

# Aerobic microbiology and culture sensitivity of head and neck space infection of odontogenic origin

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## ABSTRACT

**Context:** Head and neck space infections source, age, gender, tooth involved, fascial spaces involved, microbiological study of aerobic flora, and antibiotic susceptibilities. **Aims:** The aim of the present study is to identify causative aerobic microorganisms responsible for deep fascial spaces of head and neck infections and evaluate the resistance of antibiotics used in the treatment of such. **Settings and Design:** Prospective study in 100 patients. **Materials and Methods:** This prospective study was conducted on 100 patients who reported in the outpatient department and fulfilled the inclusion criteria to study aerobic microbiology and antibiotic sensitivity in head and neck space infection of odontogenic origin. Pus sample was obtained either by aspiration or by swab stick from the involved spaces, and culture and sensitivity tests were performed. **Statistical Analysis Used:** Chi-square test and level of significance. **Results:** Result showed aerobic Gram-positive isolates were 73% and aerobic Gram-negative isolates were 18%. Nine percent cases showed no growth. *Streptococcus viridans* was the highest isolate in 47% cases among Gram-positive bacteria, and in Gram-negative, *Klebsiella pneumoniae* was the highest isolate of total cases 11%. Amoxicillin showed resistance (48.4%) as compared to other antibiotics such as ceftriaxone, carbenicillin, amikacin, and imipenem had significantly higher sensitivity. **Conclusions:** Amoxicillin with clavulanic acid showed (64.8%) efficacy for all organisms isolated, whereas ceftriaxone showed (82.4%) efficacy and could be used in odontogenic infections for both Gram-positive and Gram-negative microorganisms. Substitution of third generation cephalosporin for amoxicillin in the empirical management of deep fascial space infections can also be used. Carbenicillin, amikacin, and imipenem showed (93.4%) sensitivity against all microorganisms and should be reserved for more severe infection. Newer and broad-spectrum antibiotics are more effective *in vitro* than older narrow spectrum antibiotics.

**Key words:** Antibiotic resistance, culture and sensitivity, odontogenic infection, orofacial space infections, oromicrobial flora

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## INTRODUCTION

Historically, the potential for a dental abscess to spread causing severe sepsis and death has been known since antiquity although the role of bacteria in this process was not recognized until the turn of 20<sup>th</sup> century.<sup>[1]</sup> By the turn of 20<sup>th</sup> century, dental infections were associated with mortality rate of 10–40%.<sup>[1]</sup> Mortality rate declined after the evolution of antibiotics. In addition to systemic toxicity, head and neck space infections cause advanced complications such as suppurative mediastinal, intracranial extension, retropharyngeal spread, airway obstruction, pleuropulmonary suppuration, and hematogenous dissemination to heart valves, prosthetic devices, and other metastatic foci which clearly indicate the potentially serious nature of these infections. Neu<sup>[2]</sup> said “Bacteria are cleverer than men” as they have capacity to adapt in every environmental niche on the planet and now adjusting to a world laced with antibiotics.<sup>[3]</sup> The presence of extended spectrum beta-lactamases (ESBLs) enzymes was reported in 1991 ESBLs enzymes are becoming increasingly common in hospital practice.<sup>[4]</sup> Treatment of odontogenic infection is based on two fundamental elements that are mechanical surgical management and antibiotic therapy. In some cases, antibiotics given are empirical and based on clinical condition of the patient which may lead to inadequate treatment and development of bacterial resistance and multiple resistances.<sup>[5]</sup>

## MATERIALS AND METHODS

After obtaining Ethics and Research Committee’s approval, the study was conducted in a total of 100 patients having orofacial space infections of odontogenic origin of any age. Patient who had not taken antibiotics other than metronidazole were included in the study as the present study design does not include its culture sensitivity test. Medically compromised patients (diabetic, hepatitis, and HIV<sup>+</sup>) were excluded from the study as these patients could have a low immune system which will allow other microorganisms of low virulence to be cultured not commonly found in fascial space infections and therefore interfere with the present study design. Metronidazole was given in every patient for probable anaerobic infection. Swapped pus samples and aspirates were collected aseptically from patients for aerobic culture sensitivity test. Antibiotics used for studies were amoxicillin, amoxicillin with clavulanic acid, imipenem, carbenicillin, moxifloxacin, amikacin, and ceftriaxone.

### Sample collection

Pus samples were collected either intraorally or extraorally. In cases where drainage was intraoral pus samples were collected either by sterile 18/22 gauze

needle with 2 or 5 ml syringes or it was directly collected by swab stick from the drainage site. Extraorally, pus sample was collected by sterile 18/22 gauze needle with 5 ml syringe through intact skin.<sup>[6]</sup> After aspiration, any free air in syringe was expunged, and needle was capped immediately, and material was dispensed in sterilized vials and Stuart’s transport medium.

### Specimen culture

Clinical material was transported to the laboratory. Immediately, culture was done in culture media chocolate agar or MacConkey agar medium. Plates were incubated at 37°C for 12–24 h in an aerobic atmosphere.

### Identification of microbes

After incubation for 48–72 h, all sets of plates were visualized for growth and biochemical tests were done to identify the genus and species of bacteria. Biochemical tests were lactose, glucose, sucrose, maltose, mannitol, methyl red, Voges–Proskauer test, Urease test, Citrate test, oxidation fermentation test and motility test. After 24 h of observation, diagnosis of infection was made.

### Antibiotic sensitivity test

Colonies of bacteria are spread over Mueller-Hinton agar medium. Discs impregnated with antibiotics are placed by the help of sterilized forceps. This plate was again incubated for 12–24 h at 37°C. Zone of inhibition is measured by the help of the WHO quality control chart to access the sensitivity of the antibiotics.

## RESULTS

Of the 100 patients evaluated in this study, 78% were men and 22% were women (mean age, 36.44 ± 12.00 years; range, 7–65 years) [Figure 1].

Mandibular teeth were frequently involved in infection (73.5%) as compared to maxillary teeth (26.5%) of all the cases. Most common mandibular teeth involved were right first molar which accounted for 28% and in maxillary teeth right canine (16%) involved in all the cases [Table 1].

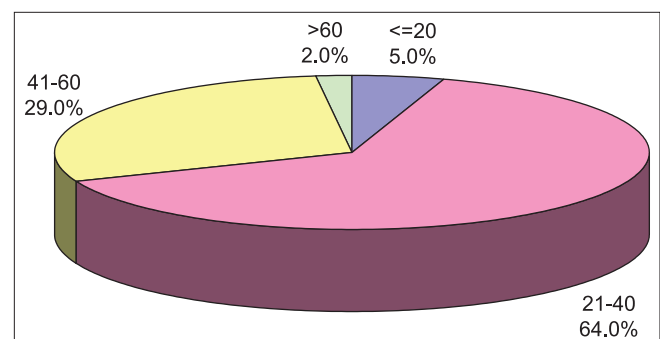


Figure 1: Distribution of cases according to age

Submandibular space infections (30%) were most frequently encountered followed by buccal (20%), submental (15%), and sublingual (10%). Lateral pharyngeal space was affected the site in a total of 8%, canine space in 5%, mesenteric in 4%, palatal 3%, and pterygoid in 2% sites. Masticator, temporal, and Ludwigs angina were affected in 1 case each [Table 2].

Aerobic Gram-positive was isolated from a total of 73% cases, whereas Gram-negative isolates were obtained from a total of 18% cases. No microbes could be isolated from (9%) specimen [Figure 2].

Amoxicillin and clavulanic acid were the most common first line of antibiotic prescribed to the patients (51%) followed by amoxicillin (27%) and ceftriaxone (16%). One (1%) patient each was prescribed amikacin and moxifloxacin, respectively. There were 3% of patients who were not prescribed any antibiotics.

*Streptococcus viridans* was the most common microbe isolated followed by *Staphylococcus aureus* (16%) and *Klebsiella pneumoniae* (11%). Coagulase negative *Staphylococcus* and *Pseudomonas aeruginosa* were isolated from six specimens each. *Escherichia coli* was isolated from 3% specimen while nine specimens were sterile. No anaerobe could be isolated from any of the specimen [Table 3].

*E. coli*. and *P. aeruginosa* showed maximum resistance for amoxicillin and amoxicillin with clavulanic acid (100%). *K. pneumoniae* showed maximum resistance for amoxicillin (63.6%) while moxifloxacin showed a resistance of 36.4%. Ceftriaxone, carbenicillin, amikacin, and imipenem showed (100%) sensitive.

For staphylococci (coagulase negative) strain, maximum resistance was observed for amoxicillin (83.3%), whereas ceftriaxone, carbenicillin, imipenem, and moxifloxacin showed minimum resistance (16.7%) to all three antibiotics. Ceftriaxone and carbenicillin showed maximum sensitivity (83.3%).

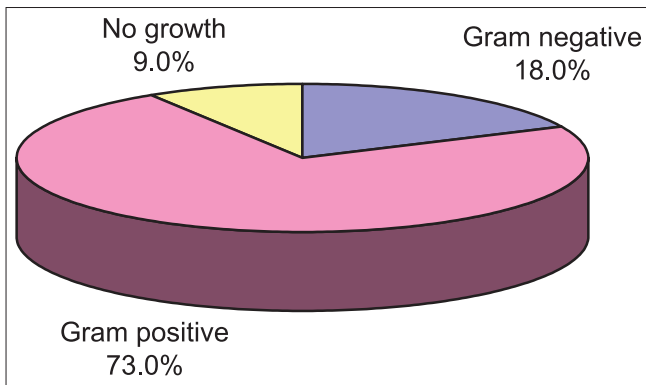


Figure 2: Distribution of cases according to type of microbial isolate

For staphylococci (coagulase positive), amoxicillin and amoxicillin with clavulanic acid showed maximum resistance (100%), whereas imipenem showed a sensitivity of 100%. The sensitivity pattern for moxifloxacin observed intermediate while carbenicillin and amikacin were (50%) resistant.

For *S. aureus*, amoxicillin showed maximum resistance (31.3%) while all the other antibiotics, except amoxicillin with clavulanic acid showed 100% sensitivity, which showed 93.8% sensitivity.

For *S. viridans*, amoxicillin showed maximum resistance (34.0%). Amoxicillin with clavulanic acid showed sensitivity of 68.1%. Ceftriaxone showed 89.4% sensitivity, whereas carbenicillin, amikacin, and imipenem showed 100% sensitivity. Moxifloxacin showed intermediate susceptibility of 64%.

Table 1: Distribution of cases according to infected tooth involved

Variable	n (%)
Total number of teeth involved	113 (100)
Average number of teeth involved in a patient (n = 100)	1.13
Total number of patients with involvement of maxillary teeth	(25)
Total number of patients with involvement of mandibular teeth	(75)
Total number of maxillary teeth involved	30/113 (25.7)
Total number of mandibular teeth involved	83/113 (74.3)
Most common maxillary tooth involved	Right canine-4/25 (16)
Most common mandibular tooth involved	Right first molar-21/75 (28.0)
Overall most common tooth involved	Mandibular right first molar-21/113 (18.6)

Table 2: Distribution of cases according to affected site

Site	Number of cases	Percentage
Submandibular	30	30
Buccal	20	20
Submental	15	15
Sublingual	10	10
Lateral pharyngeal	8	8
Canine	5	5
Masseteric	4	4
Palatal	3	3
Pterygoid	2	2
Masticator	1	1
Ludwigs	1	1
Temporal	1	1

Table 3: Aerobic microbes isolated

Aerobic microbes	Number of cases	Percentage
No isolate	9	9.0
<i>Escherichia coli</i>	3	3.0
<i>Klebsiella pneumoniae</i>	11	11.0
<i>Pseudomonas aeruginosa</i>	6	6.0
Staphylococci (coagulase - ve)	6	6.0
Staphylococci (coagulase + ve)	2	2.0
<i>Staphylococcus aureus</i>	16	16.0
<i>Streptococcus viridans</i>	47	47.0

Relative efficacy of amoxicillin and amoxicillin with clavulanic acid had significantly higher resistance against all the microorganisms isolated, whereas ceftriaxone, carbenicillin, amikacin, and imipenem had a significantly higher sensitivity ( $P < 0.05$ ). Moxifloxacin showed no significant difference from other antibiotics in terms of resistance ( $P = 0.053$ ) [Table 4 and Figure 3].

## DISCUSSION

Head and neck space infections of odontogenic origins can be life threatening if they remain untreated. Space infections if detected early can be treated in clinics on outpatient basis by routine procedures such as extraction of offending tooth, root canal therapy and incision and drainage along with antibiotic therapy. With the use of broad-spectrum antibiotics as routine practice severe complications of infections are rarely seen these days.<sup>[7]</sup> This study is an effort in the context of source of infection, age, gender, tooth involved, fascial spaces involved, microbiological study of aerobic flora, and antibiotic susceptibilities. In the present study, 73% aerobic Gram-positive were isolated and 18% aerobic Gram-negative isolated. Studies by Hunt and Meyer,<sup>[8]</sup> Storoe et al.,<sup>[9]</sup> and Rega et al.<sup>[10]</sup> showed predominance of Gram-positive bacteria in such infection.

In this study, *S. viridans* is the most common pathogens in the head and neck space infections. Literature also mentions it to be main causative organism for head

and neck space infection.<sup>[8,11,12]</sup> Second most common microorganism isolated was the *Staphylococcus* group. The third most common microorganism isolated was *K. pneumoniae* which was found in 11 cases (11%). Rao et al.<sup>[13]</sup> reported *K. pneumoniae* was the second most common organism in diabetic patients, suffering from maxillofacial space infection present in 12.9% patient. In Indian population, most patient suffering from maxillofacial space infection of odontogenic origin are of low socioeconomic group with poor oral hygiene, undernourished, and malnourished having low average autoimmune resistance status with compromised host defense mechanism. Therefore, *Klebsiella* came to be third most common organism. Isolation of *Pseudomonas* in six cases (6%) in our study is high as compared to other studies by Kuriyama et al.,<sup>[14]</sup> Gill and Scully,<sup>[15]</sup> Helstad et al.,<sup>[16]</sup> coagulase negative staphylococci are an important source of nosocomial infections. Methicillin resistance in coagulase-negative staphylococci is associated with therapeutic and prophylactic use of cephalosporins.<sup>[17]</sup> In the present study, we found (6%) coagulase negative staphylococci which are showing the emergence of antibiotic-resistant superbug due to indiscriminate use of antibiotics. *E. coli* (3%) was surprise finding as it generally do not cause space infection of odontogenic origin. Har-El et al. reported Gram-negative aerobes such as *Pseudomonas* and *E. coli* were found in <6% cases.<sup>[11]</sup> The normal oral flora may be altered with tobacco use, pregnancy, diet, nutrition, age, oral hygiene, deciduous teeth eruption, dental caries, periodontal disease, antibiotics, hospitalization, and by genetic or racial factors. In these situations, commensal flora may become pathogenic and cause tissue inflammation and destruction.<sup>[18]</sup>

Penicillin was considered the drug of choice for odontogenic infection because of growing resistant strains, limit the use of this drug. Recurrence of penicillin-resistant organism in patients may require the administration of other antimicrobial agents. These include clindamycin, chloramphenicol, carbenicillin, cefoxitin, and imipenem.<sup>[19]</sup>

In the present study, *S. aureus* showed resistance to amoxicillin (31.3%) and 93.8% patients were sensitive to amoxicillin/clavulanic combination and can be

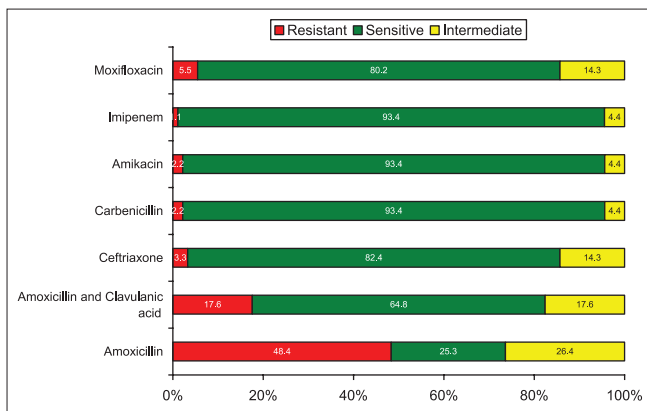


Figure 3: Relative efficacy of different antibiotics against all microbes

Table 4: Relative efficacy of different antibiotics against all microbes (n = 91)

Antibiotic	Resistant, n (%)	Sensitive, n (%)	Inter-mediate, n (%)	Statistical significance for resistance	
				$\chi^2$	P
Amoxicillin	44 (48.4)	23 (25.3)	24 (26.4)	142.1	<0.001
Amoxicillin and clavulanic acid	16 (17.6)	59 (64.8)	16 (17.6)	3.895	0.048
Ceftriaxone	3 (3.3)	75 (82.4)	13 (14.3)	6.996	0.008
Carbenicillin	2 (2.2)	85 (93.4)	4 (4.4)	9.001	0.003
Amikacin	2 (2.2)	85 (93.4)	4 (4.4)	9.001	0.003
Imipenem	1 (1.1)	85 (93.4)	4 (4.4)	11.259	0.001
Moxifloxacin	5 (5.5)	73 (80.2)	13 (14.3)	3.742	0.053

used as the first line of drug in odontogenic infection. Ceftriaxone, carbenicillin, amikacin, and moxifloxacin were effective. Other strain of *Staphylococcus* coagulase negative found mainly in nosocomial infection showed maximum resistance toward amoxicillin (83.3%), amoxicillin with clavulanic acid (50%), whereas ceftriaxone, carbenicillin, imipenem, and moxifloxacin showed minimum resistance (16.7%). Ceftriaxone and carbenicillin showed maximum sensitivity (83.3%) and can be used in tough nosocomial hospital borne infection. *S. viridans* showed amoxicillin resistance (34%), whereas amoxicillin with clavulanic acid showed (4.3%) resistance which makes it the first-line drug of choice in head and neck space infections of odontogenic origin. All other drugs showed 100% sensitivity.

*K. pneumoniae* showed maximum resistance to amoxicillin (63.6%) followed by moxifloxacin (36.4%). Ceftriaxone, carbenicillin, amikacin, and imipenem were (100%) sensitive to *Klebsiella*. Amoxicillin with clavulanic acid showed 90.9% sensitivity. In case of *P. aeruginosa*, amoxicillin and amoxicillin with clavulanic acid showed maximum resistance (100%). Carbenicillin showed 16.7% resistance only. Carbenicillin could be used as the first line of drug in case of *P. aeruginosa*. *E. coli* was (100%) resistant to amoxicillin and amoxicillin with clavulanic acid. Ceftriaxone was (33.3%) resistant, whereas carbenicillin, amikacin, and moxifloxacin were most sensitive (66.7%). Imipenem was intermediate sensitive in all (3%) cases. *E. coli* naturally produces beta-lactamase enzyme and is classified as resistant to penicillin.<sup>[20]</sup> *E. coli* was the first bacteria to produce beta-lactamase reported by Abraham and Chain in 1940.<sup>[21]</sup>

In the present study, ceftriaxone, carbenicillin, and amikacin showed maximum efficacy 93.4% to 100% followed by moxifloxacin 80% to 94% and amoxicillin with clavulanic acid 64% to 81%. Hence, successful management of oral infections usually achieved by appropriate surgical intervention to establish drainage, good overall supportive care of the patient, Gram-staining of purulent exudates to provide immediate information needed for the rational selection of an antibiotic and *in vitro* microbiological culture and antibiotic susceptibility.

## CONCLUSIONS

Head and neck space infections are most commonly seen in the third decade of life. Most common aerobic microorganism isolated was *S. viridans* (47%) among Gram-positive followed by *S. aureus* (16%). Total *Staphylococcus* genus isolated was 24%. Among Gram-negative aerobes *K. pneumoniae* were most common (11%).

Amoxicillin with clavulanic acid used as first-line empirical therapy in current practice showed overall efficacy for all organism (64.8%). In this study, ceftriaxone showed (82.4%) efficacy for all organisms and could be used in odontogenic infections for both Gram-positive and Gram-negative microorganisms.

For deep fascial space infections, there could be substitution of third generation cephalosporin which has approximate efficacy of 82% in place of amoxicillin in the empirical management. Carbenicillin, amikacin, and imipenem showed 93.4% sensitivity against all microorganism and should be used caution in more severe infection after culture sensitivity newer, and broader-spectrum antibiotics were found more effective *in vitro* than older narrower-spectrum antibiotics.

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## Conflicts of interest

There are no conflicts of interest.

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