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ORIGINAL ARTICLE

Effects of nasal septum deviation and concha bullosa surgery on the frequency and financial burden of acute rhinosinusitis

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Abstract

Background Nasal septum deviation/concha bullosa (DNS)/(CB) are known to be predisposing factors in the pathophysiology of acute rhinosinusitis (ARS). However, the effects of surgical treatment of these pathologies on ARS have not been adequately investigated.

Aims To reveal the effects of the surgical treatment of DNS and CB on the frequency of the ARS, the use of antibiotics (ABs), and the direct cost incurred.

Methods Medical records of the patients who had undergone successful surgery for DNS/CB and were diagnosed with ARS in the preoperative and postoperative 3-year period were retrospectively analyzed. The average annual number of ARS examinations of the patients, the number of ABs prescribed, and prescription, examination, and total health system costs were compared.

Results Fifty-three patients (33 men (62%) and 20 women (38%)) were included in the study. There was a statistically significant decrease in the mean annual number of examinations for ARS, the number of ABs prescribed, prescription, examination, and total health system costs ($p < 0.05$) in the postoperative period compared with the preoperative period.

Conclusions The present study determined that successful surgeries performed in patients with DNS/CB resulted in a significant decrease in the average annual number of examinations performed for ARS, number of AB prescriptions, and prescription, examination, and total health system costs. With these results, it seems beneficial to direct patients to surgery within the framework of the health policies of countries to reduce the frequency and financial burden of ARS in DNS/CB patients.

Keywords Acute rhinosinusitis · Concha bullosa · Cost · Nasal septum deviation · Septoplasty

Introduction

Acute rhinosinusitis (ARS) is a condition characterized by nasal obstruction and discharge, facial pain-pressure sensation, and a decrease in the sense of smell, which is seen in 6–15% of the population [1]. Although it is generally a self-limiting disorder, it affects the quality of life as well as the working and social life of patients depending on the severity and duration of the symptoms. Patients usually search several treatment options to recover quickly. Related with this search, although bacterial rhinosinusitis incidence requiring ABs usage is 0.5–2%, unnecessary antibiotics (AB) prescription by health caregivers, unnecessary and excessive ABs usage by patients occur in many countries [2]. All these factors can be termed as direct and indirect negative effects of ARS on the patient and healthcare system [1].

Predisposing factors in the development of ARS include active and passive smoking, immune deficiencies, allergies, dental infections, previous orofacial surgeries, and pathologies that lead to nasal obstruction, such as deviated nasal septum (DNS), nasal polyp, and middle concha hypertrophies [2]. Among these, DNS and concha bullosa (CB) are common pathologies that are frequently encountered in society and treated surgically in otorhinolaryngology practice.

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Although DNS and CB are considered predisposing risk factors for ARS, opting for surgical treatment for DNS/CB is often made according to the severity of the symptoms of nasal obstruction, and patients' ARS complaints can generally be ignored and do not questioned enough [3, 4].

Additionally, although the influence of DNS/CB in the etiology of ARS has been established, there are limited studies that objectively examine the effects of DNS/CB surgery on the frequency of examinations performed for ARS, the number of ABs prescribed, and prescription, examination, and total health system costs.

This study aimed to reveal the effects of surgical treatment of DNS/CB on ARS in patients in terms of healthcare and economics, especially the changes in the prescription, examination, and total health system costs.

Methods

Patients between the ages of 18–65 years who underwent surgery for DNS/CB in a tertiary healthcare facility between 2014 and 2019 were included in the study. The patient records were examined retrospectively, and data on age, gender, and diagnosis (DNS, DNS + unilateral CB, DNS + bilateral CB) were collected.

DNS/CB diagnoses were made by anterior rhinoscopy, endoscopic examination, and paranasal computed tomography.

In order to standardize the DNS pathology in patients, pathologies were classified as follows:

- According to the deviation severity as those obstructing the nasal air passage by 1/3 and 2/3 [5]. Total obstructions which were treated with open technic septoplasty were excluded.
- According to the deviation location as anterior, posterior, and antero-posterior deviation with reference to the anterior end of the middle concha.
- According to the deviation height as superior, inferior, and supero-inferior deviation with reference to the lower end of the middle concha.
- According to the presence of crest formation as a crest in contact with the lower or middle concha and crest not in contact with the concha.

In addition, the presence of CB, if detected, in patients was recorded as unilateral or bilateral on paranasal computed tomography without distinguishing between lamellar and bulbous types. Septoplasty was performed using Cottle's closed technique, and surgery for CB was performed by excising the lateral half of the middle concha with the help of a 0° rigid endoscope under general anesthesia.

Medical records of the patients who had successful DNS/CB surgery were analyzed in the preoperative and postoperative 3-year period. In our country's health care system, all patients' data were recorded in the Internet-based data system. In this data collecting system, health care providers are able to see the patients' all medical records, such as prescription numbers, recipe ingredients, attendance to territory reference hospitals, private hospitals, and general practitioners. The sum of the number of ARS attacks (viral, post-viral, and bacterial) diagnosed in the preoperative and postoperative 3-year period of the patients included in our study were calculated and divided by 3 to obtain the preoperative and postoperative annual mean number of diagnosed ARS attacks. In addition, to reveal the treatment costs of the patients, records of the prescriptions following ARS diagnosis were examined, and the number of prescribed ABs and prescription, examination, and total health system costs (in national currency—NC) were summed up separately and divided by 3 to obtain their preoperative and postoperative annual means. Examination costs and AB costs had been determined for all territory reference hospitals, private hospitals, and general practitioners by our country's health care system, and all were standardized according to the type of health caregivers. Although there are some price policy differences that might occur according to the private health institutions' examination price, cost analyses can generally be calculated objectively with this Internet-based data collecting system. Furthermore, in our health care system, without prescription, AB's usage is restricted, and AB payment costs were defined according to the minimum equivalent type of ABs price. Related with this, the prescribed AB number and costs are able to be revealed objectively.

In addition, the differences between preoperative and postoperative mean annual parameters were investigated to reveal the relationship between the diagnosis of the patients, severity, location, height, and crest formation of DNS. Local ethics committee approval (number 2021/82) was obtained for the study. Written informed consent was obtained from the patients included in the study.

Smokers, patients with or without polyps; those with chronic rhinosinusitis, allergic and vasomotor rhinitis, history of previous nasal–paranasal surgery, obstructive sleep apnea syndrome, chronic systemic disease (diabetes mellitus; cardiac, renal, pulmonary and hepatic pathology; and immunodeficiency), chronic nasal or systemic medication use, pathological images other than DNS and CB (inferior concha hypertrophy, nasal polyp, ethmoid cell variation, tumor, and foreign body), and external nasal deviation; and those who underwent open technique septoplasty and developed recurrent DNS, septal perforation, synechiae, saddle nose deformity, and atrophic rhinitis in the postoperative period were accepted as unsuccessful surgery, and these patients were excluded from the study.

Statistical analysis

Statistical package for social sciences for Windows v.20.0 software (SPSS Inc., IL, USA) was used for statistical analysis. Continuous variables were presented as mean ± standard deviation (mean ± SD), and categorical variables were presented as numbers and percentages. The Kolmogorov–Smirnov test was used to check the normality of the data. The Mann–Whitney *U* test and Kruskal–Wallis test were used in the comparisons between the groups. Wilcoxon signed-rank test was used in the comparisons within the groups. A p-value < 0.05 indicated a statistically significant difference.

Results

Data of 212 patients who had undergone septoplasty and CB surgery during the study date range were obtained. However, 12 patients that had unsuccessful surgery, 25 patients that were unable to obtain the necessary data, 50 patients that were allergic or non-allergic rhinitis patients, and 72 patients that had chronic diseases or chronic drug use were excluded, and a total of 53 patients were included in the study. Thirty-three of the patients (62%) were male, and 20 (38%) were female. The mean age of the patients was 36.92 ± 12.01 years (18–65). Of these, 19 patients had DNS (36%), 12 had DNS + unilateral CB (23%), and 22 had DNS + bilateral CB (41%).

When the data of all patients included in the study were examined, a statistically significant decrease was observed in the postoperative period compared to the preoperative period in the mean annual number of examinations, the number of prescribed ABs, and prescription, examination, and total health system cost parameters due to ARS ($p < 0.05$) (Table 1, Fig. 1).

In the comparisons made according to the presence of CB, location, height, severity, and crest formation of DNS, no significant difference was observed between the groups in terms of differences between preoperative and postoperative mean annual number of examinations, the number of ABs prescribed, and prescription, examination, and total health system cost parameters due to ARS ($p > 0.05$) (Tables 2, 3, and 4).

Table 1 Comparison of the preoperative and postoperative 3-year mean data of the patients

Parameters (*n*, NCU) Mean ± SD	**Preoperative**	**Postoperative**	p^*
Number of AB boxes	0.76 ± 0.71	0.34 ± 0.42	**< 0.001**
Number of examinations	2.48 ± 1.15	1.32 ± 0.99	**< 0.001**
Examination cost	139.12 ± 64.51	74.31 ± 55.94	**< 0.001**
Medication cost	102.27 ± 79.77	76.29 ± 75.15	**0.028**
Total cost	241.39 ± 135.25	150.60 ± 127.76	**< 0.001**

NCU, National Currency Unit; *AB*, antibiotic

*Wilcoxon signed-rank test

Bold values are statistically significant

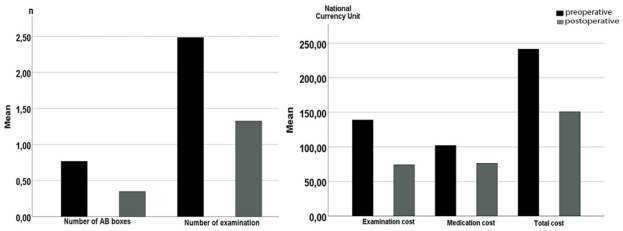

Fig. 1 Change in preoperative and postoperative 3-year mean data of the patients

Discussion

ARS is defined as the presence of nasal obstruction or anterior/posterior nasal discharge and one or more of the symptoms of pain/pressure sensation on the face and loss of sense of smell, which begins acutely and lasts for less than 12 weeks [2]. Although it may develop due to bacterial, fungal, or viral etiology, the most common among them is viral etiology. Clinical subgroups, such as viral, post-viral, and bacterial ARS, have been defined according to the severity and duration of the clinical course of the disease [2], and diagnostic criteria have been set for these groups. However, as most centers, especially primary healthcare institutions, usually do not emphasize the differentiation of the ARS subtypes according to the diagnostic criteria, generally inappropriate diagnosis and treatment processes may occur. Such situations reduce the reliability of the diagnoses in patients' medical records that are planned to be used in retrospective studies and may lead to overdiagnosis of bacterial ARS subtype, overuse of diagnostic tests, unnecessary, early, and excessive AB prescriptions, and an ultimate increase in health costs [6, 7]. Although ARS is generally a self-limiting disease with a low morbidity risk, it can lead to negative effects on the quality of life of patients and public health, loss of workforce (absenteeism and presenteeism), and increased costs for public health insurance due to the problems in its diagnosis and treatment. When the financial burden of ARS in terms of health expenses was examined, it was observed that the cost per ARS attack was 275 euros in Sweden and 320–440 euros in Spain [6, 7]. The direct annual health expenditure due to ARS in the USA is 3.390 million US dollars [8].

Table 2 Comparison of the differences between the preoperative and postoperative 3-year mean data of the patients according to the presence of concha bullosa (CB) in addition to a deviated nasal septum (DNS)

Presence of concha bullosa				
Parameters (*n*, NCU) Mean ± SD	**No CB + DNS** ***n* = 19**	**Unilateral CB + DNS** ***n* = 12**	**Bilateral CB + DNS** ***n* = 22**	$p^{\dagger}$
Number of AB boxes*	0.44 ± 0.75	0.36 ± 0.77	0.44 ± 0.80	0.899
Number of examinations*	1.05 ± 0.85	1.11 ± 0.87	1.27 ± 0.86	0.681
Examination cost*	58.95 ± 47.90	62.22 ± 48.63	71.27 ± 48.07	0.681
Medication cost*	49.51 ± 85.36	15.32 ± 71.60	11.48 ± 78.68	0.389
Total cost*	108.45 ± 123.99	77.54 ± 101.37	82.75 ± 116.51	0.857

NCU, National Currency Unit; *SD*, standard deviation; *AB*, antibiotic

*Difference between preoperative and postoperative data

†Kruskal—Wallis test

When considering the predisposing factors in the development of ARS, nasal pathologies such as DNS and CB are common disorders in the general population, and surgical treatments for these conditions are frequently applied in otorhinolaryngology practice. Pathologies like DNS/CB cause nasal obstruction and nasal cycle changes and disrupt functions, such as humidification, filtering, and heating. As a result of these changes, viral load and nasal epithelium contact, secretions stagnation, inflammatory cell infiltration in the nasal epithelium related with viral load, fluid extravasation, edema, and mucus production increase, and a vicious cycle occurs which can cause mucociliary clearance disorders [2]. These disorders increase susceptibility to nasal infections, sinus ostia obstruction, and insufficient sinus ventilation [9, 10]. Previous studies concerning the relationship between DNS and rhinosinusitis generally focused on DNS with recurrent acute and chronic rhinosinusitis, which can be diagnosed and followed easily. However, in terms of ARS, the challenges in diagnosing its subtypes and related variable alterations on treatment and follow-up processes lead to the reliability and validity of the collected data and the results of the studies questionable. Such difficulties have also been considered limitations in previous studies [4]. In the present study, in order to prevent such limitations, we included all of the ARS subtypes in our study rather than classifying them as viral, post-viral, or bacterial. We included only the patients with DNS/CB, who were surgically treated successfully and excluded the other predisposing factors in ARS pathophysiology, such as smoking, allergies, and other nasal pathologies, such as inferior concha hypertrophy.

In previous studies, the relationship between the DNS presence and its properties with rhinosinusitis was frequently investigated. In a systematic review, Orlandi RR [11] reported that the possibility of bilateral rhinosinusitis

Table 3 Comparison of the differences between the preoperative and postoperative 3-year mean data of the patients according to the location or height of the deviated nasal septum

Location of the nasal septum deviation				
Parameters (n, NCU) Mean ± SD	**Anterior** ***n* = 7**	**Posterior** ***n* = 27**	**Antero-posterior** ***n* = 19**	$p^{\dagger}$
Number of AB boxes*	0.43 ± 0,60	0.58 ± 0.92	0.19 ± 0.51	0.434
Number of examinations*	1.28 ± 0.85	1.29 ± 0.95	0.91 ± 0.65	0.407
Examination cost*	72 ± 47.50	72.59 ± 53.38	51.08 ± 36.72	0.407
Medication cost*	21.49 ± 41.55	40.59 ± 87.87	6.87 ± 78.21	0.326
Total cost*	93.48 ± 81.24	113.19 ± 128.79	57.97 ± 99.81	0.393
Height of the nasal septum deviation				
	Superior ***n* = 10**	**Inferior** ***n* = 20**	**Supero-inferior** ***n* = 23**	
Number of AB boxes*	0.23 ± 0.42	0.63 ± 0.99	0.32 ± 0.63	0.462
Number of examinations*	0.93 ± 0.56	1.25 ± 0.98	1.17 ± 0.85	0.862
Examination cost*	52.26 ± 31.48	70 ± 54.80	65.74 ± 47.38	0.862
Medication cost*	20.73 ± 73.39	48.30 ± 88.29	8.86 ± 73.99	0.214
Total cost*	73.01 ± 95.29	118.30 ± 135.46	74.60 ± 102.16	0.668

NCU, National Currency Unit; *SD*, standard deviation; *AB*, antibiotic

*Difference between preoperative and postoperative data

†Kruskal—Wallis test

Table 4 Comparison of the differences between the preoperative and postoperative 3-year mean data of the patients according to the crest formation or severity of the deviated nasal septum

Crest formation of nasal septum deviation			
Parameters (*n*, NCU) Mean ± SD	**Contacting the concha *n* = 32**	**Not contacting the concha *n* = 21**	$p^{\dagger}$
Number of AB boxes*	0.41 ± 0.85	0.45 ± 0.64	0.430
Number of examinations*	1.20 ± 0.96	1.08 ± 0.66	0.840
Examination cost*	67.67 ± 53.79	60.44 ± 36.82	0.840
Medication cost*	29.39 ± 95.54	20.79 ± 50.08	0.889
Total cost*	97.06 ± 135.26	81.24 ± 75.49	0.889
Severity of the deviated nasal septum			
	1/3 obstructed *n* = 26	**2/3 obstructed *n* = 27**	
Number of AB boxes*	0.28 ± 0.86	0.55 ± 0.65	0.095
Number of examinations*	1.13 ± 0.94	1.18 ± 0.76	0.597
Examination cost*	63.18 ± 52.82	66.37 ± 42.79	0.597
Medication cost*	28.01 ± 102.99	24.02 ± 51.39	0.749
Total cost*	91.19 ± 141.42	90.39 ± 84.19	0.557

NCU, National Currency Unit; *SD*, standard deviation; *AB*, antibiotic

*Difference between preoperative and postoperative data

†Mann—Whitney U test

increases when the deviation angle is ≥ 10° in patients with DNS. However, he stated that there is not enough objective data to show the relationship between DNS and the occurrence of rhinosinusitis, which has multiple etiological factors. Yasan H et al. [12] stated that although mild to moderate DNS is not a risk factor for chronic rhinosinusitis, severe DNS (≥ 21°) is a risk factor for the development of this disease. They argued that severe DNS might cause rhinosinusitis by affecting the mechanical and aerodynamic structure in the nasal cavity. However, although such studies seem useful from an explanatory perspective, it is clear that a standard angle measurement in 2-dimensional plane paranasal CT scan of DNS will be insufficient to explain the role of DNS in the pathophysiology of rhinosinusitis when the 3-dimensional construction of nasal cavity was considered. For these reasons, in the present study, we further aimed to examine the severity, location, height, crest formation of DNS, and presence of unilateral or bilateral CB in addition to DNS to reveal the possible relationship between DNS/CB and ARS. We revealed a significant improvement in all parameters in the postoperative period for DNS/CB surgery compared with those in the preoperative period. However, co-occurrence of unilateral or bilateral CB, in addition to DNS, did not affect the results. In addition, we revealed that the variables such as severity, location, height, and crest formation of DNS did not make a significant difference in the difference between preoperative and postoperative data.

The study in the literature that is most similar to the present study is the study conducted by Leung R et al. [13]. They conducted a macroeconomic cost analysis for surgical treatment decisions in patients with recurrent ARS. In this study, the authors investigated the productivity losses (absenteeism and presenteeism) experienced by patients due to the medical and surgical treatment of recurrent ARS. They determined that the number of ARS attacks per year when the operation of patients was more cost-effective than medical treatment and follow-up was ≥ 3.7. In addition, they recommended determining the most cost-effective decision by interviewing the patient when they decide to opt for surgery and evaluating the disease burden, patient quality of life, and planned surgery risks. In another study following the study mentioned above, the authors conducted a cost analysis for the annual frequency of ARS attacks based on financial factors to make a decision at the patient level and investigated the number of attacks after which it became more economical to direct patients to endoscopic sinus and septum surgery [3]. They found that a mean of 1.3–2.8 rhinosinusitis attacks per year contributed to patients opting for surgery and added two more episodes to this level due to confusion in the diagnosis of upper respiratory tract infection. They concluded that surgery was a more economical option if there were five or more attacks per year. In their studies, the authors calculated the cost of surgical and medical treatment preferences by including direct health expenses (prescription, examination, surgery, and hospital costs) as well as indirect factors, such as the number of days of hospitalization, loss of workforce, decrease in work productivity, and time spent seeking medical treatment. In the present study, a 47% reduction was found in the mean annual number of ARS examinations calculated preoperatively and postoperatively (from 2.48 ± 1.15 to 1.32 ± 0.99) for patients who underwent DNS/CB surgery only without including endoscopic sinus surgery. A 38% reduction was found in direct health expenses (outpatient clinic cost, prescription cost) (from 241.39 ± 135.24 national currency units (NCU) to 150.60 ± 127.76 NCU). In addition, we found a 55% decrease (from 0.76 ± 0.71 to 0.34 ± 0.42) in the mean number of ABs prescriptions in the postoperative period compared with that in the preoperative period in patients who underwent DNS/CB surgery. Thus, an advantage of surgical treatment for DNS/CB patients with frequent ARS complaints is that it can be beneficial for preventing the morbidities that may develop due to polypharmacy and overuse of ABs, as well as for the reduction of the annual number of examinations and health costs. As mentioned before, ARS, a self-limiting disease with low morbidity, is often associated with early, unnecessary, and excessive prescription of ABs. Pouwels et al. [14] stated that ABs were significantly over-prescribed in the British primary health care services, which was most common in respiratory tract pathologies.

They showed that nearly 90% of the ABs prescribed for rhinosinusitis are unnecessary. Unnecessary and excessive use of ABs may lead to an increase in resistance of ABs, change in the natural flora of the patient, and frequency of side effects such as gastrointestinal, hematological, cardiac, hepatobiliary, renal, dermatological, and neurological complications, some of which can be morbid or mortal [15, 16]. Related to our present study, referring patients to surgery who have ARS complaints might overcome the problem of overusing and unnecessary usage of ABs. One factor that we could not find the opportunity to examine in the present study and that can be considered a study limitation is our inability to calculate the indirect costs associated with ARS. Because, when considered the factors such as impaired quality of life, decreased work productivity (absenteeism and presenteeism), increased non-prescription healthcare costs, paramedical supplements usage rate, waste of time, economic loss, and additive treatment search, that lead to an indirect cost should be accepted as a major comorbidity. As 85% of patients with rhinosinusitis belong to the working-age group (18–65 years), factors such as absenteeism and reduced productivity in the workplace cause a significant increase in the economic burden of the disease [17].

Other limitations of our study are its retrospective design, the inability to examine self-medication in addition to the clinical examination of the patients, the lack of quality-of-life evaluation, and the differences in health payment systems and drug costs between countries. Furthermore, the limited number of patients, which is related to the elaborated exclusion criteria to reveal the sole effect of DNS + CB surgeries on ARS parameters, might clearly be encountered as another limiting factor for our study. Accordingly, further studies with large-scaled number of patients should be performed to clarify this relationship.

Conclusions

Our study results revealed that the mean annual number of examinations for ARS, the number of ABs prescribed, and prescription, examination, and total health system costs can be decreased significantly following the successful surgical treatment of patients with DNS/CB. Therefore, we believe that it might be favorable to refer patients with DNS/CB to surgery to prevent the frequency of ARS and associated health, social, and economic losses. However, each country should conduct its own cost analysis according to the variations in its health care payment systems to give the right decision for referring the DNS/CB patients to surgery or not.

Author contribution All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Erhan Arslan, Kamil Gokce Tulaci, Hasan Canakci, and Seda Arslan. The first draft of the manuscript was written by Hasmet Yazici and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Declarations

Ethics approval This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Clinical Research Ethics Committee of Balikesir University Medicine Faculty (Date: 24.03.2021/ No.: 2021–82).

Informed consent Informed consent was obtained from all individual participants included in the study.

Conflict of interest The authors declare no competing interests.

Research involving human participants and/or animals This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Clinical Research Ethics Committee of Balikesir University Medicine Faculty (Date: 24.03.2021/ No.: 2021–82).

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