

Aerobic and Anaerobic Microbiology of Surgical-Site Infection Following Spinal Fusion

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The aerobic and anaerobic microbiology of surgical-site infections (SSI) following spinal fusion was retrospectively studied. This was done by reviewing the clinical and microbiological records at the Naval Hospital in Bethesda, Md., from 1980 to 1992. Aspirates of pus from 25 infection sites showed bacterial growth. Aerobic bacteria only were recovered from 9 (36%) specimens, anaerobic bacteria only were recovered from 4 (16%), and mixed aerobic and anaerobic bacteria were recovered from 12 (48%). Sixty isolates were recovered: 38 aerobes (1.5 isolates per specimen) and 22 anaerobes (0.9 isolate per specimen). The predominant aerobes were *Escherichia coli* ($n = 8$) and *Proteus* sp. ($n = 7$). The predominant anaerobes were *Bacteroides fragilis* group ($n = 9$) and *Peptostreptococcus* sp. ($n = 6$) isolates. An increase in recovery of *E. coli* and *B. fragilis* was noted in patients with bowel or bladder incontinence. This study highlights the polymicrobial nature of SSI and the importance of anaerobic bacteria in SSI following spinal fusion.

Postoperative spine infection can cause significant morbidity and may compromise the outcome of spinal surgery to correct scoliosis. Several reports have described the clinical and microbiological features of this infection in adults (8, 10, 12, 13). The organisms that predominated in these infections were reported to be *Staphylococcus aureus*, *Staphylococcus epidermidis* (8, 10, 13), members of the family *Enterobacteriaceae*, *Pseudomonas aeruginosa* (10, 13, 12), and *Enterococcus* sp. (12). Anaerobic bacteria were rarely recovered (12); however, methods adequate for the recovery of these organisms were not used in those studies.

This report of a retrospective study describes the experience of the Naval Hospital in Bethesda, Md., in isolating aerobic and anaerobic organisms from patients who had surgical-site infections (SSI) following spinal fusion.

Between June 1980 and January 1992, 33 SSI specimens obtained after spinal fusion surgery and processed for aerobic and anaerobic bacteria showed bacterial growth. The medical and bacteriological records of the patients were reviewed. Included in the final analyses were only 25 patients whose medical records were available for review and whose true wound infection and not colonization was observed. This was defined as the presence of pus and erythema. The patients' ages ranged from 16 to 73 (mean, 43.5) years, and 18 were males.

Patients required surgery for the following diagnoses: spinal cord injury ($n = 8$), stenosis ($n = 6$), cerebral palsy ($n = 4$), muscular dystrophy or deformity ($n = 3$), spondylosis ($n = 2$), and idiopathic scoliosis ($n = 2$). Presurgical prophylaxis with a cephalosporin was given to all patients.

The infected site was first scrubbed with povidone-iodine. Culture specimens were obtained either by needle aspiration of fluctuant material or by deep swabbing. A syringe was immediately sealed and transported to the laboratory within 30 min, or a swab was dipped in the pus and introduced into anaerobic transport medium (Port-A-Cul; BBL Microbiology Systems, Cockeysville, Md.), and the sample was generally inoculated within 2 h after collection.

Sheep blood (5%), chocolate, and MacConkey agar plates were inoculated for the isolation of aerobic organisms. The plates were incubated at 37°C aerobically (MacConkey agars) or under 5% carbon dioxide (blood and chocolate agar) and examined at 24 and 48 h. For the isolation of anaerobes, specimens were plated onto prereduced, vitamin K₁-enriched brucella blood agar, an anaerobic blood agar plate containing kanamycin and vancomycin; or an anaerobic blood plate containing colistin and nalidixic acid and then inoculated into enriched thioglycolate broth. The plated media were incubated in GasPak jars (BBL Microbiology Systems) and examined at 48, 96, and 120 h. The thioglycolate broth was incubated for 14 days. Aerobes and anaerobic bacteria were identified by techniques previously described (11, 14). Blood obtained from 13 patients was cultured.

Microbiology. Aerobic bacteria only were recovered from 9 (36%) specimens, anaerobic bacteria only were recovered from 4 (16%) specimens, and mixed aerobic and anaerobic bacteria were recovered from 12 (48%) specimens. Sixty isolates were recovered: 38 aerobes (1.5 isolates per specimen) and 22 anaerobes (0.9 isolate per specimen) (Table 1).

A total of 38 aerobic isolates were recovered. The predominant ones were *Escherichia coli* ($n = 8$), *Proteus* sp. ($n = 7$), *P. aeruginosa* ($n = 5$), *Enterococcus* sp. ($n = 4$), *Klebsiella pneumoniae* ($n = 3$), and *S. aureus* ($n = 3$). A total of 22 anaerobic bacteria were recovered. The predominant anaerobes recovered were the *Bacteroides fragilis* group ($n = 9$) and *Peptostreptococcus* sp. ($n = 6$). There was no consistent pattern of combinations, although *B. fragilis* group isolates were recovered in six instances with *E. coli*.

The recovery of two types of isolates was associated with the presence of bowel and bladder incontinence: four of the eight patients with *E. coli* and five of the nine with *B. fragilis* group isolates were incontinent. The organisms were associated with incontinence more often than with other associated conditions. Organisms similar to the one isolated from the wound (*E. coli* and *B. fragilis*) were also recovered in the blood of four patients.

Clinical presentation. The diagnosis of wound infection was made 4 to 25 days after surgery (average, 14.5 days). All wounds were draining, dehiscence was present in 14 (56%). Fever (>38.5°C) was present in 15 (60%) cases, and leukocy-

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TABLE 1. Bacteria isolated from 25 SSI following spinal fusion

Aerobic and facultative bacteria	No. of isolates	Anaerobic bacteria	No. of isolates
Gram-positive cocci			
<i>Enterococcus</i> sp.....	4	<i>Peptostreptococcus</i> sp.....	6
<i>Staphylococcus aureus</i>	3	<i>Veillonella parvula</i>	2
Nonhemolytic streptococci.....	2		
		Gram-positive rods	
		<i>Propionibacterium acnes</i>	3
		<i>Clostridium perfringens</i>	2
Gram-negative bacilli		<i>B. fragilis</i> group	
<i>Escherichia coli</i>	8	<i>B. fragilis</i>	4
<i>Proteus mirabilis</i>	5	<i>B. thetaiotaomicron</i>	3
<i>Proteus vulgaris</i>	2	<i>B. vulgatus</i>	1
<i>Pseudomonas aeruginosa</i>	5	<i>B. distasonis</i>	1
<i>Klebsiella pneumoniae</i>	3		
<i>Acinetobacter</i> sp.....	2		
<i>Serratia marcescens</i>	2		
<i>Providencia</i> sp.....	1		
<i>Enterobacter</i> sp.....	1		
Total.....	38	Total	22

tosis (>12,000/ml) was present in 16 (52%) cases. A concomitant urinary tract infection (with *E. coli*) was present in three patients. Four patients had bowel and bladder incontinence. The extent of the wound was deep in 14 (56%) cases and superficial (above the fascia) in 11 (44%) cases. Pus and/or necrosis was present in 12 (48%) cases.

Management. Sixteen (64%) patients had surgical drainage, debridement, and closing over drains. Bone graft removal was done in five (20%) instances. Continuous irrigation for 2 to 7 days was used for nine (3%) children.

Parenteral antimicrobial therapy was given to all patients for 10 to 38 days, and 10 continued to receive oral therapy for an additional 10 to 21 days. The parenteral antimicrobials used were an aminoglycoside ($n = 15$), clindamycin ($n = 8$), ceftazidime ($n = 7$), vancomycin ($n = 6$), ticarcillin-clavulanate ($n = 5$), cefoxitin ($n = 4$), imipenem ($n = 2$), and metronidazole ($n = 2$). Oral antimicrobials were amoxicillin-clavulanate ($n = 5$), clindamycin ($n = 5$), dicloxacillin ($n = 4$), ciprofloxacin ($n = 3$), erythromycin ($n = 3$), and cefixime ($n = 2$).

Four patients developed urinary tract infections (due to *E. coli* in three and *Enterococcus* sp. in one), and two developed aspiration pneumonia while receiving therapy for their wounds.

All but five patients responded well to medical therapy and surgical debridement. These patients required repeat debridement 3 to 6 weeks later and finally responded to therapy.

This study demonstrates the polymicrobial aerobic-anaerobic nature of SSI following spinal fusion. The predominant isolates were the *B. fragilis* group, *Peptostreptococcus* sp., and *Enterobacteriaceae*, all of which are known to be part of the normal gastrointestinal bacterial flora (6). Similar flora were recovered in patients with infected pilonidal sinuses (1) and perirectal abscesses (2) and in abscesses of the vulvovaginal areas (3).

Bowel and bladder incontinence predisposes patients with back surgery to infection (12). These patients require external condom catheters or padding, which may increase skin irritation. They also show increased colonization of the perirectal skin with gram-negative enteric bacilli. Pre-existing urinary tract infection also predisposes these patients to postoperative

wound infection (9). The higher recovery of *E. coli* and *B. fragilis* from incontinent patients is probably due to the origin of these bacteria in the stool. The increased incidence of recovery of gram-negative aerobic bacteria in this study, in contrast to the predominance of *S. aureus* in previous studies (8, 10, 13), may be due to the higher rate of urinary and fecal incontinence in our patients and the routine use of a cephalosporin effective against *S. aureus*.

Similar findings were also reported by Perry et al. (12), who also noticed a high incidence of infections with gram-negative aerobic bacteria. However, they were able to correlate their recovery with the length of surgery into the sacral region, as well as with bowel and/or bladder incontinence.

Anaerobic infections are generally polymicrobial where anaerobic organisms are recovered mixed with other facultative anaerobic and aerobic bacteria (5). Previous studies have found that the association between anaerobic bacteria and their aerobic counterparts is generally synergistic (4, 7).

The isolation of anaerobic bacteria mixed with aerobic and facultative organisms from SSI after spinal fusion is not surprising because anaerobic bacteria are the predominant organisms in the gastrointestinal tract, outnumbering aerobic bacteria by a ratio of 1,000:1 (6). Because anaerobic bacteria are often associated with wound infection after spinal fusion, physicians should consider their presence when antimicrobial treatment is used. This may be especially indicated for patients with bowel or bladder incontinence. Because some anaerobes are resistant to penicillin, treatment should also include appropriate coverage of those organisms.

Surgical management, including drainage, is still the treatment of choice for SSI. The presence of penicillin-resistant anaerobic bacteria, however, such as the *B. fragilis* group (15), may warrant the administration of appropriate antimicrobial agents, such as clindamycin, cefoxitin, metronidazole, a carbapenem, or a combination of a β -lactamase inhibitor and a penicillin. Antimicrobial prophylaxis with agents also effective against anaerobic bacteria (e.g., cefoxitin, cefotetan) should be considered, and prospective studies to assess the aerobic and anaerobic microbiology of postoperative spinal infection are warranted.

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