Odontogenic infections: Microbiology and management

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Abstract

Objective: The aim of this retrospective study was to evaluate the involvement of fascial spaces, their bacteriology, sensitivity to antibiotics and management of odontogenic infection in 100 patients of age less than 60 years. **Results:** The mandibular 3rd molar was found to be the most commonly offending tooth, followed by the mandibular 2nd molar. The submandibular space was the most frequently involved fascial space both in single fascial space infections and multiple fascial space infections. Mixed growth (aerobic and anaerobic) was seen in culture smears of 60 patients, only aerobic bacterial growth was seen in 25 patients and anaerobic bacterial growth was seen in culture smears of 15 patients. Streptococcus viridans was the most frequently isolated bacteria among the aerobes, whereas Bacteroides and Prevotella were the most common bacterial species among anaerobes. Empirical antibiotic therapy in the form of Co amoxiclav and Metronidazole was given. Incision and drainage followed by extraction of the offending tooth/teeth was carried out. **Conclusion:** It was concluded that odontogenic infections were mixed aerobic–anaerobic infections. Anaerobic as well as aerobic cultures were necessary to isolate all pathogens. Successful management of these infections depends on changing the environment through decompression, removal of the etiologic factor and by choosing the proper antibiotic.

Keywords: Antibiotic sensitivity, fascial space infection, odontogenic infection

Introduction

Odontogenic infection has plagued human kind for as long as the human species has existed. Yet, even after centuries of research, mankind has not succeeded in eradicating bacterial infections. Generally, in the orofascial region, most bacterial infections involve either a disturbance of the normal flora or a displacement of the normal organisms to the site, where they are usually not seen.[1]

The pyogenic oro-fascial infections are most commonly odontogenic in origin. They may range from periapical abscesses to superficial and deep infections in the neck. If untreated, they generally spread into the contiguous fascial spaces (masseteric, sublingual, submandibular, temporal, buccal, canine and parapharyngeal) and may lead to additional complications. Hence, early recognition of infections and appropriate therapy is essential.

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Modern antibiotic therapy has greatly reduced the complications from spread of these infections, but the management of pus in head and neck infection still requires a continuous call for the surgeon's best judgment and skills.

The aim of the present study is to determine the anatomic and microbiologic considerations of odontogenic infections of both maxilla and mandible, their clinical manifestations and discuss their response to medical as well as surgical treatment.

Materials and Methods

This study consisted of a retrospective analysis of 100 patients aged less than 60 years with odontogenic infections who received management between December 2004 and November 2012. Inclusion criteria consisted of patients with or without a history of systemic diseases like hypertension, diabetes mellitus and human immunodeficiency virus (HIV), frequency of offending teeth, distribution of single and multiple fascial space involvement and its bacteriology, antibiotic sensitivity and management.

Routine investigations of blood and complete urine examination were carried out. For bacteriological examination, the pus sample was collected by aspiration from the abscess site with a disposable 16-gauge needle and syringe. The collected sample was immediately transferred to pre-reduced thioglycollate broth prepared and sterilized in a bijou bottle and then transported to the clinical microbiology laboratory for gram staining, bacterial culture and antimicrobial sensitivity. A portion of the collected sample in the bijou bottle was incubated on two culture plates of Brucella Agar base with 5% sheep blood. One of the culture plates was incubated at 37°C in the incubator under aerobic environment. Second culture plate was incubated in an anaerobic jar (Himedia: Shown in Figure 1) in which anaerobic conditions were created using chemicals supplied by Himedia (LE002B: Shown in Figure 2). This was incubated at 37°C for 48 hours. The bacteria isolated were identified.

The diagnosis was made on the basis of history of the patient, clinical examination and investigations. Definitive management consisted of either only extraction of the offending tooth or incision and drainage of the abscess followed by tooth extraction as indicated.

Empiric antimicrobial therapy was started in all cases, which consisted of intravenous Amoxycillin 1 g + Clavulanic acid 0.2 g, 8 hourly and intravenous Metronidazole 7.5-15 mg/kg was infused depending on the severity of the individual infection. After the culture and sensitivity report was available, culture and sensitivity-directed antimicrobial therapy was instituted. Supportive therapy in the form of parentral fluid, high-protein diet and multivitamin was given as indicated in the individual cases.

Results

One hundred patients of age less than 60 years were included in the study. The patients were assessed for involvement of fascial spaces, their bacteriology, sensitivity to antibiotics and management. Of the 100 patients included in the study, 10% of patients were in the age group of 0-20 years, 75% were in the age group of 21-40 years and 15% were in the age group of 41-60 years. Fifty-five percent of the patients were male and 45% of the patients were female.

The incidence of systemic diseases found in the patients of odontogenic infections was that 10% of the patients were suffering from diabetes mellitus, 10% had hypertension and 1% had HIV. Of these patients, 10% had both diabetes and hypertension. Seventy-nine percent of the patients had no systemic disease.

The mandibular 3rd molar was the most frequently involved offending tooth [Table 1] in odontogenic infections in this study (60 patients), followed by the mandibular 2nd molar (50 patients). The next tooth in order of frequency involved was the mandibular 1st molar (30 patients), followed by the mandibular 2nd premolar (10 patients) and the mandibular 1st premolar (5fivepatients).

Sixty-five patients presented with single fascial space infection. The submandibular space was involved in 20 patients, the pterygomandibular and buccal spaces were involved in 15 patients each, the submasseteric space in was involved in 10 patients and the infratemporal space was involved in only five patients.

However, multiple fascial spaces were involved, with the submandibular space being involved in 25 patients, the submental space in 20 patients, the pterygomandibular space in 15 patients and the sublingual space in 10 patients. The buccal, temporal and submasseteric spaces were involved in five patients each.

Table 1: Frequency of offending teeth

Offending tooth	Right side	Left side	Total
Mandibular 3rd molar	35	25	60
Mandibular 2nd molar	35	15	50
Mandibular 1st molar	15	15	30
Mandibular 2nd premolar	10	0	10
Mandibular 1st premolar	5	0	5

Figure 1: Gas pack holding jar

Figure 2: Anaerobic gas pack

Of the 100 samples subjected to gram's staining, gram-positive cocci were isolated in 85%, gram-negative cocci in 5%, gram-positive bacilli in 5% and gram-negative bacilli in 50%. Microorganisms were identified on gram's staining in 100% of the isolates, whereas microbial culture was positive in 95% smears. Only aerobic bacteria were isolated in 25 patients, only anaerobic bacteria were isolated in 15 patients and both aerobic and anaerobic bacteria were isolated in 60 patients.

Five aerobic bacterial isolates were identified in microbial cultures. *Staphylococcus aureus* was found in 20% of the pus sample cultures, Coagulase negative staphylococci in 10%, *Streptococcus viridans* in 45% and Corynebacterium species and *Pseudomonas aeruginosa* in 5% each [Table 2]. Four anaerobic bacteria were isolated in the culture smears. Peptostreptococcus was found in 20%, Porphyromonas in 5% and both Bacteroides and Prevotella were found in 30% each of the cultures [Table 3].

Sensitivity of aerobic strains isolated in this study to antibiotics was 90.0% to Co-amoxiclav and 60.0% to Erythromycin. Ninety percent of the organisms were sensitive to Azithromycin, 25.0% to Ceftazidime, 70.0% to Ciprofloxacilin, 15.0% to Gentamycin and 70.0% to Gatifloxacin. Only 10.0% of the organisms isolated in the pus culture were sensitive to Ampicillin.

Sensitivity of anaerobic strains to Metronidazole and Clindamycin was found to be 85.0% each [Table 4].

Discussion

Most dental abscesses are caused by the resident oral microflora that enters normally sterile tissues. The major isolates are streptococci and anaerobic bacteria, which are regarded as normal flora of the tooth and gingival crevice.[2]

The microbial specificity in odontogenic infections has been more clearly delineated with technologic advances in sampling and anaerobic culturing. Laboratories now routinely culture for anaerobic microorganisms in oxygen-free gas environments, which increases the yield of anaerobic bacteria in culture.[3]

In the present study, the age of the patients ranged from 14 to 60 years. Individuals of odontogenic infections were seen more in the patients of the third and fourth decade age groups. This finding is in concurrence with those of Kannangara *et al.*,[4] who reported the highest incidence of odontogenic infections in patients of the third decade in their series in which the age of the patients ranged from 6 to 79 years.

The gender distribution in this study showed a preponderance of male patients as compared with female patients. Of the 100 patients included in our study, 55 patients were male and 45 patients were female. Gender distribution in patients of odontogenic infections concurs with Whitesides *et al.*,[5] Sennes *et al.*[6] and Rega *et al.*[7]

Swelling was present in all patients at the time of reporting, which was almost negligible on the 7th day of surgical management, which is in concurrence with Adekeye and Adekeye,[8] who reported that after the incision and drainage, purulent exudates stopped within 2-3 days and resolution was complete within 5-12 days.

In this study, the mandibular 3rd molar was the offending tooth (60 patients) followed by the mandibular 2nd molar (50 patients). The high incidence of odontogenic infections arising from the mandibular 3rd molar followed

Table 2: Number and types of aerobic bacteria isolated in the culture smears

Organism	No. of isolates	Percentage of organisms isolated in 100 samples
Staphylococcus aureus	20	20
Coagulase negative staphylococci	10	10
Streptococcus *viridians*	45	45
Corynebacterium species	5	5
Pseudomonas aeruginosa	5	5

Table 3: Number and types of anaerobic bacteria isolated in the culture smears

Organism	No. of isolates	Percentage of organisms isolated in 100 samples
Peptostreptococcus	20	20
Porphyromonas	5	5
Bacteroides	30	30
Prevotella	30	30

Table 4: Antibiotic sensitivity of aerobic and anaerobic strains

Antibiotic	Sensitivity	Percentage sensitivity (organisms isolated)
Ampicillin	10	10
Co-amoxiclav	90	90
Erythromycin	60	60
Azithromycin	90	90
Ceftazidime	25	25
Ciprofloxacilin	70	70
Gentamycin	15	15
Gatifloxacin	70	70
Metronidazole	85	85
Clindamycin	85	85

by the mandibular 2nd molar has also been reported by Whitesides *et al*.[5]

In the present study, microorganisms were isolated in all 100 pus samples by gram staining. Of the 100 isolates, gram-positive cocci were found in 85 isolates, gram-negative bacilli in 50 isolates and gram-negative cocci and gram-positive bacilli in five isolates each. The results concurred with those of Lewis *et al.,*[9] who reported 82 gram-positive cocci of 166 isolates, followed by gram-negative bacilli, which were seen in 68 of 166 isolates. Rega *et al*.[7] also reported that gram-positive cocci are the most frequent infective microorganisms in the orofascial infection.

The pus samples obtained were inoculated for culture. On culture study, microbial growth was present in 95% of the smears. Of the 100 pus samples cultured, 60 cultures yielded mixed aerobic –anaerobic growth, 25 yielded aerobic bacteria only and 15 yielded anaerobic bacteria only. This high incidence of mixed microflora in odontogenic infection has also been reported by Bartlett and O'Keefe.[10] However, in contradiction to the present study, the authors have reported a higher incidence of purely anaerobic infection as compared with purely aerobic infection. Moenning *et al*.[3] reviewed and stated that there is a predominance of mixed aerobic–anaerobic infections, with anaerobes outnumbering aerobes 2:1. In the present study, the total number of aerobic species is five and anaerobic species isolated is four, which is in concurrence with the results from Rega *et al*.,[7] who reported a predominance of aerobic species over anaerobic species isolated.

In this study, the most common aerobic bacteria isolated was *Streptococcus viridans*,[11] which was isolated in 45 patients. This is in concurrence with Hunt *et al*.,[12] who observed the presence of *Streptococcus viridians* in 20 of 49 isolates, and Bartlett and O'Keefe[10] and Rega *et al*.,[7] who also reported *Streptococcus viridans* to be the most frequent microbe to be isolated in the odontogenic infection.

Other aerobic organisms isolated were *Staphylococcus aureus*, Coagulase negative staphylococci, Corynebacterium species and *Pseudomonas aeruginosa*, which is in concurrence with the findings of Hunt *et al*.,[12] Sennes *et al*.[6] and Rega *et al*.[7]

Bacteroides and Prevotella[11] were the most common anaerobes (30%) each isolated in the present study, followed by Peptostreptococci (20%) and Porphyromonas (5%). Gill and Scully,[13] Sennes *et al*.[6] and Rega *et al*.[7] have documented that Peptostreptococci and Bacteroides are the most frequent anaerobic microorganisms isolated in odontogenic infections.

The aerobic microbial strains isolated in the present study were most sensitive to both Co-amoxiclav and Azithromycin (90%), followed by Erythromycin (60%). The efficacy of Co-amoxiclav and Azithromycin against the aerobic organisms of odontogenic infection has also been reiterated by Lewis *et al*.[9]

In the present study, all the anaerobic microbial strains isolated were found to be sensitive to both Metronidazole and Clindamycin. Metronidazole has been used as an empirical antibiotic for anaerobic cover. Sutter and Finegold[14] reported Clindamycin to be active against oral anaerobes, whereas Tetracycline and Erythromycin were somewhat erratic in activity against anaerobes. Balcerak *et al*.[15] stressed on the importance of initiating broad-spectrum antimicrobial therapy early without waiting for culture results.

Twenty-one patients had systemic diseases, of whom 10 were diabetic, 10 were hypertensive and one was HIV postivie; however, 79 patients had no systemic disease. Whitesides *et al*.[5] reported 45% of their patients having diabetes mellitus and hypertension. He stated that in diabetic patients, the hyperglycemia impairs leukocyte function and contributes to suppression of the host's immune system, making the individual more susceptible to exacerbation of typical odontogenic infection.

As far as the anatomic distribution of single fascial space infection is concerned, the submandibular space was the most frequently involved fascial space in 20 patients, followed by the pterygomandibular and buccal spaces in 15 patients each and the submasseteric space in 10 patients. The infratemporal space was involved in only five patients. However, the anatomic distribution of multiple fascial space infection was that the submandibular space was found to be involved the most (25 patients), followed by the pterygomandibular (15 patients), sublingual space (10 patients) and then the buccal, temporal and submasseteric spaces were found to be involved in five patients each. In the present study, the submandibular space was found to be involved most frequently (20 spaces in single fascial space infection and 25 spaces in multiple fascial space infection), which is in concurrence with two different studies conducted by Haug *et al*.[16] and Rega *et al*.[7]

In this study, one patient reported with right submandibular space abscess with cervical necrotizing fasciitis; the isolates identified were *Staphylococcus aureus*, Bacteroides and Peptostreptococcus. Co-amoxiclav and Metronidazole were administered as per antibiotic sensitivity testing and the patient recovered successfully. Mruthycinjaya[17] stated that necrotizing fasciitis is a relatively rare but fulminating clinical entity characterized by necrosis of fascia with widespread undermining of the superficial tissue and extreme systemic toxicity. Balcerak *et al*.[15] reported three cases with similar culture results, which included β-hemolytic Streptococcus, a gram-negative anaerobe (Bacteroides or Fusobacterium), *Staphylococcus epidermidis* and α-hemolytic Streptococcus isolates.

The choice of antibiotic for the management of odontogenic infection depends ideally on the definitive laboratory results of culture and antibiotic sensitivity testing. A pragmatically rational approach to empirical antibiotic selection is acceptable clinically and legally, if the choice is based on specific data and on contemporary experience with the microbiology of the oral cavity.

Penicillin remains the drug of choice in the management of most odontogenic infections being reported with increasing frequency; however, if the infection fails to respond to the initial antibiotic choice, one must have a high index of suspicion that a resistant organism is involved.[3]

In the present study, empiric antimicrobial therapy was started in all patients, which consisted of intravenous Amoxycillin 1 g + Clavulanic acid 0.2 g, 8 hourly for severe infections. For serious anaerobic bacterial infections, intravenous Metronidazole 7.5-15 mg/kg was infused depending on the severity of the individual infection as documented by Goodman and Gilman.[18] Dahlen[19] has documented that in case of emergency, because resistance to Penicillin is increasing, Metronidazole or Amoxycillin/Clavulanic acid may serve as alternative antibiotics. In case of Penicillin allergy, Metronidazole is the drug of choice.

Hunt *et al*.[12] reported that the most common aerobic organism in pyogenic infection was *Streptococus viridans*, which was 100% sensitive to Ampicillin. In most of the studies, it is proven that all the anaerobic strains are sensitive to Metronidazole.[20]

The most important therapeutic modality for pyogenic orofacial infections is surgical drainage and the need for the definitive restoration or extraction of the infected teeth, which is the primary source of infection. Principles suggested by Topazian *et al*.[1] were employed for incision and drainage in the present study.

Laskin[21] recommended heat application in the form of moist packs and/or mouth rinses as supportive therapy in the management of orofacial infections. Heat produces vasodilatation and increased circulation, more rapid removal of tissue breakdown products and great influx of defensive cells and antibodies.

All the patients had good healing after incision and drainage, antibiotic therapy and extraction of culprit teeth. They were followed-up for 1 month postoperatively.

In conclusion, successful management of odontogenic infections depends heavily upon changing the environment through decompression, removal of etiologic factor and by choosing proper antibiotic.

It is suggested that to reach a definitive conclusion about the factors influencing the microbiology and management of odontogenic infections, more studies are required over a period of time at a larger sample size and need to be reviewed from time to time due to the advent of newer antibiotics and their changing sensitivities to different isolates.

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