CLINICAL MICROBIOLOGY

Aerobic and anaerobic microbiology of suppurative sialadenitis

ITZHAK BROOK

Georgetown University School of Medicine, Washington DC, USA

Aspirates of pus from acute suppurative sialadenitis were investigated for the presence of aerobic and anaerobic bacteria. A total of 47 specimens, 32 from parotid, 9 from submandibular and 6 from sublingual glands yielded bacterial growth. Fifty five isolates, 25 aerobic and 30 anaerobic, were isolated from parotid infection: anaerobic bacteria only were detected in 13 (41%) specimens, aerobic or facultative bacteria only in 11 (34%) and mixed aerobic and anaerobic bacteria in 8 (25%). Of a total of 17 isolates, 8 aerobic and 9 anaerobic, from submandibular gland infection: anaerobic bacteria only were detected in 3 (33%) specimens, aerobic or facultative bacteria only in 4 (44%) and mixed aerobic and anaerobic bacteria in 2 (22%). Ten isolates, 5 aerobic and 5 anaerobic, were from sublingual gland infection: anaerobic bacteria only were detected in 2 (33%) specimens, aerobic or facultative bacteria only in 2 (33%) and mixed aerobic and anaerobic bacteria in 2 (33%). The predominant aerobes were *Staphylococcus aureus* and *Haemophilus influenzae* while the predominant anaerobes were gram-negative bacilli (including pigmented *Prevotella* and *Porphyromonas* spp., and *Fusobacterium* spp.) and *Peptostreptococcus* spp. The study highlights the polymicrobial nature and importance of anaerobic bacteria in acute suppurative sialadenitis.

Introduction

Sialadenitis, an acute infection of the salivary glands, can occur in any of the glands. The parotid gland is the salivary gland most commonly affected by inflammation and most previous reports of the microbiology of sialadenitis were limited to this condition [1]. The microbiology of infection of the submandibular and sublingual glands has rarely been reported [1].

Staphylococcus aureus is the most common pathogen associated with acute parotitis. However, streptococci (including *Streptococcus pneumoniae* and *Str. pyogenes*) and gram-negative aerobic bacilli (including *Escherichia coli*) have also been reported [1]. Gram-negative organisms are often isolated from hospitalised patients. Organisms less frequently found are *Arachnia* spp., *Haemophilus influenzae*, *Treponema pallidum*, cat-scratch bacillus and *Eikenella corrodens*. *Mycobacterium tuberculosis* and atypical mycobacteria are rare causes of parotitis. The importance of anaerobic bacteria in parotid infections was demonstrated when

appropriate methods for their cultivation were employed [2, 3]. However, the role of anaerobic bacteria in infection of the submandibular and sublingual glands has not yet been determined.

This report describes the aerobic and anaerobic microbiology of acute infection of the submandibular, sublingual and parotid glands.

Patients and methods

Between June 1975 and June 1999, culture of 47 aspirates from acute suppurative sialadenitis, obtained from hospitals in the Greater Washington DC area, yielded bacterial growth. These included 32 specimens from parotid gland (23 of these had been reported previously [2], 9 from submandibular gland and 6 from sublingual gland infections. Only specimens that yielded bacterial growth were included in the analysis.

The mean age of the patients was 48 years (range 5–76 years), 32 were males, and 7 were <18 years old. Sixteen of the patients had received oral antimicrobial therapy before sample collection. A β -lactam-resistant penicillin (oxacillin or dicloxacillin) was given to seven

Received 3 Sept. 2001; accepted 3 Dec. 2001.

Corresponding author: Professor I. Brook (e-mail: ib6@georgetown.edu).

patients, a macrolide to four, a cephalosporin to three and amoxicillin to two. Patients' medical records were reviewed and correlated with their microbiological findings.

Cultures were obtained after cleansing of the skin with povidone-iodine and alcohol 70% by either direct needle aspiration of the purulent contents or during surgical incision and drainage. The material was placed into a syringe which was sealed immediately and transported to the laboratory within 30 min, or a swab was dipped into the pus and introduced into an anaerobic transport system (Port-A-Cul, BBL, Cockeysville, MD, USA), which was transported to the laboratory within 4 h. In the laboratories, the material was inoculated into media supportive of the growth of aerobic and anaerobic bacteria, fungi and mycobacteria.

For anaerobic bacteria, the specimen was plated on to pre-reduced vitamin K₁-enriched Brucella blood agar, an anaerobic blood agar plate containing colistin and nalidixic acid, and an enriched thioglycolate broth (containing haemin, and vitamin K₁) [4], incubated in GasPak jars (BBL) and examined at 48 and 96 h. Plates that yielded growth were held until the organisms were processed and identified. All cultures that yielded no growth were held for at least 7 days. Anaerobes were identified by the Minitek system (Baltimore Biological Products, Cockeysville, MD, USA). Other carbohydrate tests (Scott Laboratories, Fiskeville, RI, USA) and gas liquid chromatography [4] were performed as needed to identify the organisms.

For aerobic bacteria, sheep blood (5%) agar, chocolate and MacConkey agar plates were incubated at 37°C aerobically (MacConkey) and in air with CO₂ 5% (blood and chocolate agar), and examined after 24 and 48 h. Aerobic bacteria were identified by conventional methods [5]. β -Lactamase activity was determined with a cefinase disk.

Results

Parotid gland infection

Anaerobic bacteria only were detected in 13 (41%) specimens, facultative bacteria only in 11 (34%) and mixed aerobic and anaerobic bacteria in 8 (25%). A total of 55 bacterial isolates (30 anaerobic and 25 facultative) were obtained, accounting for 1.7 isolates per specimen (0.9 anaerobes and 0.8 aerobes per specimen) (Table 1).

A few consistent patterns or combinations were noted. These were a combination of anaerobic gram-negative bacilli and *Peptostreptococcus* spp. in four specimens and single bacterial isolates in 11 specimens. The single isolates were *S. aureus* (seven), *Pr. intermedia* (two), *Pr. melaninogenica* (one) and *Fusobacterium nucleatum* (one). β -Lactamase production was detected in 17 isolates from 15 (47%) patients (Table 1).

Conditions predisposing to parotitis were observed in 16 patients. These included dehydration and malnutrition (six), immunosuppression (five), dental infection

Table 1. Bacterial isolates* from 47 aspirates of acute suppurative sialadenitis

Organism	Number of isolates from		
	Parotid gland (n = 32)	Submandibular gland (n = 9)	Sublingual gland (n = 6)
Facultative bacteria			
<i>Str. pneumoniae</i>	3	1	0
<i>Str. pyogenes</i>	2	1	0
<i>S. aureus</i>	10 (10)	4 (4)	3 (3)
<i>H. influenzae</i>	4 (2)	1 (1)	1 (1)
<i>E. coli</i>	2 (2)	0	0
α -Haemolytic streptococci	4	1	1
Subtotal	25 (14)	8 (5)	5 (4)
Anaerobic bacteria			
<i>Peptostreptococcus</i> sp.	6	3	2
<i>Pept. magnus</i>	1	0	0
<i>Pept. intermedius</i>	1	0	1
<i>Pept. anaerobius</i>	1	0	0
<i>Actinomyces israelii</i>	2	1	0
<i>Propionibacterium acnes</i>	4	1	0
<i>Eubacterium lentum</i>	2	0	1
<i>Fusobacterium</i> sp.	1	0	—
<i>F. nucleatum</i>	3	1	—
<i>Bacteroides</i> sp.	1	—	—
<i>B. fragilis</i>	1 (1)	—	—
<i>Pr. melaninogenica</i>	1	2 (1)	1 (1)
<i>Pr. intermedia</i>	4 (2)	—	—
<i>Porphyromonas asaccharolytica</i>	2	1 (1)	—
Subtotal	30 (3)	9 (2)	5 (1)
Total	55 (17)	17 (7)	10 (5)

*Numbers in parentheses indicate the number of β -lactamase-producing bacteria.

(three), and consumption of antihistamines and hypothyroidism (one patient each). There was no correlation between these predisposing conditions and the microbiological findings, except for the isolation of anaerobes in all three patients with dental infection.

Submandibular gland infection

Anaerobic bacteria only were detected in three (33%) specimens, facultative bacteria only in four (44%) and mixed aerobic and anaerobic bacteria in two (22%). A total of 17 bacterial isolates (9 anaerobic and 8 facultative) were obtained, accounting for 1.9 isolates per specimen (1.0 anaerobes and 0.9 aerobes per specimen) (Table 1).

Single bacterial isolates were obtained from four samples. These included three isolates of *S. aureus* and one of *Peptostreptococcus* sp. β -Lactamase production was detected in seven isolates from 5 (56%) individuals.

Predisposing conditions to sialadenitis were observed in seven patients, including dehydration and malnutrition (three), immunosuppression (two), and dental infection and diabetes (one each).

Sublingual gland infection

Anaerobic bacteria only were detected in 2 (33%) specimens, facultative bacteria only 2 (33%) and mixed aerobic and anaerobic bacteria in 2 (33%). A total of 10 bacterial isolates (5 anaerobic and 5 facultative) were obtained, accounting for 1.7 isolates per specimen (0.8 anaerobes and 0.8 aerobes per specimen) (Table 1).

Single bacterial isolates were obtained from two samples from one patient infected with *S. aureus*, and another with *Peptostreptococcus* sp. β -Lactamase production was detected in five isolates recovered from 4 (67%) patients.

Conditions predisposing to sialadenitis were observed in five patients. These included dehydration and malnutrition (two), immunosuppression, dental infection and consumption of an anticholinergic drug (one each).

Discussion

This study illustrates the importance of anaerobic bacteria in acute suppurative sialadenitis, where these organisms were isolated from 30 (64%) of 47 patients. The isolation of anaerobic bacteria alone or mixed with facultative organisms from all types of infected salivary glands (submandibular, sublingual and parotid glands) is not surprising, as anaerobes are the predominant organisms in the oropharynx, where they outnumber aerobes by a ratio of 10–1000:1 [6] and are

important pathogens in other suppurative infections in and around the oropharynx [7].

Pigmented *Prevotella* and *Porphyromonas* spp. are the most common gram-negative anaerobic bacilli in the oral flora [6] and, like *Peptostreptococcus* spp., are frequently isolated from odontogenic and orofacial infections [7]. The paucity of reports of involvement of anaerobic organisms in bacterial infections of the salivary gland probably indicates that anaerobic cultures were not performed, or that inadequate transportation or culture techniques have been used.

These data demonstrate the isolation of 29 (35% of all isolates) β -lactamase-producing organisms from 24 of 47 (51.1%) individuals with suppurative sialadenitis. These organisms can survive penicillin therapy and may also protect penicillin-susceptible bacteria from penicillin by releasing the enzyme into the abscess cavity [8]. The resistance of *S. aureus* and *Bacteroides* spp. to penicillin has been recognised for over two decades. However, in recent years, a growing number of anaerobic gram-negative bacilli, *Prevotella* and *Fusobacterium* spp. in particular, has been observed to produce the enzyme [4, 5]. These anaerobes are the predominant bacterial pathogens present in anaerobic infections in and around the oral cavity [7]. Penicillin was considered to be the drug of choice for the therapy of such infections because of its activity against most of the oral pathogens. However, the growing resistance of these bacteria to penicillin limits the use of this drug.

The administration of antimicrobial therapy is an essential part of the management of patients with suppurative sialadenitis. The choice of antibiotics depends on the aetiological agent(s). Most cases respond to antimicrobial therapy; however, sometimes an inflamed gland may reach a stage of abscess formation that requires surgical drainage. Broad-spectrum antimicrobial therapy is indicated for the treatment of all possible aerobic and anaerobic pathogens.

A penicillinase-resistant penicillin or a first-generation cephalosporin is generally adequate coverage for *S. aureus* infection. However, infection with methicillin-resistant *S. aureus* (MRSA) may require the use of vancomycin, teicoplanin or linezolid. Clindamycin, cefoxitin, imipenem, the combination of metronidazole and a macrolide or a penicillin (e.g., amoxicillin) plus a β -lactamase inhibitor (clavulanate), should provide adequate coverage for anaerobic as well as aerobic bacteria.

References

1. McQuone SJ. Acute viral and bacterial infections of the salivary glands. *Otolaryngol Clin North Am* 1999; **32**: 793–811.

2. Brook I, Frazier EH, Thompson DH. Aerobic and anaerobic microbiology of acute suppurative parotitis. *Laryngoscope* 1991; **101**: 170–172.
3. Matlow A, Korentager R, Keystone E, Bohnen J. Parotitis due to anaerobic bacteria. *Rev Infect Dis* 1988; **10**: 420–423.
4. Summanen P, Barron EJ, Citron DM, Strong C, Wexler HM, Finegold SM. Wadsworth Anaerobic Bacteriology Manual, 5th edn. Belmont, CA, Star Publ Co. 1993.
5. Murray PR, Baron EJ, Pfaller MA, Tenover FC, Tenover RH. Manual of Clinical Microbiology, 6th edn. Washington, DC, ASM Press. 1995.
6. Socransky SS, Manganiello SD. The oral microbiota of man from birth to senility. *J Periodontol* 1971; **42**: 485–496.
7. Brook I. Microbiology of abscesses of the head and neck in children. *Ann Otol Rhinol Laryngol* 1987; **96**: 429–433.
8. Brook I. The role of beta-lactamase-producing bacteria in the persistence of streptococcal tonsillar infection. *Rev Infect Dis* 1984; **6**: 601–607.