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ORIGINAL ARTICLE

A Review of the Microbiology of Submandibular Space Infections

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Abstract
Introduction The submandibular space is part of the deep neck fascial spaces. Infection within these spaces can cause significant mortality and morbidity.
Materials and methods The study is a review of the microbiology of the submandibular space infections seen at the tertiary academic referral hospitals, University of the Witwatersrand. The period of the study is from January 1, 2006, to December 31, 2006. Ninety-three patients were reviewed of which 52 had aspirates taken. The predominant microorganisms were the gram-positive anaerobic cocci. A literature search for this category of infection was also conducted.
Conclusion The most commonly isolated microorganisms were the gram-positive cocci.

Keywords Microbiology · Submandibular · Infections · Antibiotics

Introduction

The structures within the neck are surrounded by a fibrous connective tissue called the cervical fascia. The fascia is divided into a deep and superficial layer. These layers of fascia create potential spaces. These spaces are divided into superficial and deep spaces. The submandibular space is part of the deep neck spaces. The submandibular space can be affected by many disease processes including acute and chronic infections. These infections can lead to a suppurative process occurring within the submandibular space. Infections within the submandibular space can spread along fascial planes into the neck and into the mediastinum. It can also involve the neurovascular structures within the neck. Surgery is often necessary to establish drainage and for the culture diagnosis of microorganisms. Antibiotics are vital in treatment. These antibiotics need to adequately cover the microorganisms that cause infection within the submandibular space. The choice of antibiotic is best determined by culture and sensitivity reports.

Aims and Objective of the Study

With the changing spectrum of disease seen in our environment, we sought to determine the microbiology of the aspirates obtained from the pus that was present in the submandibular space. We further looked at the antibiotic sensitivities of the organisms that were present. We believe that this will assist in the future antibiotic management of these deep neck space infections and also alert us to any resistance patterns that may be emerging.

Methodology

The study was a retrospective review conducted at the tertiary referral hospitals at the University of the Witwatersrand. The period to be reviewed was from January 1, 2006, to December 31, 2006. The study population was the patients that were admitted to the referral hospitals with submandibular space infections. An essential part of the

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management of these patients included a routine aspiration of the abscess. The pus is sent off to the National Health Laboratory Service for routine microscopy and culture (Fig. 1).

The Wits Ethics Committee granted approval for the study: M 0702621.

The characteristics of these aspirates were reviewed. These characteristics include whether an organism(s) was identified; what organisms were identified; the culture result; and the antibiotic sensitivities (Table 1).

Data Collection

The admission books in the casualty were studied for patients admitted for submandibular space infections.

These patients were then followed to the ward admission book, and the files were reviewed.

A search was conducted for all the patients with aspirates documented in the progress notes.

The following information of the aspirates was then obtained from the National Health Laboratory service. The parameters included age, gender, microbiology of infection and sensitivities to antibiotics (Table 2).

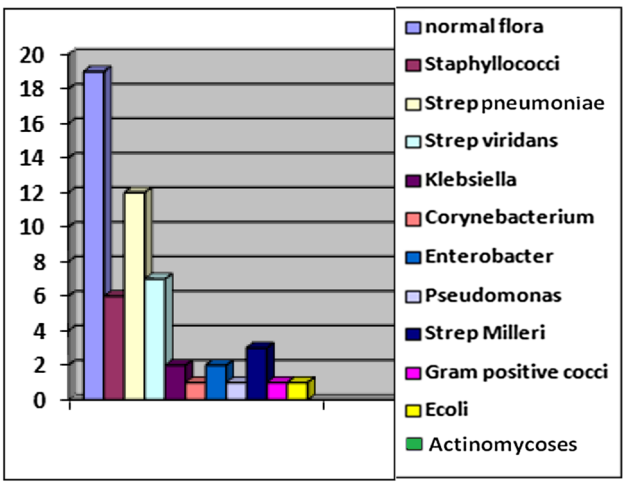

Fig. 1 Culture code: 1—normal flora, 2—*Staphylococci*, 3—*Streptococci pneumoniae*, 4—*S. viridans*, 4—*Klebsiella*, 5—*Corynebacterium*, 6—*Enterobacter*, 7—*Pseudomonas*, 8—*Strep milleri*, 9—gram positive, 10—*E. coli*, 11—*Actinomycoses*

Table 1 Frequency of identifying organisms in the aspirates taken

Growth	Frequency	Percentage	Cumulative
No bacterial growth	19	34.55	34.55
Bacterial growth	36	65.45	100.00
Total	55	100.00	

The table shows that in the 55 aspirates taken 36 resulted in an organism being identified which is a percentage of 65.45%, thus showing that there is a significant yield in doing the aspirate, as an organism is identified 65.45% of the time

Data analysis was performed in conjunction with a statistician. A probability (p) value of less than (or equal to) 0.05 is regarded as significant.

Results

The period of the study resulted in 95 patients presenting with submandibular space infections. An aspirate was taken and submitted for further investigation in 55 of the subjects. Forty patients have no recorded aspirate.

The 55 aspirates provided a yield of 36 identified organisms on microscopy and culture.

A further extrapolation of the data reveals that this percentage stays the same for hospital, age and gender.

Thus, there is no association between the following variables and growth of an organism. The p values for the following associations are:

Between positive isolation and gender = 0.29;

Between positive isolation and age = 0.482;

Btween positive isolation and the hospital = 0.429.

Characteristics of the patients

Age

The age ranged from 5 months to 66 years, and 3 were not stated. The average age of the study group was 36.5 years. Most of the patients ranged between third to fifth age group; the trend is such that the greatest number of samples falls between the ages of 20–40 years of age.

Gender

In the study sample, there were more male patients than female patients recorded; however, there were 25 patients with no recorded gender, and this may bias the result. Thus, no further comments can be made about the gender of the sample size.

Isolated Bacteria

There were nine different types of bacteria that were isolated on the samples. There were also samples that yielded a result on the gram stain but no identification on culture. A large number of samples also came back with the result of normal flora of the oral cavity, or no pathogen isolated.

Antibiotic Sensitivities

Seven of the aspirates were tested for antibiotic sensitivities and resistance. Four of the organisms were *Staph aureus* from these aspirates sensitive to cloxacillin, and

Table 2 Antibiotic sensitivities

Age	Sex	Gram stain	Organism isolated	Antibiotic sensitivity
10 months	M	Gram-positive cocci	*S. aureus*	Cloxacillin, resistant to penicillin/ampicillin
3 years 8 months	M	Gram-positive cocci	*S. aureus*	Cloxacillin, resistant to penicillin/ampicillin
38	M	Gram-positive cocci	*S. aureus*	Cloxacillin, resistant to penicillin/ampicillin
42	F	Gram-positive cocci	*S. aureus*	Cloxacillin
23	F	Gram-positive cocci	*S. pyogenes*	Penicillin, ampicillin and erythromycin
Not stated	M	Gram-positive cocci	*S. pyogenes*	Penicillin, erythromycin and clindamycin
33	M	Gram-positive cocci	*S. viridans*	Cefazolin, cefuroxime and co-amoxiclav

three of these four were resistant to penicillin and ampicillin. Two of the samples were *Strep pyogenes*, sensitive to penicillin and erythromycin. One of the samples with a mixed infection is *Strep viridans* and *Klebsiella* of which the *Klebsiella* was sensitive to cefazolin, cefuroxime and co-amoxiclav but resistant to ampicillin.

Literature Review

According to Harrison, antibiotics have reduced the prevalence and improved the outcome of deep neck space infections; however, deep neck infections do continue to be associated with severe illness and death [1].

The submandibular space abscess was the most common area of infection (67%), followed by the lateral pharyngeal space (17%), Ludwig's angina (12%) and the retropharyngeal space (4%) as reported in a paper by Jankowska, involving 24 patients with deep neck infections [2].

Bodner [3] in a study of submandibular sialolithiasis in children pointed out that the main complaint in acute sialadenitis is a submandibular swelling. This swelling, however, is often confined to the gland, but may go on to involve the submandibular space [4, 5].

Stalfars stated that submandibular space infections (originating from oral mucosal infections, dental infections, submandibular salivary gland infection, blunt or penetrating trauma to the region and spread from adjacent spaces) commonly cultured anaerobic bacteria: Bacteroides species and Peptostreptococcus [4].

Staphylococcus aureus and *Streptococcus* species dominate among the aerobic bacteria. Other changes include the emergence of gram-negative organisms, primarily *Klebsiella* as important pathogens. Bubbico reported an unusual presentation of actinomycosis of the submandibular gland [5].

In a study done by Brook on the microbiology of suppurative parotitis in 23 aspirates, it was found that the predominant bacteria were Bacteroides (6 isolates) and *S. aureus* (6 isolates) [6].

Due to the widespread use of antibiotics, certain patterns of resistance have emerged. Currently, methicillin-resistant *S. aureus* (MRSA) is responsible for a number of serious infections. Abscess secondary to intravenous drug abuse is likely to harbor these organisms. The frequency of beta-lactamase production by oral anaerobes has also increased.

There is a large amount of submandibular space swellings that are non-infectious, as De Vries points out that the histology of salivary gland masses, particularly the submandibular gland, can include lymphoma [7].

With a resurgence of tuberculosis among the immunocompromised population as well as the population in general, one has to be aware of Pott's diseases of the cervical spine as a source of prevertebral space infections with the potential for spread to the other deep spaces of the neck. Stanley concluded that cervicofacial mycobacterial infections might present as parotid and submandibular space masses.

They added that successful treatment would require medication as well as excision of the submandibular and/or parotid gland with the accompanying lymph nodes. Important differences in presentation that can lead to early diagnosis include initial complaints consisting mainly of neck pain and stiffness as well as neurological findings including paraplegia [8].

Nahlieli described endoscopic treatment of salivary gland inflammatory diseases to great effect [9].

Complications of submandibular space infections

Complications, although rare nowadays, are important to keep in mind because of their potential for severe morbidity and even death, as well as the fact that their early recognition is important to further management.

Aspiration is most commonly seen as a result of spontaneous intraoral drainage, with its resultant airway compromise or pneumonia. Airway compromise can also be a result of intraoral swelling. In the past this was most commonly seen with Ludwig's angina. Due to the anatomic relationships of the submandibular space and other deep neck spaces, extension into the mediastinum is possible. This can cause a mediastinitis as well as resulting pericarditis or empyema.

Discussion

The study illustrates the importance of aspiration of the submandibular abscess for culture and sensitivity. This routine investigation is often omitted in our study population. However, it is clearly evident that the yield of getting a result in terms of gram staining and culture is good.

The microbiology of the aspirates in the study population was in keeping with studies done in other centers such as those done by Janowski [2]. The most commonly isolated microorganism is the gram-positive cocci, particularly Streptococci and *S. aureus*.

The incidence of tuberculosis in our study population was low, and this is primarily due to the lack of request for investigation for tuberculosis. In the study only one of the aspirates was sent for acid-fast bacilli and TB culture. This microscopy and culture were negative; however, more samples are required to assess the incidence of TB in the patient population. Thus, there is not enough material to make an accurate assessment of the role of TB in our study population.

The sample population ranged from children (the youngest aspirate being from a 5-month-old), to adults (the oldest sample being taken from a 66-year patient). However, the vast majority of patients were adults. This is in keeping with Salfers who also found predominance in adults [4]. Brook in a study of 47 aspirates found 7 patients below the age of 18 [5].

A possible explanation for the findings in our population is that needle aspiration is more challenging and risky in children and the parent may not always consent to the procedure.

The culture results in our population reflect a single organism in the majority of patients, and a mixed infection was only seen in one patient. This finding was different to other studies such as Brook who reported a combination of anaerobic gram-negative bacilli and Peptostreptococcus in eight specimens [5].

The resistance and sensitivity patterns of the microorganisms in the study were conducted in seven samples. The two dominant organisms were *S. aureus* and *Streptococcus*.

The *S. aureus* was sensitive to cloxacillin and resistant to penicillin and ampicillin.

The *Streptococcus* species was sensitive to penicillin, ampicillin and erythromycin.

Klebsiella was isolated in one of the samples and was sensitive to cefazolin, cefuroxime and co-amoxiclav but resistant to ampicillin.

In the study population there was one aspirate that demonstrated methicillin-resistant *S. aureus* (MRSA).

The clinical implication of the above findings is important in that all patients presenting with submandibular space infections are treated with intravenous antibiotics. This can be as the sole treatment or as an adjunct to surgery. In the study population, the first-line drug of choice for a patient upon the first presentation is co-amoxiclav. Our study, however, indicates that most of the samples have *Streptococcus* and *S. aureus* isolated.

It is worth noting that the *S. aureus* is sensitive to cloxacillin but resistant to penicillin and ampicillin. Thus, the first-line antibiotic treatment should include *S. aureus* cover, as the co-amoxiclav may not be adequate.

A single-aspirate cultured *Klebsiella* was reflected in a study done by Brook [6] who reported gram-negative organisms to be seen in aspirates from hospitalized patients.

The effect of the AIDS and HIV has not changed the pattern of disease as seen in the study, and there were no opportunistic microorganisms isolated. However, a larger sample population should be studied over a longer period to make a comment on the effect of Immunosuppression and opportunistic infections.

Conclusion

The submandibular space infection continues to be a source of morbidity in the study population and is often treated with broad-spectrum antibiotics with resolution and recovery

The microorganisms seen are in keeping with the commensal bacteria of the oral cavity, and the antibiotic treatment of these infections should be directed toward these microorganisms; however, due to the changing spectrum of diseases and patients, regular surveillance of the microorganisms needs to be done.

The pattern of infection and microorganisms causing submandibular space and deep neck space infections needs to be constantly reviewed to avoid complacence and ensure better patient care.

Summary

- The submandibular space is part of the deep neck fascial spaces. Infection within these spaces can cause significant mortality and morbidity.
- The infections are usually opportunistic, being commensal microorganisms from the oral cavity and oropharynx.
- The study is a review of the microbiology of the submandibular space infections seen at the tertiary academic referral hospitals, University of the Witwatersrand.

- The period of the study is from January 1, 2006, to December 31, 2006. Ninety-three patients were reviewed of which 52 had aspirates taken.
- The predominant microorganisms were the gram-positive anaerobic cocci.

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