusion patients. Lastly, although hypertrophied inferior concha is an important factor that can have effect on nasotracheal intubation, inferior concha (mucosal or bony) hypertrophy is not considered due to various reasons as previously mentioned.

5. Conclusions

This study showed that the frequency of anatomical variation affecting nasotracheal intubation was high in Korean patients with malocclusion. Therefore, we emphasize that checking on the presence of nasal septal deviation and concha bullosa and the degree of deviation and pneumatization closely through radiologic findings including CT and preoperative evaluation using nasal endoscopy can reduce the mucosal injury and complications caused by the nasotracheal intubation in patients planning on surgery for malocclusion using nasotracheal intubation.

Conflicts of interest

All authors have none to declare.

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