Bacteriology of middle meatal aspirate of adult patients with chronic rhinosinusitis in Lagos University Teaching Hospital, Lagos

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Abstract

*Background***:** Chronic rhinosinusitis (CRS) significantly lowers the quality of life of patients. The common use of broad spectrum antibiotics for its treatment may alter the pathogens that promote the persistence of this condition. However, the data concerning the distribution of bacteria species in patients with CRS are not consistent.

Objective: To isolate the common aerobic and anaerobic bacteria from the middle meatal aspirates of adult patients with CRS and determine their antibiotic sensitivity patterns

Methods: This was a case-control study of adults with diagnosis of CRS. Middle meatal aspirate and swab were obtained from cases and control respectively for bacteriological studies. Data analysis was done using Statistical package for social sciences (SPSS) version 17

Result: Forty one aerobic bacteria were cultured. Sixty one percent of the aerobic bacteria isolated were gram positive (*staphylococcus aureus* was the most frequently found) organisms while the remaining 39% was gram negative. Fifteen percent of the cultured isolates yielded mixed growth of both aerobes (Gram positive and gram negative).3(6%) isolates of *Bacteroides species* were cultured

Conclusion: The present study found that *Staphylococcus aureus, streptococcus pneumoniae, Proteus mirabilis, Klebsiella spp, Escherichia coli* and *Bacteroides spp* were the common bacterial flora in the paranasal sinuses of patients with CRS.

Keywords: *Middle meatus, bacteriology, chronic rhinosinusitis*

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Résumé

Contexte: La rhino-sinusite chronique (RSC) diminue de manière significative la qualité de vie des patients. L'utilisation commune des antibiotiques à large spectre pour son traitement peut modifier les agents pathogènes qui favorisent la persistance de cette condition. Toutefois, les données concernant la répartition des espèces de bactéries chez les patients atteints de RSC ne sont pas compatibles.

Objectif: Pour isoler les bactéries aérobies et anaérobies communs des aspirats méat moyen des patients adultes atteints de RSC et de déterminer leurs profils de sensibilité aux antibiotiques

Méthodes: Ceci était une étude prospective cas-témoins des adultes ayant un diagnostic de RSC. L'aspirat méat moyen et écouvillon ont été obtenus chez les cas et les contrôles respectivement pour des études bactériologiques. L'analyse des données a été effectuée en utilisant le logiciel statistique pour les sciences sociales (SPSS) version 17.

Résultat: Quarante un bactéries aérobies ont été cultivées. Soixante un pour cent des bactéries aérobies isolées étaient desorganismesà gram positif (Staphylococcus aureus a été le plus fréquemment trouvés) tandis que les 39% restants étaient à gram négatif. Quinze pour cent des isolats cultivésont abouti à la croissance mixte des deux aérobies (Gram positif et Gram négatif). Trois (6%) isolats des espèces Bacteroides ont été cultivées

Conclusion: La présente étude a révélé que Staphylococcus aureus, Streptococcus pneumonie, Proteus mirabilis, Klebsiellaspp, Escherichia coli et Bacteroide sspp étaient les flores bactérienne commune dans les sinus des patients atteints de RSC.

Mots clés; M*méat moyen, bactériologie, rhino-sinusite chronique*

Introduction

Chronic Rhinosinusitis (CRS) is a common Otorhinolaryngological disease worldwide [1]. Patients with CRS have a substantial negative health impact owing to the disease [1]. It adversely affects their mood, physical and social functioning [2]. The osteomeatal complex is located within the middle meatus and is the key area in the pathogenesis of sinusitis [3]. Though the pathophysiology of CRS is not fully understood [4] it is said to result primarily from a non-infective etiology but have secondary bacterial infection [5].

Drainage and ventilation of these major paranasal sinuses are dependent on the patency of the osteomeatal complex [6,7]. This is usually as a result of inflammation or anatomic obstruction in this area thereby causing a block in the drainage of the sinuses and thus stagnation of secretion [6,8,9]. The oxygen tension within these sinuses will be reduced and the acidity within the sinus cavity is increased thereby creating a relatively anaerobic environment and impaired opsonization with phagocytosis [6, 10].

All these will lead to creation of a culture medium for bacterial proliferation and infection [5] in addition to this, the selective pressure of antimicrobial agents also enable resistant organisms to survive [10,11]. The presence of bacteria within the nose or paranasal sinuses might initiate CRS, cause persistence of the disease, or exacerbate a noninfectious inflammatory process through bacterial colonization [7]. The predominant aerobic and facultative anaerobic isolates are -*Hemolytic streptococci, Enterobacteriaceae* (*Escherichia coli, Proteus mirabilis, Klebsiella pneumoniae*), and *Staphylococcus aureus*. *Coagulase-negative Staphylococcus* isolated in nasal secretion cultures are usually considered as a contaminant [12].

There is no definitive and consistent data on the distribution of bacteria in patients with CRS [10]. The variability of result from studies are due to; the different techniques used as harvesting method, variations in culture methods, prior use of antibiotics and difficulties in distinguishing the colonizing agents from the truly pathogenic ones [13]. This study was aimed at the identification of pathogenic organisms (aerobic and anaerobic) in middle meatal aspirates of adult patients with CRS in this environment.

Materials and methods

This was a hospital-based cross sectional study of the middle meatal aspirate of adult patients with CRS and age-sex matched controls taken under endoscopic guidance. An ethical clearance for the conduct of the study was obtained from Lagos University Teaching Hospital Ethical Review Board. A clear and written consent was obtained from all the participants and the study was done in accordance with the Helsinki Declaration of 1975 as revised in 1996.

Included were patients with clinical and radiological diagnosis of CRS and excluded those who had received antibiotics in the preceding 2 weeks prior to presentation and those with septal deviation which impaired visualization of the middle meatus.

Data collection procedures

A structured questionnaire was administered to collect the participants' biographic and clinical data. The diagnosis of CRS was based on a positive history, nasal endoscopy and radiological findings. Clinical diagnosis of rhinosinusitis was made if there were 2 or more major factors or 1 major factor and 2 minor factors [14]. Major factors for diagnosis includes facial pain or pressure, facial congestion or fullness, nasal obstruction or blockage, nasal discharge or purulence or discolored postnasal discharge, hyposmia or anosmia. Minor factors were defined as headache, halitosis, fatigue, dental pain, cough, and ear pain or pressure, or fullness [15] with history of continuous nasal symptoms for 12 consecutive weeks.

Radiological evidence of CRS was Water's view revealing mucous membrane thickening of 5 mm or complete opacification of one or more sinuses or presence of fluid level

Nasoendoscopy and collection of Specimen

The diagnostic nasal endoscopy was carried out to examine the nasal cavity and to also obtain aspirate from the middle meatus of the CRS patients while middle meatal swabs were obtained from the middle meatus of the control group for microbiological studies. Rigid nasal endoscope (Tiang song 4mm scopes with 0º angle) was used for this purpose. Each participant was comfortably seated on a chair and the investigator sat in front of the participant, the nasal mucosa was prepared with ribbon gauze strips dipped in 1:100,000 dilution of xylocaine in adrenaline solution which helped to shrink the mucosa and achieve surface anaesthesia. The ribbon gauze strip was then applied to areas which were likely to come in contact with the nasal endoscope during the procedure. This included the nasal septum, the base and the free edge of the middle turbinate, the middle meatus, floor of the nose and sphenoethmoidal recess.

The diagnostic nasal endoscopy was performed by two passes, thereafter secretion was aspirated directly from the middle meatus (in both nasal cavities) using sterile pipette tube while for the control group, middle meatal swabs were obtained from the control group. This procedure was performed carefully without touching the adjacent structures Those for aerobic isolation were plated directly into the culture medium while the second set of the specimen were placed into anaerobic transport medium.

Processing of specimens

Middle meatal aspirate and swab specimen from patients with CRS and control were inoculated into 5% sheep blood agar, chocolate agar and MacConkey agar plates. Specimen on anaerobic transport medium were plated onto anaerobic blood agar and fastidious anaerobe agar, supplemented with vitamin K1, hemin and 5% sheep's blood in the laboratory. Anaerobic atmosphere was generated by Gas generating kit in an anaerobic jar (Anaerogen (Oxoid) UK). Aerobic plates were examined at 24 and at 48 hours while anaerobic plates were incubated further for 5-7 days.

Bacteria identification

Aerobes were identified by standard biochemical procedures and with the aid of API 20E (Biomerieux France). Anaerobes were principally identified according to the methods described in the Wadsworth Anaerobic Bacteriology Manual and API 20A (Api Bio-Merieux, Lyon, France).

Antibiotic susceptibility tests

Aerobic species

Antibiotic sensitivity testing was conducted following the guideline of the Clinical laboratory standard institute (CLSI) using the disc diffusion method. The antibiotics (oxoid) employed were; Ciprofloxacin (5ug), Ceftriazone (30ug), Erythromycin (15ug), Amoxycillin/clavulanic acid (30ug), Cotrimoxazole (1.25/23.75ug), Penicillin G (110ug), Cefoxitin (30ug), Tetracycline (30ug).

Anaerobic species

Antibiotic susceptibility testing of anaerobic isolate was done by agar diffusion method as recommended by CLSI using the antibiotic disc (Oxoid antibiotic disc): metronidazole (5ug), Ciprofloxacin (5ug), ceftriaxone (30ug), Amoxycillin/clavulanicacid (30ug), Clindamycin (30ug) Penicillin G (10ug).

Data analysis

Data collected was collated, presented in descriptive format, tables, diagrams and graphs where appropriate.

Table 1: Socio-demographic characteristics of the study group

Variable	Case n=136(%)	Control=136(%)	Testofsignific.	
Sex				
Male	58 (42.6%)	67(49.3%)		
Female	78(57.4%)	69(50.7%)	x^2= 2.441df = 1	p=0.230
Age (years)				
<20	25(18.4%)	33(24.3%)		
20-34	39(28.7%)	37(27.2%)		
35-49	48(35.3%)	45(33.1%)		
>=50	24(17.6%)	21(15.4%)	x^2= 8.824df = 1	p= 0.056
Mean age (SD)	36.3 (14.2)	38.1 (13.2)	t=1.1653df=318,	p=0.2448
Occupation				
Class 1	15(11.0%)	23(16.9%)		
Class 2	23(16.9%)	24(17.6%)		
Class 3	28(20.6%)	27(19.8%)		
Class 4	27(19.9%)	29(21.4%)	x^2= 3.766df=3	p= 0.447
Class 5	43(31.6%)	33(24.3%)		
Educational background				
None	12 (8.8%)	19(14.0%)		
Primary	29(21.3%)	27(19.8%)		
Secondary	36(26.5%)	39 (28.7%)		
Tertiary	59 (43.4%)	51(37.5%)	x^2=17.294df=3	p= 0.061

Analysis was done using Statistical package for social sciences (SPSS) version 17. The Yates Chi-square statistics was used to test for associations in the contingency tables and for comparison of proportions. Statistical significance was said to be achieved if the 'p' value is equal to or less than 0.05.

Table 2: Clinical presentations of patients with chronic rhinosinusitis

Symptoms	Frequency	Percentage	Signs	Frequency	Percentage
Nasal discharge	110	80.88	Mouth breathing	20	14.70
Alternating nasal blockage	75	55.14	Nasal polyp	0	0
Hyposmia/ anosmia	48	35.29	Mucopurulent rhinorrhea	108	79.41
Excessive sneezing	54	39.70	Engorged turbinate	113	83.08
Itching of eye or ear or nose or throat	32	23.52	Edematous nasal mucosal	92	67.64
Fatigue	11	8.08	Septal deviation	34	25
Ear pain	5	3.67	Postnasal discharge	65	47.79
Halitosis	11	8.08	Granular posterior pharyngeal wall	59	43.38
Frequent throat hawking & clearing	40	29.41	Dull tympanic membrane	42	30.88
Tooth ache	0	0	Retracted tympanic membrane	19	13.97
Cheek pain	8	5.88			
Facialpain/pressure or headache	7	5.14			
Hoarseness	0	0			

Table 3: Aerobic bacteria isolates from the middle meatal aspirates of patients with CRS

	Bacteria isolated	Frequency n (%)	Control (%)	
Gram Positive	*Staphylococcus aureus*	22(53%)	10(30%)	P = 0.111
	Streptococcus pneumoniae	3(7%)		
	Coagulase negative Staphylococcus		23(70%)	
Gram Negative	*Proteus mirabilis*	5(12%)		
	Klebsiellaspp	6(14%)		
	Escherichia coli	5(12%)		

Results

The study population was made up of one hundred and thirty six CRS adult patients comprising 58(42.6%) male and 78(57.4%) female among the cases while there were 67 (49.3%) males, 69 (50.7%) females for the control, the difference in the sex distribution of the case and control group was not statistically significant (x^2 =2.441, p =0.230). The mean age of the study group was 36.3+14.2 years. Using the social strata classification of Famuyiwa *et al* [17], most of the subjects studied belonged to the class 5 occupational level(unemployed, retired or students) 43 (31.6%) and33 (24.3%) for the cases and control respectively (p= 0.447) as shown in table 1.

The clinical features of these patients is as shown on table 2. In this study, the proportion of the

CRS patients that had pathogenic bacteria growth was 42%, No growth was found in the culture from 58% specimens. A total of forty one aerobic bacteria were cultured. About sixty one percent of the aerobic bacteria isolated were gram positive organisms while the remaining 39% was gram negative. Fifteen percent of the cultured isolates yielded mixed growth of both aerobes (Gram positive and gram negative). Twenty two (53%) of the isolates were *Staphylococcus aureus* while 3 (7%) of the isolates were *Streptococcus pneumonia*. The gram negative bacteria isolated were *Proteus mirabilis, Klebsiella species, Escherichia coli* with the frequency of 5(12%), 6 (14%), 5(12%) respectively (table 3).

In this study, only fifty specimen were cultured for anaerobes (this make n i.e. sample size for anaerobic study 50 specimen) due to inadequate funds and facilities and from this, we were able to recover three (6%) isolates of *Bacteroides species* from the middle meatal aspirates of the cases. Antibiotic sensitivity pattern of the cultured bacteria in the study group is shown in table 4; most of the isolates were sensitive to ciprofloxacin, ceftriaxone and Amoxycillin/clavulanic acid while penicillin was the least effective antimicrobial agent.

Discussion

The main findings in this study were; higher percentage of CRS patients studied were female (57%),this is in agreement with the observation of Adoga *et al* [18] carried out among the chronic rhinosinusitis patients in Jos University Teaching Hospital, Jos which reported that 60% of the study group were female and 40% were male. Ologe *et al* [1] also had a similar finding in a study done in Ilorin. This is similar to most of the findings in the western world which reported a higher prevalence of chronic rhinosinusitis in female patients irrespective of their age [19].

Previous studies showed a high correlation between the results from cultures done on secretions harvested from the middle meatus and ethmoid/ maxillary sinuses [13, 20-22]. This may be due to the fact that, the middle meatus drains the anterior ethmoid, frontal and maxillary sinuses [21]; thus the bacteriology of this area better represents the organisms found within these paranasal sinuses when compared to material from the maxillary puncture. However, the culture from endoscopic harvest of secretion from the middle meatus is a feasible alternative to antral puncture. It is an effective and non-invasive way in identifying the pathogens for routine investigation and monitoring thus increasing the effectiveness of antibiotics [13,21,22].

In this study, the proportion of the CRS patients that had pathogenic bacteria growth was 42%, No growth was found in the culture from 58% specimens. The aerobic bacteria cultured in this study include *Staphylococcus aureus* (53%), Streptococcus pneumonia (7%), Proteus mirabilis (12%), Escherichia coli (14%), and Klebsiella species (12%).

This result is comparable to previous studies done worldwide which reported *Staphylococcus aureus* as the commonest pathogen associated with chronic rhinosinusitis[1,23-25].Aneke and Ezeanolue (32.3%)[23], Ijaduola *et al*(24.03%) [24], Ologe *et al* (48.1%) [1], Doyle *et al* (48.6%) [25]. The role of staphylococcal exotoxins as superantigens with the ability to incite an exaggerated inflammatory reaction provides a possible explanation for the predominance of *Staphylococcus aureus* in chronic rhinosinusitis [26]. Likewise, the ability of these bacterial species to organize biofilms, may contribute towards its' high incidence in CRS cultures [27].

Gram negative bacteria constitute significant proportion of the aerobic organisms cultured from the middle meatal aspirate of patients with chronic sinusitis in this study. This is comparable with the observation of some researchers like Araujo *et al* (37%) [13], Bolger *et al* (31%) [28], Nadel *et al*. (27%) [29] and Gold and Tami (32%) [30]. This may be attributed to misuse of antibiotics, a problem in developing countries, which generally leads to persistence of resistant strains and chronicity.

The most common aerobic species detected among the control patients (patients who had no blockage of their sinus or signs of sinus inflammation) was *coagulase negative staphylococci* (60.5%).This is comparable to findings in previous studies done [1,13] Hence, it can be assumed that *coagulase negative staphylococci* belong to the physiologic flora of the middle meatus, hence, are predominantly saprophytes; however, when found with numerous leucocytes and/ or massive growth, may represent a true infection [12].

Anaerobic organisms have long been implicated as a causative organism in chronic rhinosinusitis. In this study, anaerobic bacteria were cultured in 6% of the patients, which is comparable with the findings of previous studies; Vogan *et al*. [31], Muntz *et al*., [32], Rontal *et al*. [33] and Doyle *et al*, [25] cultured anaerobic bacteria in 6% or less in their series. Meanwhile Brook *et al*. [34] and Erkan *et al*. [35],

analyzing aspirates from maxillary sinuses, found anaerobes in 82% and 88% of the cases, respectively. This difference may be due to the prolonged conservative medical treatment (e.g. decongestants, antibiotics) which some of these patients had.

Such treatment may increase the drainage of purulent material and may sufficiently allow for the oxygenation of the middle meatus to eliminate the anaerobes. In addition to this, studies have shown that more isolates of anaerobes are cultured from specimen taken from the sinuses than those gotten from the middle meatus [25]. *Bacteroides species* was isolated in this study, this is similar to the finding of Doyle et al [25] but contrary to the result of Brooks *et al* [34] who isolated *Prevotella species, Peptostreptococcus species and Fusobacterium species*.

The antibiotic sensitivity pattern showed that all the aerobic bacteria were sensitive to ciprofloxacin, Cefriaxone and Amoxycillin-clavulanic acid. Meanwhile all the anaerobes were sensitive to metronidazole. This is comparable to many of the previous studies done [1,23,24]. Penicillin was the least effective antibiotic against the aerobic bacteria. This suggest that most pathogens produce beta-lactamase. The most commonly encountered organism, *Staphylococcus aureus*, showed 37% of Cefoxitin resistance, which supports today's increasing tendency toward MRSA (methicillin resistant *Staphylococcus aureus*). These observations suggest that appropriate antibiotic treatment can help to eradicate bacteria in chronically-infected sinuses and thus justify the need for microscopy, culture and sensitivity in the management of these patients.

This study has some limitations: Anaerobic study was not carried out on all the samples from CRS patients. In addition to this, the control group were completely excluded from the anaerobic study due to limited funds available for this study, hence there is need for further studies (especially anaerobic studies).

Conclusion

The present study found that *Staphylococcus aureus*, *streptococcus pneumoniae, Proteus mirabilis, Klebsiella spp, Escherichia coli* and *Bacteroides spp* were the common bacterial flora in the paranasal sinuses of patients with CRS.

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