Microbiology and Antibiotic Sensitivities of Head and Neck Space Infections of Odontogenic Origin

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Purpose: The purpose of this study is to assess the anatomical spaces and causative micro-organisms responsible for deep fascial space head and neck infections and evaluate the resistance of antibiotics used in the treatment of these infections.

Patients and Methods: A 6-year retrospective study evaluated hospital records of 103 patients. All patients in this study underwent surgical incision and drainage, received IV antibiotics, and had culture and sensitivity performed. Patient demographics reviewed were gender, age, involved fascial space(s), micro-organisms identified and antibiotic resistance from culture and sensitivity testing.

Results: There were 56 male (54%) and 47 (46%) female patients. The submandibular space was the most frequent location for a single space abscess (30%), followed by the buccal space (27.5%) and the lateral pharyngeal space (12.5%). Sixty-three patients presented with multiple space involvement, totaling 142 spaces involved. A total of 269 bacterial strains were isolated from 103 patients. The bacteria were found to be 63.5% gram-positive. Gram-positive cocci were isolated 57.7% of specimens and gram-negative rods were isolated in 33% of cultures. There were 178 aerobes (65.7%) and 91 anaerobes (34.3%) isolated. The most common bacteria isolated were *Viridans streptococci, Provetella, Staphylococci,* and *Peptostreptococcus*. Culture and sensitivities were reviewed on 101 patients.

Conclusion: Patients who underwent surgical incision and drainage in the operating room had a tendency for involvement of multiple space abscesses with the submandibular space, submental, and lateral pharyngeal spaces effected most frequently. Cultures and sensitivities commonly showed greater growth in aerobes (65.7%) than in anaerobes. Gram positive cocci and gram negative rods had the greatest growth percentage in cultures.

J Oral Maxillofac Surg 64:1377-1380, 2006

Maxillofacial deep space head and neck infections of odontogenic origins have afflicted mankind for all recorded history. Remains of early Egyptians have been discovered with signs of dental abscesses and evidence suggesting osteomyelitis. In 1928, Sir Alexander Fleming observed that colonies of the bacterium *Staphylococcus aureus* could be destroyed by the mold *Penicillium notatum*. Routine use of penicillin did not begin until the 1940s, when Howard Florey and Ernst Chain developed a powdery form of the antibiotic. The discovery of penicillin significantly changed the management of odontogenic infections.

Just 4 years after drug companies began mass-producing penicillin in 1943, antibiotic-resistant micro-organisms began to develop. The increased prevalence of antibiotic resistance is an outcome of evolution.[1] To combat penicillin resistance, synthetic antibiotics have subsequently been synthesized; however, resistance has also developed to these newer synthetic drugs. Penicillin still remains the empirical drug of choice for odontogenic infections because of its effectiveness, minimal side effects, low cost, patient tolerability, and ready availability.

The purpose of this study was to assess the causative micro-organisms responsible for deep space head and neck infections and resistance of antibiotics

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0278-2391/06/6409-0010$32.00/0
doi:10.1016/j.joms.2006.05.023

Table 1. SINGLE-SPACE ABSCESS

Abscess Location	Number (%) of Cases
Submandibular space	12 (30%)
Buccal space	11 (27.5%)
Canine space	5 (12.5%)
Lateral pharyngeal space	5 (12.5%)
Submental space	3 (7.5%)
Masseteric space	1
Pterygomandibular space	1
Sublingual space	1
Palatal space	1
Total	40

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Table 2. MULTIPLE-SPACE ABSCESS

Abscess Location	Number (%) of Cases
Submandibular space	40 (28.2%)
Submental space	21 (14.8%)
Lateral pharyngeal space	20 (14.1%)
Buccal space	17 (12%)
Sublingual space	16 (11.3%)
Multiple space (undefined)	11 (7.7%)
Masseteric space	10 (7%)
Canine space	2
Pterygoid space	2
Masticator space	2
Ludwigs angina space	1
Total	142

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used in the treatment of fascial space infections at an urban tertiary care medical center.

Patients and Methods

A 6-year retrospective study evaluated hospital records of 103 patients that were treated for deep neck fascial space infections from 1997 to 2003 at The University of Medicine and Dentistry of New Jersey-University Hospital, Newark, NJ. All patients in this study underwent surgical incision and drainage in the operating room. Patient characteristics reviewed were gender, age, fascial space(s) involved, bacteria identified, and antibiotic resistance from culture and sensitivity.

Results

There were 56 male (54%) and 47 (46%) female patients ranging in age from 7 to 93 years, with a mean age of 33 years (SD = 14.5). Forty patients (38.8%) presented with a single fascial space abscess. The submandibular space was the most frequent location for a single-space abscess (30.0%), followed by the buccal space (27.5%) and the lateral pharyngeal space (12.5%) (Table 1).

Sixty-three (61.2%) patients presented with multiple space involvement, totaling 142 spaces involved. The submandibular space (28.2%) was again the most frequent location, followed by the submental space (14.8%) and the lateral pharyngeal space (14.0%) (Table 2).

A total of 269 bacterial strains were isolated from 103 patients, accounting for 2.6 isolates per patient. Two patients showed no growth from cultures. *Candida Albicans* (4 isolates) and *Aspergillus Fumigatus* (1 isolate) were also identified. There were 178 aerobes (strict and facultative) (65.7%) and 91 anaerobes (34.3%) isolated (Tables 3, 4). The bacteria were found to be 63.5% Gram-positive. Gram-positive cocci were isolated in 57.7% of specimens and Gram-negative rods were isolated in 33.0% of cultures. The most common bacteria isolated were *Viridans streptococci, Provetella, Staphylococci*, and *Peptostreptococcus*. *Viridans streptococci* accounted for 28.99% (78 isolates), *Provetella* for 21.2% (57 isolates), *Staphylococci* for 8.9% (24 isolates) and *Peptostreptococcus* for 4.8% (13 isolates) from the total isolates.

Culture and sensitivities were reviewed on 101 patients; however, anaerobic sensitivities are routinely not performed at this institution. Antibiotics

Table 3. AEROBIC ORGANISMS COUNT FROM TOTAL ISOLATES

Bacterial Strains	Number of Aerobes
Aspergillus Fumigatus	1
Candida Albicans	5
Enterobacteria	3
Haemophilus	11
Klebsiella Pneumoniae	2
Moraxella Catarrhalis Beta Lac −	1
Neisseria	8
Stentotrophomonas Maltophilia	1
Diphtheroids	6
Gemella Haemolysans	1
Gemella Morbillorum	1
Gemella Morgillorum	1
Group A Beta Strep	5
Group A Beta Streptococcus	4
Group A Streptococcus	1
Group B Streptococcus	3
Group C Streptococcus	6
Group D Streptococcus	5
Group F Streptococcus	10
Group G Beta Streptococcus	1
S. Viridans	78
Staphylococci	24
Total	178

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Table 4. ANAEROBIC ORGANISMS COUNT FROM TOTAL ISOLATES

Bacterial Strains	Number of Aerobes
Bacteroides	
Capnocytophaga Species, *Beta Lactamase −*	2
Eikenella Corrodens	2
Enterococcus Faecalis	1
Fusobacterium Necrophorum	3
Moraxella Catarrhalis Beta Lac −	1
Prevotella, Beta Lactamase +	15
Prevotella	42
Veillonella Species, Beta Lactamse −	1
Clostridium	3
Diphtheroids	2
Lacotobacillus	3
Peptostreptococcus	13
Propionibacterium Acnes	3
No growth	2
Total	91

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evaluated for resistance included ampicillin, cefazolin, ciprofloxacin, clindamycin, erythromycin, levofloxacin, penicillin and vancomycin. *Viridans streptococci* demonstrated an 87.1% sensitivity rate to penicillin. *Viridans streptococci* also exhibited high susceptibility to ampicillin (98.4%), cefazolin (100%), ciprofloxacin (100%), clindamycin (86.3%), erythromycin (83.4%), levofloxacin (98.6%) and vancomycin (100%). *Staphylococci* showed a 27.3% susceptibility rate to penicillin and sensitivity to ampicillin (41.2%), cefazolin (70.0%), ciprofloxacin (95%), clindamycin (89.5%), erythromycin (75%), levofloxacin (84.2%), and vancomycin (100%).

Discussion

Head and neck infections of odontogenic origins are routinely treated as an office procedure. Untreated or rapidly spreading odontogenic infections can be potentially life-threatening secondary to airway compromise or septicemia. This study investigates patients with head and neck infections of odontogenic origin, who required emergent surgical incision and drainage due to the severity of the infection. Many patients had prolonged intubations or tracheostomies postoperatively due to a compromised airway.

There was no statistical difference between male and female patients, with a mean age of 33.3 ± 14.5 years. This data is similar to many other investigations of head and neck infections.[2-4] Multiple-space infections are more commonly seen than single-space infections in patients with head and neck infections of odontogenic origins.[2] This result may be related to the latency in presentation of the patients to the treating facility. In the literature, the submandibular space is the most commonly seen in multiple-space infections, followed by the lateral pharyngeal space, buccal space and submental space.[2] Our data deviated from this trend with more submental spaces than lateral pharyngeal spaces on presentation of multiple-space infections. In a review of the literature, the single-space abscess had 3 very common findings, including the submandibular space as the most predominant, followed by the buccal space and the canine space abscesses.[2,5] This may be due to the anatomical relationship of odontogenic infections and close relationship to the affected space(s).

Most organisms involved in infections of the head and neck are of odontogenic origin.[6] Bacteria that were isolated consisted of both aerobic and anaerobic organisms. Infections due to anaerobic and Gram-negative organisms have increased in comparison with past reports in medical and dental literature. This may be related to improvements in isolating and culturing methods of anaerobic organisms.[3] Our study showed predominance in aerobic (strict and facultative) over anaerobic species isolated. This institution uses the swab method for bacterial cultures, which in turn produces a higher aerobic yield.[7] Gram-positive cocci were the predominant bacteria cultured from our specimens and Gram-negative rods were the second most common bacteria isolate. This is consistent with results of other studies in the literature.[2]

Our study had an average of 2.6 isolates per specimen from 103 patients. This is slightly lower than specimens that were obtained by aspiration, which averaged from 3 to 3.3 isolates per sample.[8,9] In contrast to samples collected by swabbing, our results were slightly higher when compared with other studies ranging from 1.1 to 1.4 isolates per specimen.[10,11]

In this study, *Viridians streptococci* were the predominant species, followed by *Provetella, Staphylococci* and *Peptostreptococcus*. A high rate of *Staphylococci* (8.9%) was cultured from the total isolates, which may be due to contaminant of cultures from the skin or an actual finding. The prevalence of bacterial species varies, with multiple studies demonstrating *Streptococci Viridans* as their predominant species[2,5,10,12] and other studies that show predominance of Gram-negative rods (*Bacterioides/Provetella*).[3,13-15] The differences may be due to the way the cultures are obtained, suggesting that aspirations of cultures may produce predominant anaerobic species, and swabbing of cultures may grow predominantly aerobic species.

Culture and sensitivities were reviewed on 101 patients in this study. *Viridans streptococci* and *Staphylococci* groups were the only isolates with sufficient data to report sensitivities to commonly used antibiotics. *Viridans streptococci* showed an 87.1% susceptibility rate to penicillin. *Viridans streptococci* also showed high susceptibility to ampicillin (98.4%), cefazolin (100%), ciprofloxacin (100%), clindamycin (86.3%), erythromycin (83.4%), levofloxacin (98.6%), and vancomycin (100%). Kuriyama et al[16] reported *Viridans streptococci* to have a susceptibility rate of 77% to penicillin and 100% to cefepime. Kuriyama et al[17] also reported susceptibilities of 85% to ampicillin, 96% to cefazolin, 87% to clindamycin, 77% to erythromycin, and 92% to levofloxacin. Penicillin continues to be a highly effective antibiotic to be used against *Viridans streptococci* groups.

Staphylococci presented 8.9% of total isolates obtained in this study. Although a small percentage of the total isolates, *Staphylococci* provided an expected poor susceptibility rate to penicillin (27.3%) and ampicillin (41.2%) in this study. Initially susceptible to penicillin (1944), very few isolates of *Staphylococcus* are now susceptible to penicillin.[18] *Staphylococci* showed susceptibility to cefazolin (70.0%), ciprofloxacin (95%), clindamycin (89.5%), erythromycin (75%), levofloxacin (84.2%), and vancomycin (100%). There have been increasing concerns about the possible emergence of vancomycin-resistant *S. Amreus* strains. Intermediate sensitivity to vancomycin has been documented in 4 recent cases (1 from Japan and 3 from the United States).[19]

Patients who underwent surgical incision and drainage in the operating room had a tendency for involvement of multiple-space abscesses, with the submandibular space, submental, and lateral pharyngeal spaces affected most frequently. Cultures and sensitivities commonly showed greater growth in aerobes (65.7%) than in anaerobes. Gram-positive cocci and Gram-negative rods had the greatest growth percentage in cultures. The most common bacteria isolated were *Viridans streptococci, Provetella, Staphylococci*, and *Peptostreptococcus*. *Viridans streptococci* showed an 87.1% susceptibility rate to penicillin. *Staphylococci* showed a 27.3% susceptibility rate to penicillin. Penicillin was still shown to be effective as an empirical drug of choice for odontogenic infections.

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