Available online at www.ijpsdr.com

International Journal of Pharmaceutical Sciences and Drug Research 2015; 7(6): 474-477

Research Article

ISSN: 0975-248X
CODEN (USA): IJPSPP

Primary Antibiotic Susceptibility against Streptococci in Odontogenic Infections – A Clinical Study

Rachita Chengappa[1*], Mangala Rakaraddi[2], Asim Mustafa Khan[3], Veena Narayanan[1], Jijin Mekaddath[4], Krupashankar Rangaswamy[1]

[1]*Coorg Institute of Dental Sciences, Virajpet, Coorg, Karnataka, India*
[2]*Daswani Dental College, Kota, Rajasthan, India*
[3]*College of Dental Sciences, University Of Dammam, Saudi Arabia*
[4]*Malabar Dental College, Mallapuram, Kerala, India*

ABSTRACT

Antibiotics form an intergral part in the management of odontogenic infections. Streptococci group of bacteria have been implicated as one of the important causative agents in dental caries and dental abscess. The objective of this study was to determine the sensitivity and resistance of pathogenic facultative anaerobic streptococci to various routinely used antibiotics in odontogenic infections and also to determine appropriate empirical antibiotic therapy for the orofacial infections of odontogenic origin. Primary culture was performed for duration of 48 hours with the samples obtained from the patient. A lawn culture from the primary culture was made and antibiotic sensitivity testing was done using commercially available antibiotic disks by disk diffusion method. Standard strain of *Streptococcus mutans* (MTCC 497) was subjected to susceptibility testing by the above mentioned method. Poor susceptibility was seen in amoxicillin (18.4%), amoxicillin clavulanic acid (14.3%), and erythromycin (26.5%). Maximum resistance was noted for metronidazole (89.8%). High susceptibility was observed in tetracycline (67.3%), streptomycin (61.2%) and ciprofloxacin (44.9%). Low resistance was also exhibited by gentamycin (22.4%) and doxycycline (40.8%). *Streptococcus mutans* (MTCC 497) too showed similar results as that of the test samples. Due to the evolving resistance to all major antimicrobial agents used for treatment of odontogenic infections, antibiotic susceptibility testing is important to direct therapy. Antimicrobial susceptibility helps in monitoring the changing patterns of resistance and can be useful for empirical treatment of odontogenic infections.

Keywords: Odontogenic infections, Antibiotic susceptibility, Streptococci.

INTRODUCTION

Odontogenic infections are one of the most common reasons for the patients to visit the dentist and are frequently encountered in day to day practice.

***Corresponding author: Dr. Rachita Chengappa,**
Senior Lecturer, Coorg Institute of Dental Sciences, Maggulla Village, Virajpet-571218, South Coorg, Karnataka, India; **E-mail:** rachitachengappa@gmail.com
Received: 23 August, 2015; **Accepted:** 17 November, 2015

The etiology of odontogenic infections is mixed where both aerobic and anaerobic bacteria are involved. The most commonly found facultative anaerobes belong to the viridans group streptococci and the milleri group streptococci. The viridans group of Streptococci comprises the mitis group, oralis group, salivarius group, sanguinis group and the mutans group. The milleri group comprises the anginosus group, constellatus group, intermedius group. *Streptococcus*

mutans are implicated in causing dental caries. Streptococci are frequently isolated from acute dental abscess and draining sinuses. The most effective microorganisms in Ludwig's angina are streptococci. [1]
The oral cavity microbiota consists predominantly of viridans group streptococci (VGS), which play an important role in inhibiting colonization of pathogens. [2] *Streptococcus viridians* have been implicated in occurrence of transient bacteremia as a result of invasive dental procedures. [3-4]
Odontogenic infections are usually treated by surgical drainage and antibiotic administration. Occasionally the infection involves the fascial planes, resulting in life threatening condition which requires hospital admission and aggressive antibiotic therapy. Many orofacial infections are treated successfully without identifying or testing the antimicrobial susceptibility of the pathogen. Antibiotic resistance has become a world-wide issue and is the leading cause for therapy failure. Random prescribing, inappropriate dosing and duration of treatment, over the counter availability of antibiotics have contributed to the rise of antibiotic resistance among various common human pathogens. Therapy failure may occur if the pathogens involved are resistant to the drug of choice. Antimicrobial susceptibility testing is performed to guide the clinician in decision making. The aim of this study is to determine the sensitivity and resistance of pathogenic facultative anaerobic streptococci to various routinely used antibiotics in odontogenic infections.

MATERIALS AND METHODS

In this study, 49 samples were obtained from 49 patients with jaw abscesses. Patients on antibiotic therapy within 48 hours at the time of collection of sample, patients with compromised immune profile (e.g. taking immunosuppressive drugs, HIV positive patients) and patients requiring intensive medical care (e.g. uncontrolled diabetes mellitus, respiratory tract infections, leukemia), patients with other systemic diseases like bacterial endocarditis, valvular disorders, bleeding and clotting disorders and pregnant patients were excluded from the study. After obtaining informed consent from the patient pus samples were collected using sterile swabs. Samples from consolidated abscess were collected using sterile wide bore needles.
Samples were immediately inoculated into blood agar plates and were incubated for a period of 48 hours in an anaerobic jar. The streptococci were identified based on colony characteristics, α-haemolysis and catalase test. Since it was a preliminary study and life threatening infections were not incorporated further species identification was not performed. The identified organisms were further subjected to antibiotic susceptibility testing using disc diffusion method using Muller Hinton agar. Standardized inoculum was prepared by McFarland 0.5 turbidity standard. Commercially available antibiotic discs were utilized for the study (Hi Media Mumbai). They were: amoxicillin 25 mcg, amoxicillin-clavulanic acid 30 mcg, gentamycin 10 mcg, streptomycin 10 mcg, erythromycin 15 mcg, metronidazole 5 mcg, doxycycline 30 mcg, tetracycline 30 mcg, and ciprofloxacin 5 mcg. The agar plates were incubated for a period of 24 hours in an anaerobic jar.
The circular zone of inhibition were inspected and measured in millimeters across center of disks using calipers (no zone is equal to 6 mm). The size of the zones was interpreted as resistant, intermediate and susceptible as per the critical diameters indicated by current guidelines (CLSI/NCCLS and CA-SFM). [5-6]
Standard strain of *Streptococcus mutans* (MTCC 497) was used for quality control. The strain was subjected to primary culture followed by antibiotic susceptibility testing, similar to that of test samples. This study was approved by the Ethics committee and Institutional Review Board.

RESULTS

49 patients of ages ranging from 10 years to 65 years were included in the study. 17 patients of the study group was formed by males (34.7%) and 32 patients were females (65.3%). 18 patients were in the age group of 10-30 years (36.7%), 22 patients in age group of 31-50 years (44.9%) and 9 patients were belonging to age groups between 51-65 years (18.4%). Amongst the 49 cases 20 cases were involving the mandibular posterior region, 3 cases involved the mandibular anterior region, 16 and 10 cases were involving the maxillary posterior and anterior region respectively. Amongst the 49 patients 30 patients had Periapical abscess (61.2%), 13 had periodontal abscess (26.5%), 5 patients had Pulpo - periodontal abscess and 1 patient had residual abscess (2.0%).
Amoxicillin showed a susceptibility of 18.4%, intermediate susceptibility of 20.4% and resistance of 61.2%, amoxicillin clavulanic acid showed a susceptibility of 14.3%, intermediate susceptibility of 16.3% and resistance of 69.4%. Gentamycin showed a susceptibility of 32.7%, intermediate susceptibility of 44.9% and resistance of 22.4%. Streptomycin showed a susceptibility of 61.2%, intermediate susceptibility of 32.7% and resistance of 6.1%. Erythromycin showed a susceptibility of 26.5%, intermediate susceptibility of 20.4% and resistance of 53.1%. Ciprofloxacin showed a susceptibility of 44.9%, intermediate susceptibility of 26.5% and resistance of 28.6%. Tetracycline showed a susceptibility of 67.3%, intermediate susceptibility of 26.5% and resistance of 6.1%. Doxycycline showed a susceptibility of 30.6% intermediate susceptibility of 28.6% and resistance of 40.8%. Metronidazole showed a susceptibility of 4.1%, intermediate susceptibility of 6.1% and resistance of 89.8% (Table 1).
The standard strain of *Streptococcus mutans* (MTCC 497) showed susceptibility to gentamycin and resistance to

Table 1: Results of the three susceptibility patterns of nine antibiotics in percentage

Antibiotics	AMX	AMC	GEN	STREP	ERY	CIP	TETRA	DOXY	MET
Resistant (%)	61.2%	69.4%	22.4%	6.1%	53.1%	28.6%	6.1%	40.8%	89.8%
Intermediate Susceptible (%)	20.4%	16.3%	44.9%	32.7%	20.4%	26.5%	26.5%	28.6%	6.1%
Susceptible (%)	18.4%	14.3%	32.7%	61.2%	26.5%	44.9%	67.3%	30.6%	4.1%

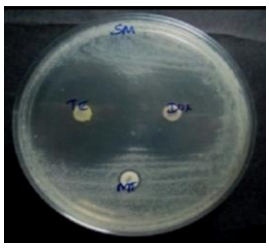

Fig. 1: Antibiotic susceptibility results of *Streptococcus mutans* (MTCC 497). Susceptibility to Tetracycline (TE), Doxycycline (DOX) and resistance to Metronidazole (MT).

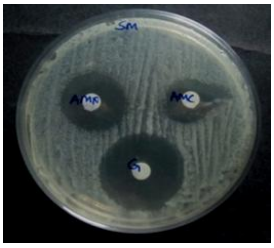

Fig. 2: Susceptibility to Gentamycin (G) and resistance to Amoxicillin (AMX), Amoxicillin -clavulanic acid (AMC)

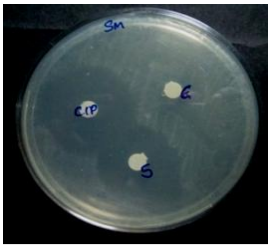

Fig. 3: Susceptibility to Streptomycin (S), Ciprofloxacin (C) and resistance to Erythromycin (E)

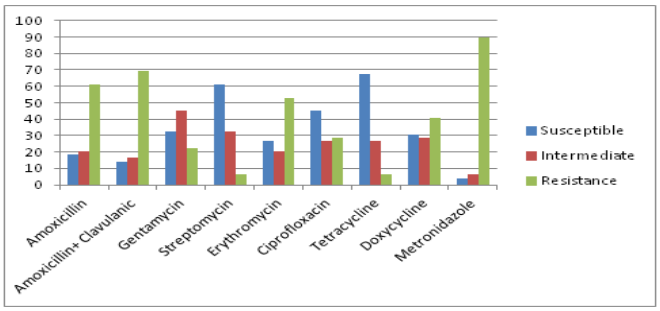

Fig. 4: Overall susceptibility and resistance patterns of antibiotics

amoxicillin, amoxicillin clavulanic acid in Figure 1, susceptibility to streptomycin, ciprofloxacin and resistance to erythromycin in Figure 2, susceptibility to tetracycline, doxycycline and resistance to metronidazole in Figure 3.

DISCUSSION

Approximately 50% of odontogenic infections are caused by anaerobic bacteria alone, 44% by a combination of aerobic and anaerobic bacteria and only 6% by aerobic bacteria alone. The most common species of bacteria isolated in odontogenic infections are the anaerobic gram-positive cocci, *Streptococcus milleri* group and *Peptostreptococcus*; anaerobic gram negative rods, such as Bacteroides also play an important role. Anaerobic gram-negative cocci and anaerobic gram-positive rods have little effect. [7-8]

Broth dilution methods, which are the gold standard in determining susceptibility, are time consuming to perform. The disc diffusion technique for antibiotic susceptibility assay is relatively easy to perform and the results can be ascertained in a period of 24 hours by interpretation of the zone size. However disk diffusion tests should not be performed for strict anaerobic bacteria for the purpose of obtaining susceptibility, as the results are inaccurate and do not correlate with the agar dilution method. [9]

β-lactum antibiotics remain the mainstay for prevention and treatment of most bacterial infections of the head and neck because of their efficacy and relatively low side effects. [10] The bacterial profiles differ with the type of infection, methods of sample collection, isolation techniques and culture techniques. [11] The antibiotic susceptibility varies from different regions and also with the previous exposure of the patients to antibiotics. [12]

Matijević S, *et al.*, [13], in a study on 90 patients with acute odontogenic abscess, the most common were Gram-positive facultative anaerobic bacteria (81.1%), especially Streptococcus viridians. Susceptibility of isolated bacteria to amoxicillin was 76.6%. Highest susceptibility was registered in *Streptoccocus viridans* to amoxicillin. β-lactamase producing bacteria were isolated frequently from the β-lactam administered group (38.5%) than from the β-lactam non administered group (10.9%), and the frequency of isolation increased as the duration of administration increased. [14]

The resistance to amoxicillin + clavulanic acid in our study was far exceeding the susceptibility, indicating a possibility that a majority of the patients has been previously administered with β-lactam antibiotics.

Metronidazole is effective only against strict anaerobic bacteria including those in the oral cavity. [15] However this antibiotic should be administered along with another antibiotic because of its reduced effect over gram positive aerobic bacteria. [16] Metronidazole is a prodrug that has to be activated by redox reaction. This reduction takes place most effectively under anaerobic conditions. [17] Hence metronidazole showed poor results in our study because culture of strict anaerobic bacteria was not performed. Chan and Chan in their study have found that metronidazole had absolutely no effectiveness against facultative bacteria such as Streptococci and *E. corrodens*. [18]

Aminoglycosides have not been usually recommended in the treatment of odontogenic infections showed excellent susceptibility results in our study. Their use is restricted to severe cases where there is a need for intravenous antibiotic administration and in nosocominal infections. [19]

Erythromycin has been recommended as an alternative treatment for patients who are allergic to penicillin and is widely used in antibiotic prophylaxis of bacterial

endocarditis associated with dental procedures. Erythromycin has a questionable benefit in the treatment of severe odontogenic infections and is only recommended in mild to moderate infections in patients with penicillin allergy. [20]

Kohli *et al*., have found ciprofloxacin to be 100% sensitive to streptococci isolated from odontogenic infections and high resistance rates to amoxicillin and ampicillin. [21] High level resistance to tetracycline, gentamycin and ciprofloxacin was observed among VGS strains in a study conducted by Rozkiewicz *et al*. [2] However this is not in agreement with our study where good susceptibility results were observed for tetracycline, gentamycin and ciprofloxacin.

The standard strain of *Streptococcus mutans* (MTCC 497) showed resistance to amoxicillin, amoxicillin clavulanic acid, erythromycin, metronidazole and susceptibility to gentamycin, streptomycin, ciprofloxacin, tetracycline and doxycycline. These results are similar to the overall test results of clinical samples.

Antibiogram tests are not frequently used in everyday management of odontogenic infections; they are usually used for more serious infections. Therefore, in most cases treatment is empirically determined. Empirical antibiotic therapy in odontogenic infections involves use of penicillin based antibiotics primarily. However in our study high resistance was noted for amoxicillin. No advantage was observed in the use of amoxicillin + clavulanic acid combination over amoxicillin alone. High consumption and irrational use of antibiotics has triggered the rise of resistant microorganisms. The development of the resistant bacteria is in proportion with the amount of time for which an antibiotic has been used.

Keeping these points in mind it becomes necessary that a previous history of antibiotic therapy should be one of the leading questions to the patients before any fresh prescription. Knowing the group of antibiotic which was administered in the past is also essential. Also inclination towards other groups of antibiotic other than β-lactum group of antibiotics has become necessary because of high resistance in the latter. Surgical intervention of odontogenic infections involving eradication of microorganisms at the vicinity of infection should necessarily be undertaken to avoid or reduce antibiotic intake.

Since our institution is a tertiary referral hospital the patients would have acquired resistance towards antibiotics as a result of medication prescribed by previous medical attainders. This can be another reason for poor results exhibited by β-lactum group of antibiotics. Our study gave an insight to the existing primary antibiotic susceptibility profile in this region.

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Source of Support: Nil, Conflict of Interest: None declared.