Original Research Article

CHARACTERIZATION AND ANTIBIOTIC SENSITIVITY OF BACTERIA IN OROFACIAL ABSCESSES OF ODONTOGENIC ORIGIN

ABSTRACT

Background: Odontogenic infections range from peripheral abscesses to superficial and deep infections that lead to severe infections in the head and neck area that may threaten the patient's life. This study aimed to define the bacterial isolates responsible for orofacial infection of odontogenic origin and their susceptibility patterns to drugs in order to provide a better understanding of dental infection management in Yemen. **Methods:** The study was conducted on a selected group of patients, regardless of age and gender, who suffer from moderate to severe orofacial infections of odontogenic origin and were admitted to the dental clinic at the Republican University Hospital in Sana'a city. Pus samples were collected and the bacteria were identified by cultivation in suitable medium and then identified by standard bacteriological techniques. Antimicrobial susceptibility testing was also performed using the Kirby-Bauer disc diffusion method. **Result:** A total of 118 cases were positive for bacterial culture, 63 males and 55 females ranged between 5 and 65 years of age, most of them in the age group> 45 years (39.8%), 51.7% had dental abscesses and 48.3% had periodental abscesses. *Staphylococcus aureus, Bacteroides* spp. and *S. epidermidis* were isolated from patients with dental abscesses, *Staphylococcus aureus, Bacteroides spp., S. epidermidis* and *S. pyogens* from perio-Dental abscesses. The most prevalent bacteria were *Staphylococcus aureus* (about 63% of the total isolates), more than 40% of which were resistant to ceftizoxime, calithromycin, augmentin, tetracyclines, erythromycin and oxacillin. While *S. epidermidis* showed less antibiotic resistance than *Staphylococcus aureus*. As for the *Bacteroids* species, it was sensitive to metronidazole and clindamycin (100%), augmentin (98.6%), calrithromycin (94.4%) and finally vancomycin (76.1%). **Conclusion:** A high prevalence of bacterial isolates was found, and *Staphylococcus aureus* was predominant. Most of the bacteria were resistant to different classes of antibiotics. Appropriate antibiotics should be administered based on the bacterial isolates, culture sensitivity, and clinical course of disease.

Keywords: Antibiotic susceptibility; Odontogenic infection; Orofacial abscesses, Sana'a, Yemen.

INTRODUCTION

The odontogenic infection is the most common infection of the mouth and face area and has plagued the human race for centuries. Oral and facial infections resulting from a purulent cause are the most common odontogenic[1] and range from periapical abscesses to superficial and deep infections of the neck [2]. These infections are usually due to tooth decay, gingivitis, crown infection, dental trauma, and to some extent due to complications from dental procedures[3, 4]. The successful management of this infection depends on changing the environment by relieving pressure, removing the causative agent of the disease and choosing an appropriate antibiotic [2]. The National Center for Disease Control and Prevention in the United States of America estimated that approximately one third of all outpatient antibiotic prescriptions are not necessary and this rate is higher in developing countries such as Yemen, where most prescriptions are unnecessary [5]. Failure to prescribe appropriate antibiotics may be associated with the development of resistance and unfavorable side effects[6]. Despite all the improvements in diagnostic testing and the availability of modern antibiotic treatment, such infections continue to cause significant morbidity and mortality rates, particularly when there is no early treatment [7, 8]. The significant problems linked with antibiotic use have encouraged studies looking at antibiotic prescribing practices for dentists [9-13]. Furthermore, the option of antibiotic to manage a dental infection preferably depends on the appropriate culture and susceptibility profile. Patients with this infection are normally prescribed antibiotics on an experimental basis without knowledge of the exact pathogen. This antibiotic treatment may or may not lead to positive results due to a variety of factors such as microbial specificity and drug resistance. In immunocompromised patients, this treatment schedule directs to a faster decline in health situation. These limits are compounded by a lack of advanced facilities to quickly and precisely detect pathogenic microorganisms. Dentists must understand pathobiology and proper management of this infection as it is so important. In addition, differences in geography, prevalence of resistant bacterial strains and local antimicrobial prescribing practices lead to variation in the antibiotic properties of the bacteria between populations in different regions of the world[14]. Updated information on the pattern of microbial resistance at the national and local levels should inform the rational use of existing antimicrobial drugs [15]. It is known that early finding of pathogens and enhanced diagnostic methods are necessary to improve the healthcare system. Because microorganisms differ from region to region in addition to their sensitivity, it is vitally important to conduct such studies that will help monitor the constant development of the susceptibility of bacteria to commonly used drugs. Several studies have found that there are changes that have occurred in the organisms that cause maxillofacial infection in the world in general[16]. Therefore, this clinical and microbiological study was designed

to verify the validity of these allegations. The aim of this study was to identify the bacteria responsible for orofacial abscesses infections and to find out the pattern of their sensitivity to antimicrobials against the commonly prescribed antibiotics in Yemen.

SUBJECTS AND METHODS

Patients

This study included 118 patients suffering from moderate and severe oral infections of odontogenic origin (abscesses), who were admitted to the dental clinic at the Republican University Hospital in Sana'a, during a period of about one year, which started in December 2019 and ended in November 2020, of whom 63 were males and 55 were females. Their ages ranged from 5 to 65 years with an average of 36.2 years.

Study design

This study was a case-finding study.

Data collection and processing

A questionnaire was filled out for each patient with the patient's personal and clinical data. This included age, gender, occupation and relevant clinical information regarding bacterial oral infections. Upon initial hospital registration, cultures were obtained from pus collected by surgeons in order to isolate various bacterial etiological agents.

Microbiological methods

Patients who had undergone antibiotic treatment and / or had incision and drainage were excluded. Pus samples were collected by aspiration of the abscess from inside the mouth after further oral sterilization, using a disposable syringe (5 ml) with a disposable needle of 18/22 gauges. Each sample was rigorously examined for appearance with regard to color and consistency. The collected pus was inoculated immediately in trypticase Soy broth and/or thioglycollate broth then cultured into proper solid media in aerobic and anaerobic conditions at 37 ° C for 18-48 h. After incubation, each separate morphological colony species was counted using a digital colony counter. If no growth is observed, the culture is reported as "no growth". All similar individual colonies were also processed for Gram staining, and pure cultures were obtained and also used for identification. All samples were operated according to the Clinical Microbiology Laboratory Standard Operating Procedures [17].

Antibiotic sensitivity tests

Antimicrobial susceptibility testing was carried out using the Kirby-Bauer disk diffusion method on Muller-Hinton agar according to CLSI guidelines. Antimicrobial susceptibility have been determined using commercial antimicrobial discs. We selected ten antibiotics with a wide range of mechanisms of action, including drugs that target the cell wall, DNA, and protein (Tables 5, 6, 7). After incubation, the antimicrobial effectiveness was determined by determined the diameter of the inhibition zones. The bacterial strains were classified as Sensitive (S), Intermediate (I), or Resistant (R) according to the diameter of the inhibition zone[18].

Data analysis

The clinical and personal data in addition to the results of culture of the specimens were entered into a questionnaire and analyzed by the Epi Info, Version 6. The significance of difference in proportion was analyzed by Pearson Chi-square ($\chi 2$) which is Greater than 3.84 and probability value (p) is less than 0.05 was considered statistically significant.

ETHICAL APPROVAL

Ethical approval was obtained from the Medical Research & Ethics Committee of the Faculty of Medicine & Health Sciences at Sana'a University. All data, including patient identification were kept confidential.

RESULTS

A total of 118 cases were positive for bacterial culture, 63 males and 55 females ranged in age from 5 to 65 years, most of them in the age group> 45 years (39.8%), 51.7% had dental abscesses and 48.3% had perio-dental abscesses (Table 1, 2). *Staphylococcus aureus, Bacteroides* spp. and *S. epidermidis* were isolated from patients with dental abscesses, *Staphylococcus aureus, Bacteroides* spp., *S. epidermidis* and *S. pyogens* were isolated from perio-Dental abscesses (Table 3, 4). The most prevalent bacterium was *Staphylococcus aureus* (about 63% of the total isolates, and more than 40% of them were resistant to ceftizoxime, calrithromycin, augmentin, tetracycline, erythromycin, and oxacillin (Table 5), while *S. epidermidis* showed less resistance to tested antibiotics than *Staphylococcus aureus* (Table 6). For *Bacteroides* species the paternal sensitivity is: metronidazole and clindamycin (100%), augmentin (98.6%), calrithromycin (94.4%) and finally vancomycin (76.1%) (Table 7).

DISCUSSION

Anatomical and microbial factors and the destruction of host resistance, as well as a delay in getting appropriate treatment in the early stages, can lead to the development of a dental local infection [3]. Deep space infection can carry a high rate of morbidity and mortality [19]. The presentation of the patient's condition is determined by the complex microflora, the anatomical methods of spread and the teeth involved[20]. An understanding of these

microorganisms involved in the infection, and the sensitivity profile will help improve the treatment regimen, while incision and drainage is definitely the primary treatment [21]. For the above reasons, understanding the nature and dynamics of oral flora is important in orofacial infections [22].

Most of the patients in our study were adults in the age group> 45 years as reported in other previous studies[23-25]. A possible cause of adults at higher risk is the high prevalence of of systemic diseases that compromise immunity and negligence of oral hygiene[26]. The male to female ratio presented in our study is 1.2: 1, which is consistent with most of the previous reported studies [26-28]. This possibility may be due to the reason why women tend to improve oral health and more frequently seek oral health care[22].

In this study, Gram-positive bacteria were isolated more repeatedly than Gram-negative bacteria as the origin of dental abscess by 75% versus 10% for Gram-negative bacteria (Table 3). This result is in agreement with a study conducted in Spain of 68% and 30% for Gram-positive and Gram-negative bacteria, respectively[29]. In addition, this result was lower than that recognized in Brazil, which indicates that Gram-positive bacteria account for 96.6% of patients [30]. Additionally, *Staphylococcus aureus* is the dominant bacteria isolated in our study which account for 60.7% of the total microorganisms isolated (Table 3). High frequency of *Staphylococcus aureus* in oral infections can be explained by the fact that *Staphylococcus aureus* often colonizes the nasal mucosa, where it can cause internal oral cavity infections[31] and *Staphylococcus aureus* virulence by producing various enzymes such as coagulase that coagulate the plasma and coat the bacterial cell to likely prevent phagocytosis.; Hyaluronidase breaks down hyaluronic acid and aids the spread of *Staphylococcus aureus* [32]. What is more, the prevalence of *Bacteroides* spp isolates was 16.4%. This result was lower than that documented in Brazil (26.7%) [30]. The results of this study indicate that the microbiotics of root canals with periapical abscesses have multimicrobial organisms and are predominantly Gram-positive cocci. Van Winkelhof has previously described the difficulties in isolating these bacterial species through the use of culture methods[33]. Furthermore, Dymock *et al.* [34] and Baumgartner *et al.* [35] ; they are reported that different populations have different configurations of microbes or these species may consist of both cultured and non-cultivable biotypes[36].

The antibiotic results in this study indicated that the antibiotics that remained hypersensitive to *Staphylococcus aureus* were vancomycin (91.8%), followed by clindamycin (76.7%). In contrast, the antibiotics that were highly resistant to *Staphylococcus aureus* were tetracycline (63%), followed by erythromycin and oxcillin (60%). The results of the study agreed with those of the Rams *et al.* who observed that some strains of *Staphylococcus aureus* isolated from periodontal abscesses were resistant to tetracycline and erythromycin [37]. The antibiotic results in the current study also revealed that metronidazole was 100% effective against *Bacteroides* spp. This result was consistent with that reported in Germany (100%) [38]. These results are also consistent with the results of Roche *et al.* which found anaerobes very sensitive to metronidazole[39]. Metronidazole is only active when it is reduced to form an unstable medium that binds to microbial DNA and results in damage that prevents reproduction and transcription[40]. In addition, strict anaerobic isolates (*Bacteroides* spp.) also showed to be hypersensitive to 100% clindamycin, and this result was higher than that documented in Spain (79.1%)[41]. But in accordance with that documented in Germany (100%) [38]. Clindamycin is a useful dental antibiotic, able to penetrate into bone and prevent biofilms from forming[42]. In addition, sensitivity to augmentin by *Bacteroides* spp in the current study was 94.1%, and this result was higher than that documented in Spain (76.7%) [41]. The remaining antibiotics from *Bacteroides* spp. was clarithromycin (94.1%) (macrolide and the erythromycin analog). The most resistant antibiotic used in this study was vancomycin (23.5%) for the same bacteria. The indiscriminate use of antibiotics to supplement dental treatments should be avoided as they may lead to allergic reactions, the development of super-infection with induction of resistant bacterial species and unnecessary exposure to patients with both toxicity and drug side effects [43].

Antibiotic prescription should be an aid to appropriate clinical treatment. The choice of an antibiotic regimen should be based on knowledge of the effectiveness of the antibiotic for the bacteria. It must be remembered that dental caries infections are ecosystems of bacteria where the products of one type of bacteria can be nutrients for other types of bacteria [23]. Antibiotic resistance studies have generally relied on isolating bacteria on antibiotic-free plates and post-testing of sensitivity to a group of antibiotics. The majority of the isolated antibiotic-resistant bacteria were members of the normal oral microflora; some pathogenic and opportunistic bacteria were also isolated. Antibiotic-resistant bacteria have been isolated, which are important factors for pneumonia, otitis media, sinusitis, meningitis, deep abscesses, endocarditis, and dental diseases including caries and gum disease. The carriage of these opportunistic pathogens is of clinical importance because infection caused by antibiotic-resistant bacteria can lead to treatment failure and lead to chronic infection. All subjects had antibiotic-resistant bacteria, which indicates the ability of the oral cavity to function as a reservoir for antibiotic-resistant organisms. A small number of people had very high levels of oral bacteria that are resistant to certain antibiotics. The high percentage of oral bacteria that are resistant to a particular antibiotic indicates the existence of a subgroup that can act as a reservoir for antibiotic-resistant bacteria [29-31].

CONCLUSION

Species of *staphylococcus* are the most common pathogens of orofacial infections of odontogenic origin. Most of the bacteria were resistant to different classes of antibiotics. Appropriate antibiotics must begin to correlate with clinical emergence without forgetting the importance of early surgical intervention to reduce morbidity and complications. Furthermore, antibiotics should be administered based on the bacterial isolates, culture sensitivity, and clinical course of disease. This study also indicates the effect of iceberg and that the potential public health significance of periodontal disease is perhaps underestimated in Yemen. The pattern of illnesses presented in a hospital is influenced by many confounding factors of choices that operate from the patient's home to the point at which their condition is diagnosed and treated in the hospital. Regarding the patient, his act is based on his awareness that he is sick and his knowledge that relief is available in a particular healthcare facility.

AUTHOR CONTRIBUTION

This study was under the supervision of Prof Dr. Al-Kasem M Abbas , Professor of Dental Surgery, Faculty of Dentistry, Sana'a University. Other authors analyzed the data and wrote the manuscript, and reviewed it.

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CONFLICT OF INTEREST

"No conflict of interest associated with this work".

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Table 1: The number and percentage of clinical diagnosis of different bacterial oral/facial abscesses infections

Age in years	**Total Number (%)**	**Dental abscess** n=**61**		**Perio-dental abscess** n=**57**	
		No.	**%**	**No.**	**%**
< 16	7 (5.9%)	5	**8.2**	2	**3.5**
16-25	18 (15.3%)	9	**14.8**	9	**15.8**
26-35	23 (19.5%)	13	**21.3**	11	**19.3**
36-45	22 (18.6%)	11	**18**	11	**19.3**
> 45	47 (39.8%)	23	**37.7**	24	**42.1**
Total	118 (100%)	61	**51.7**	57	**48.3**

Table 2: The number and percentage of clinical diagnosis of different bacterial oral/facial infections among different sexes

Type of infections	**Total** n=118		**Male** n=**63**		**Female** n=55		χ^2	***p***
	No.	**%**	**No.**	**%**	**No.**	**%**		
Dental abscesses	61	**51.7**	32	**50.8**	29	**52.7**	0.02	0.89
Periodental abscesses	57	**48.3**	31	**49.2**	26	**47.3**	0.21	0.61

χ^2 Chi-square = ≥ **3.84 (significant)**
p Probability value = < **0.05 (significant)**

Table 3: The number and percentage of the isolated microorganisms from the 61 patients suffering from dental abscesses in respect to gender.

Bacterial isolates	**Total** n=**61**		**Male** n=**32**		**Female** n=**29**		χ^2	***P***
	No.	**%**	**No.**	**%**	**No.**	**%**		
S. aureus	37	**60.7**	20	**62.5**	17	**58.6**	0.10	0.75
S. epidermidis	6	**9.8**	4	**12.5**	2	**6.9**	0.54	0.46
Total Gram positive	43	**70.5**	24	**75**	19	**65.5**	-	-
Bacteroides spp	10	**16.4**	5	**15.6**	5	**17.2**	0.03	0.86
Mixed growth	8	**13.1**	3	**9.4**	5	**17.2**	1.2	0.27

χ^2 Chi-square = ≥ **3.84 (significant)**
p Probability value = < **0.05 (significant)**

Table 4: The number and percentage of isolated microorganisms from the 57 patients suffering from periodental abscesses in respect to gender.

Bacterial isolates	**Total** n=**57**		**Male** n=**31**		**Female** n=**26**		χ^2	***P***
	No.	**%**	**No.**	**%**	**No.**	**%**		
S. aureus	36	**63.2**	19	**61.3**	17	**65.4**	1.33	0.24
S. epidermidis	10	**17.5**	7	**22.6**	3	**11.5**	1.19	0.27
Bacteroides spp	7	**12.3**	2	**6.5**	5	**19.2**	2.14	0.14
S. pyogens	2	**3.5**	2	**6.5**	0	**0**	1.74	0.18
Mixed growth	2	**3.5**	1	**3.2**	1	**3.8**	0.02	0.87

χ^2 Chi-square = ≥ **3.84 (significant)**
p Probability value = < **0.05 (significant**

Table 5: The susceptibility patterns of *S. aureus* isolates (73) towards the different commonly used antibiotics.

Antibiotics	Susceptibility test					
	Sensitive		Intermediate		Resistant	
	No.	%	No.	%	No.	%
Augmentin (30µg)	41	**56.2**	-	**-**	32	**43.8**
Oxacillin (1µg)	17	**23.5**	12	**16.4**	44	**60.3**
Tetracycline (30µg)	21	**28.8**	6	**8.2**	46	**63**
Erythromycin (15µg)	19	**26**	10	**13.7**	44	**60.3**
Ceftizoxime (30µg)	43	**59**	7	**9.6**	23	**31.5**
Ciprofloxacin (5µg)	52	**71.2**	4	**6.1**		**22.6**
Clindamycin (2µg)	56	**76.7**	2	**2.7**	15	**20.5**
Clarithromycin (15µg)	42	**57.5**	4	**5.5**	27	**37**
Vancomycin (30µg)	67	**91.8**	-	**-**	6	**8.2**

Table 6: The susceptibility patterns of *S. epidermidis* isolates (16) towards the different commonly used antibiotics.

Antibiotics	Susceptibility test					
	Sensitive		Intermediate		Resistant	
	No.	%	No.	%	No.	%
Augmentin **(30µg)**	10	**62.5**	1	**6.3**	5	**31.2**
Oxacillin **(1µg)**	9	**56.3**	0	**0**	7	**43.7**
Tetracycline **(30µg)**	13	**81.2**	1	**6.3**	2	**12.5**
Erythromycin **(15µg)**	8	**50.0**	5	**31.2**	3	**18.8**
Ceftizoxime **(30µg)**	11	**68.8**	3	**18.8**	2	**12.5**
Ciprofloxacin **(5µg)**	12	**75**	2	**12.5**	2	**12.5**
Clindamycin **(2µg)**	14	**87.5**	0	**0**	2	**12.5**
Clarithromycin **(15µg)**	10	**62.5**	2	**12.5**	4	**25**
Vancomycin **(30µg)**	15	**93.7**	0	**0**	1	**6.3**

Table 7: The susceptibility patterns of *Bacteroides* spp isolates (17) towards the different commonly used antibiotics.

Antibiotics	Susceptibility test					
	Sensitive		Intermediate		Resistant	
	No.	%	No.	%	No.	%
Augmentin **(30µg)**	16	**94.1**	0	**0.00**	1	**5.9**
Metronidazole **(50µg)**	17	**100**	0	**0.00**	0	**0.00**
Clindamycin **(2µg)**	17	**100**	0	**0.00**	0	**0.00**
Clarithromycin **(15µg)**	16	**94.1**	1	**5.9**	00	**0.00**
Vancomycin **(30µg)**	13	**76.5**	0	**0.00**	4	**23.5**