RESEARCH ARTICLE

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The Bacteriology of Middle Meatus and Ethmoid Sinuses in Chronic Rhinosinusitis: Epidemiological Analysis and Surgical Impact

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ABSTRACT

Objectives: The aim of this study was to explore the difference between sinus bacteriology in chronic rhinosinusitis patients with and without nasal polyposis. We also analyzed the possible differences in culture results from swabs taken from the middle meatus versus the ethmoid sinus.

Methods: Retrospective chart review of adult chronic rhinosinusitis patient data from the year 2006 to 2020. Nasal swabs were taken under endoscopic guidance either intraoperatively from either the ethmoid sinus or middle meatus, or in the outpatient clinic from the middle meatus. The results were categorized based on the most common microorganisms affecting the nose and sinuses.

Results: We found that, the presence of nasal polyps seemed to have no effect on sinus bacteriology as whole. There was also no significant difference between the bacteriology of chronic rhinosinusitis patients who did not need surgery and those who did. Finally, we found that middle meatal cultures, taken endoscopically, give similar bacteriology results to that of ethmoid sinus cultures (taken intraoperatively).

Conclusion: Middle meatal culture results accurately represent true sinus flora, and therefore can be used to aid in appropriate culture guided antibiotic therapy for patients visiting the outpatient clinic.

Keywords: Middle meatus, Ethmoid sinus, Bacteriology, Rhinosinusitis, Endoscopic Sinus surgery.

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INTRODUCTION

Chronic Rhinosinusitis (CRS) is a common multifactorial disease process affecting the paranasal sinuses affecting up to 12% of the adult population worldwide. It is characterized by the presence of two out of four major criteria, specifically, nasal obstruction, olfactory dysfunction, facial pain or pressure, and purulent nasal discharge lasting more than 12 weeks, as well as objective confirmation of sinonasal mucosal inflammation through diagnostic imaging or nasal endoscopy. CRS is further classified into two subgroups; CRS with nasal polyposis (CRSwNP) and CRS without nasal polyposis (CRSsNP)[1].

Management of CRS is mostly medical, involving a combination of antimicrobial treatment, local/systemic steroids, and saline irrigation. In patients who show no improvement after adequate medical therapy, functional endoscopic sinus surgery (FESS) is the next step and gold standard management[1,2].

The pathogenesis of CRS is complex and to this day remains unclear, but it is known that host and environmental factors, as well as the presence of viruses, bacteria and fungi play an important role in the pathophysiology of this disease. The presence of bacteria within the sinuses in CRS has been well documented, as impaired mucociliary clearance and host defense mechanisms lead to colonization of the sinus cavities with microorganisms[3].

Antibiotics are prescribed to approximately over 50% of CRS patients visiting the clinic, and CRS is recognized as one of the most common diseases associated with antibiotic prescriptions[4,5]. Therefore, it is important to be able to identify the microorganism present in order to select the proper antimicrobial therapy and reduce inappropriate antibiotic therapy and its consequences.

While the bacteriology of CRS has been widely studied, there is inadequate information about the difference between cultures isolated from patients with CRSsNP and CRSwNP, as well as the effect they may have on the need for intravenous (IV) antibiotic therapy.

In our study, we aim to explore the differences between the sinus bacteriology of patients with CRS with and without nasal polyposis, as well as the possible correlation between the presence of specific microbes and the need for IV antibiotic therapy. We also analyzed the possible differences in culture results from swabs taken from the middle meatus versus the ethmoid sinus.

MATERIALS AND METHODS

After obtaining approval from the institutional review board committee of our university hospital (Jordan University of Science and Technology, Jordan), we retrospectively reviewed adult CRS patient data from the year 2006 to 2020. Nasal swabs were taken from all patients under endoscopic guidance either intraoperatively from either the ethmoid sinus or middle meatus, or in the outpatient clinic from the middle meatus. All swabs were processed in the same laboratory within 3 hours of specimen collection, and all were tested for sensitivity to antimicrobial agents. Based on the most common microorganisms affecting the nose and sinuses, we categorized the results as *Coagulase –ve staphylococci*, *staphylococcus aureus (staph. aureus), Haemophilus influenza (H. influenza)*, *Methicillin-Resistant Staphylococcus Aureus* (MRSA), *pseudomonas aeruginosa*, and the rest were classified as "*others*" or "*negative culture*".

We included a total of 448 patients in our study, divided into 2 main groups. Group 1; patients who underwent elective FESS and group 2; patients who were successfully treated medically and did not require FESS. Group 1 was further subdivided into CRSsNP and CRSwNP.

Data was also collected about the need for IV antibiotic therapy. The average age of patients at time of surgery was (40 years ± 14). Pediatric patients, patients with immune deficiency, diabetes mellitus, and revision and emergency cases were excluded. We also excluded all patients who received antibiotic or oral corticosteroid therapy prior to surgery.

Statistical analysis was done using Chi squared test as well as Fisher's exact test, with statistical significance inferred at p values of <0.05.

RESULTS

There were 211 CRSsNP patients (59.2% male, mean age 42.9 ± 15 years), and 160 CRSwNP patients (60% male, mean age 39.7 ± 13.8 years). All swab results used for the analysis of these patients were taken intraoperatively.

The second group includes 77 patients who had CRS, who were successfully treated medically and did not require FESS. In these patients, nasal swabs were taken pretreatment from the middle meatus, and processed in a similar fashion.

Of all swabs taken intraoperatively between all patient groups (371), 184 were negative (49.6%). The most common microorganism found between positive cultures was MRSA (32.6%), followed by "*others*" (23.5%), *coagulase –ve staphylococci* (19.3%), and *staph. aureus* (10.7%).

On comparing the 2 subgroups (CRSsNP and CRSwNP), a significant difference was found between the number of patients who required IV antibiotic therapy in the CRSsNP group (9%) and the CRSwNP group (25.3%) ($p=0.0028$).

However, when comparing the sinus bacteriology of CRSsNP patients with that of CRSwNP patients, excluding unspecified microorganisms ("*others*"), we found no statistically significant difference between the 2 groups ($p=0.36$), indicating that the presence of nasal polyps in our group had no significant effect on sinus bacteriology (Table 1).

In the CRSsNP group, the rate of positive culture was 47.4%, compared to 54.4% of patients with CRSwNP. Of patients with CRSsNP, 30.6% of cultures were MRSA, 26.4% others, 25% *coagulase negative staphylococci*, 9.7% *Staph*. *aureus*, and 8.3% *H. Influenza*. We found no statistically significant difference between the bacteriology of the 2 groups (p=0.066).

Comparatively, when evaluating data from the 77 patients with CRS who were successfully treated medically and did not require FESS (all without nasal polyposis), all of whom had nasal swabs taken from the middle meatus before treatment, we found that there was also no significant difference between their sinus bacteriology and that of the CRSsNP patients who underwent FESS (p=0.102) (Table 2).

We also compared the sinus bacteriology results from all swabs taken from the middle meatus (299, of which 170 had positive cultures) with those taken from the ethmoid sinus (149, of which 68 had positive cultures). Only positive cultures were included in our analysis, and unspecified microorganisms were excluded. We found no statistically significant difference between rates of all included microorganisms from swabs taken from the middle meatus versus the ethmoid sinus (p=0.33) (Table 3).

Table 1: Patients demographic features and clinical characteristics.

Patient Group	CRSsNP	CRSwNP
Number	211	160
Age (years)(SD)	42.9±15	39.7±13.8
Gender (Male: Female)	125:86	96:64
Culture:		
Positive	100	87
Negative	111	73
Microorganism:		
• *Coag. –ve Staph.*	19	17
• *H. Influenza*	12	5
• *MRSA*	28	33
• *Staph. Aureus*	10	10
• *P. Aeruginosa*	3	6
• Others	28	16
Required IV antibiotics	9%	25.3%

*CRSsNP, Chronic Rhinosinusitis without Nasal Polyps; CRSwNP, Chronic Rhinosinusitis with Nasal Polyps; SD, Standard Deviation; FESS, Functional Endoscopic Sinus Surgery; *Coag –ve Staph*, *Coagulase-Negative Staphylococci*; MRSA, *Methicillin-Resistant Staphylococcus Aureus*.

Table 2: Swab culture results of CRSsNP patients who underwent FESS versus those who did not need FESS.

Patient Group	CRSsNP without FESS	CRSsNP + FESS
Number Culture:	77	211
Positive	51	100
Negative	26	111
Microorganism:		
• *Coag. –ve Staph.*	11	19
• *H. Influenza*	4	12
• *MRSA*	7	28
• *Staph. Aureus*	9	10
• *P. Aeruginosa*	4	3
• Others	16	28

*CRSsNP, Chronic Rhinosinusitis without Nasal Polyps; CRSwNP, Chronic Rhinosinusitis with Nasal Polyps; FESS, Functional Endoscopic Sinus Surgery; *Coag –ve Staph, Coagulase-Negative Staphylococci;* MRSA, *Methicillin-Resistant Staphylococcus Aureu*.

Table 3: Culture results of swabs taken from the middle meatus versus those taken from the ethmoid sinus.

Group	Middle meatus	Ethmoid
Number culture:	299	149
positive	170	68
Negative	129	81
Microorganism:		
• *Coag. –ve Staph.*	32	15
• *H.Influenza*	16	5
• *MRSA*	40	28
• *Staph. Aureus*	22	6
• *P.Aeruginosa*	9	4
• Others	51	10
	129	81

**Coag –ve Staph, Coagulase-Negative Staphylococci;* MRSA, *Methicillin-Resistant Staphylococcus Aureus.*

DISCUSSION

Bacterial infection is considered to play an important role in the pathogenesis of CRS. Therefore, empirical antibiotic therapy is commonly used to treat CRS in outpatient settings[6]. Inappropriate antibiotic therapy may lead to adverse effects from antibiotic overuse due to failure of treatment, as well as further the development of antibiotic resistance[7]. Therefore, it is ideal to obtain a culture reflective of the patient's sinus microbiological profile in order to allow culture guided antibiotic therapy, possibly improving treatment outcomes. Often, maxillary sinus puncture is used to obtain a sinus culture. However, this procedure is limited by discomfort to the patients as well as technical concerns[8]. Therefore, finding an alternative culture method that accurately represents the sinus bacterial profile is of importance. Ethmoid cultures are more difficult to obtain, and would most often need to be taken intraoperatively. The middle meatus, however, is easy to access in an outpatient setting, and as it is the sinus outflow area for the anterior ethmoid, frontal and maxillary sinuses, it should reflect the microbiological profile of those sinuses. Numerous studies have shown that middle meatus cultures, if taken endoscopically, accurately reflect maxillary sinus bacteriology[8]. Further studies demonstrate that there is a clear correlation between middle meatus and ethmoid sinus bacteriology in patients with CRS[9]. In accordance with these studies, our data has shown that there is no significant difference between the microbiological profile of samples taken endoscopically from the middle meatus, and those taken from the ethmoid sinus. Furthermore, we found no significant difference between the microbiological profile of CRS patients who did not require FESS, with swabs taken in an outpatient setting endoscopically from the middle meatus, and those with CRSsNP, where swabs were taken intraoperatively from the ethmoid or middle meatus. As such, endoscopic middle meatal cultures may be encouraged in outpatient settings for CRS patients, as they likely accurately reflect sinus pathology. This may lead to improved rates of culture directed antibiotic therapy in CRS patients, which studies have shown is associated with clinically meaningful improvement in patient symptoms[10].

In our data, we found the most common microorganism isolated was MRSA (32.6%), followed by *coagulase – ve staphylococci* (19.6%), then *staph. aureus* (10.7%). Comparatively, most papers report the most common microorganisms isolated in sinus cultures are *coagulase negative staphylococci* followed by *staph*. aureus[11,12]. This may indicate a recent increase in antibiotic resistant pathogens such as MRSA at our center due to antibiotic maladministration.

Only few studies have compared the bacteriology of CRSsNP patients to that of CRSwNP, and data is currently limited on the topic. Some studies have shown that there is no significant difference in isolation rates among the two groups[13-15], as was the case in our study. This indicates that a bacteriologic pathogenesis of polyps in CRSwNP patients is unlikely.

In the case of CRSwNP patients, we found that the presence of MRSA was significantly more likely to require IV antibiotic therapy peri-operatively than CRSsNP patients, owing to higher rates of antibiotic resistance. We should therefore strive to reduce rates of antibiotic resistance and aim for appropriate antibiotic therapy, as well as attempt to manage the presence of MRSA.

Of the limitations of our study is the absence of a comparison group with healthy nasal mucosa, as well as the absence of data on the severity of CRS in studied patients (as evaluated using sinus CT or intraoperatively).

CONCLUSION

While we found no significant difference between the bacterial profiles of CRSsNP and CRSwNP patients, our data has shown that the presence of a positive culture alone, as well as the presence of specific microorganisms such as MRSA, is associated with a significant increase in the need for IV antibiotic therapy. Moreover, our results indicate that swabs taken from the middle meatus endoscopically (during FESS or in an outpatient setting) are accurately indicative of true sinus microbiological profiles (as those taken from the ethmoid sinus). As such, endoscopic middle meatal cultures should be utilized in an outpatient setting as well as intraoperatively in order to enhance culture directed antibiotic therapy, reduce misuse or ineffective use of antibiotics and the rise of antibiotic resistant pathogens such as MRSA, and hopefully improve outcome in CRS patients.

AUTHOR'S CONTRIBUTION

Each author gave a substantial contribution in study design, data collection, draft writing and revision.

ETHICAL DISCLOSURE

This research was approved by Jordan University of Science and Technology IRB committee (IRB No. 23/134/2020).

CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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