CLINICAL ARTICLES

Wound Infections Following Spinal Fusion with Posterior Segmental Spinal Instrumentation

Jean W. Perry, John Z. Montgomerie, Susan Swank,* Donna S. Gilmore, and Kim Maeder

From the Departments of Medicine and Surgery, Rancho Los Amigos Medical Center, USC School of Medicine, Los Angeles, California

Twenty-three of 238 patients (9.7%) developed wound infections following segmental spinal instrumentation. When the infected group and a matched control group were compared, the infected group had a significantly higher number of patients with cerebral palsy and myelodysplasia (nonambulatory), patients with wound hematomas, patients with fusions that extended into the sacral region, and patients who were incontinent of urine. A high incidence of infections with gram-negative aerobic bacilli correlated with the extension of the surgery into the sacral region and bowel and/or bladder incontinence. Prophylactic antibiotics with broader coverage for gram-negative bacilli may be warranted for these procedures. Postoperative wound infections were managed by surgical drainage and debridement as well as antibiotics. Removal of the hardware was not necessary to control the infection in these patients who underwent segmental spinal instrumentation.

Spinal stabilization has been recommended for the correction of severe scoliosis to restore or to prevent the loss of function and sitting balance and to relieve pain. Many of the patients undergoing this type of surgery have cerebral palsy or other neuromuscular diseases that place them at particular risk for infection. The incidence of wound infection following surgery for neuromuscular scoliosis remains high compared with the overall incidence of wound infection following adolescent idiopathic scoliosis [1–5]. Our experience at Rancho Los Amigos Medical Center with the Luque rod procedure for segmental spinal instrumentation was reviewed in an attempt to identify risk factors for postoperative wound infection with this surgery.

Materials and Methods

Posterior segmental spinal instrumentation, with use of the Luque procedure or a variation thereof, was performed on 238 patients between May 1981 and May 1988. The surgery was carried out by the attending surgeon (one of the authors) on the Spinal Deformity Service. Infection control surveillance data were reviewed for that time period to determine the incidence of postoperative wound infections. Twenty-three patients developed wound infections. Information about the clinical features of the patients and the results of treatment of the infection were obtained from the charts. Information was available on 21 of 23 patients, and these were included in our retrospective study. A group of 20 control patients were matched as closely as possible to the infected group with regard to age and sex, length of the surgical procedure, and type of instrumentation used.

For the purpose of this review, wound infections were identified by means of the 1988 Centers for Disease Control criteria for surgical wound infections [6]. Hematoma was defined as clinically detectable hematoma that was described by the surgical team in the records at the time of drainage or debridement or at the bedside preoperatively.

Culture specimens were obtained at the time of surgery performed for drainage or exploration of wounds, either by needle aspiration of fluctuant or inflamed areas or by deep swabbing of wounds. Postoperative infections were usually managed by the use of appropriate antibiotics and surgical drainage and debridement.

Independent-samples t-test and Pearson's χ^2 test statistics were used to examine the data.

Results

These patients were cared for by the Spinal Deformity Service, which consisted of a team of surgeons, pediatricians, and physical and occupational therapists. The duration of follow-up after surgery was 2–9 years. The clinical features of the infected and control groups are shown in table 1. The mean age of the patients in the infected group was 14 years (range, 4–21 years), and that in the control group was 17 years (range, 10–38 years). There were 11 females and 10 males in the

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*Current affiliation: Gallatin Medical Foundation, Downey, CA

Reprints or correspondence: Dr. John Z. Montgomerie, Rancho Los Amigos Medical Center, 244 HB, 7601 East Imperial Highway, Downey, California 90242.

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Table 1. Clinical features of patients with postoperative wound infections on whom information was available.

Feature	No. of patients or other data, per group	
	Infected (n = 21)	Control (n = 20)
Diagnosis		
Cerebral palsy	9	4
Spina bifida	1	0
Spinal cord injury	3	1
Duchenne's muscular dystrophy	6	2
Polio	1	1
Idiopathic scoliosis	0	7*
Other	1	5
Sex		
Male	10	10
Female	11	10
Age (y)		
Mean	14	17
Range	4–21	10–38
Risk factor		
Presence of hematoma	9	0†
Fusion extended to sacrum	15	8*
Incontinence	13	5*
Allograft/autogenous graft	15 (n = 18)	7†
Activity (ambulant)	1	10†

* $P < .05$ (χ^2 or Fisher's exact test).
† $P < .01$ (χ^2 or Fisher's exact test).

infected group and 10 males and 10 females in the control group. There were a greater number of patients with idiopathic scoliosis in the control group.

The mean duration of perioperative use of first-generation cephalosporins was 3.8 days (range, 1–6 days) for the infected group and 4.6 days (range, 2–10 days) for the control group. Two patients in the infected group also received gentamicin for no specified reason. The mean length of surgery was 6 hours in the infected group and 6 hours, 15 minutes in the control group.

When the infected and control groups were compared, the infected group had a significantly higher number of patients with cerebral palsy and myelodysplasia (who were nonambulatory), patients with wound hematomas, patients with fusions that extended into the sacral region, and patients who were bowel and bladder incontinent.

No significant differences between the infected patients and controls were observed when the following factors were also examined: preoperative preparation with Betadine scrub (Purdue Frederick Co., Norwalk, CT), indwelling catheter utilization, estimated blood loss, intraoperative irrigations and methods of hemostasis, use of drains, and perioperative antibiotic use.

Polymicrobial infections were identified in 14 of the 21 patients. The bacteria associated with the infections are listed in table 2. Gram-negative aerobic bacilli were identified in 16 of 21 patients (76%), *Staphylococcus epidermidis* in 7 of 21 (33%), *Enterococcus* species in 4 of 21 (19%), *Staphylococcus aureus* in 1 of 21 (5%), and *Bacteroides fragilis* in 2 of 21 (10%).

Bacteria resistant to first-generation cephalosporins were identified in 14 of 21 patients (67%). Fifty-two percent of the gram-negative aerobic bacilli isolated from these wounds were resistant to cephalothin. Gram-negative enteric bacteria were associated with wound infection in incontinent patients ($P = .06$).

At the time of the wound infection, leukocytosis (>10,000/mL) was noted in 15 of 20 patients (75%). Six of 20 patients were afebrile. Two patients with *B. fragilis* wound infections and one patient with *S. epidermidis* wound infections developed bacteremia.

Surgical Treatment of Infected Wounds

Eighteen patients had surgical drainage, debridement, and closure over drains at 7–28 days after the initial surgery. Pus and/or necrosis was present in 12 of 18 patients. Bone graft was partially removed from three patients. Continuous irrigation for 3–6 days was used for five of 17 patients. Repeated debridement was necessary in only three patients. Removal of the rods or wires was not considered necessary in any patient. All the wounds healed after drainage. One patient was readmitted to the hospital on two occasions within 1 year because of repeated wound infection. Approximately 1

Table 2. Bacteria associated with postoperative wound infections.

Type, species of bacteria	No. of isolates	
	Total	Cephalothin-resistant
Gram-negative aerobic bacilli		
Pseudomonas aeruginosa	3	3
Proteus mirabilis	6	1
Escherichia coli	7	3
Klebsiella pneumoniae	2	0
Serratia marcescens	2	2
Enterobacter species	1	1
Acinetobacter anitratus	1	1
Providencia stuartii	1	1
Total	23*	12 (52%)
Gram-positive aerobic cocci		
Staphylococcus aureus	1	0
Staphylococcus epidermidis	7	1
Enterococcus species	4	4
Total	12*	5
Anaerobic bacteria		
Bacteroides fragilis	2*	2

* More than one microorganism was isolated from 13 wounds.

year after the surgery, the rods were removed because of exposure of hardware and drainage.

Antibiotic Therapy

Information on the use of antibiotics to treat the postoperative wound infection was available for 19 patients. Appropriate antibiotics (antibiotics given parenterally to which the infecting bacteria were susceptible) were used for 16 patients for 10–42 days (median, 21 days). Oral antibiotics were not given routinely after the parenteral therapy, but three patients received oral antibiotics for short periods of time after discharge from the hospital. The two patients who developed bacteremia with *B. fragilis* as a result of wound infection had been receiving inappropriate antibiotics when they developed sepsis. Both patients then received a course of antibiotics to which the *B. fragilis* was susceptible.

Three additional patients received inadequate antibiotic therapy; one received antibiotics to which the bacteria were not susceptible, and two received appropriate antibiotics for only 2 and 3 days. Despite what would appear to be inadequate antibiotic therapy, these three patients responded well to surgical debridement, although one patient months later was readmitted for two recurrent infections, and the rods were removed 1 year later.

Discussion

The Luque procedure for segmental spinal instrumentation involves a long back incision from the upper thoracic to the sacral area to include the entire deformity, excision of the ligamentum flavum, passage of wire loops underneath the lamina at each vertebral level to attach the rods, and placement of the rods into the iliac bone to produce pelvic fixation. The procedure also involves the creation of a posterolateral trough of bleeding bone into which bone graft is placed to aid in arthrodesis.

We have reviewed the clinical course of 21 patients who developed postoperative wound infection at our institution. Brown et al. [4], in 1982, had previously identified infections in five of 17 patients with cerebral palsy at our institution following combined spinal fusions, and wound infection has been a well-recognized complication of segmental spinal instrumentation [3, 7, 8]. The incidence of infection in the present study was 9.7%. This is high but is probably the result of treatment of greater numbers of patients with cerebral palsy and myelodysplasia, which have previously been recognized as predisposing clinical factors for infection [7, 9].

When the infected and control patients were compared, the infected group had a significantly higher number of patients with cerebral palsy and myelodysplasia, many of whom were nonambulatory, patients with wound hematomas, patients with fusions that extended into the sacral region, and patients who were bowel and bladder incontinent.

In the present study, hematoma was present postoperatively in nine of 21 (43%) of the wounds of the patients who developed infection. Because of the creation of bleeding bone with the surgery and wide muscle dissection, hemostasis is difficult at the time of surgery. It is difficult to apply pressure to this long wound postoperatively. We believe that hematoma was an important predisposing factor in these patients.

Preexisting urinary tract infection has been recognized as an important predisposing factor for postoperative wound infection following spinal surgery [5]. The patients in the present study did not have bacteriuria, and the results indicate that there was also a risk of infection to those patients who were incontinent of urine and feces. Bowel and bladder incontinence in these patients is usually managed with padding or external condom catheters. Previous studies of incontinent patients with spinal cord injury have shown increased colonization of perineal skin with gram-negative bacilli. The infections in our patients were associated with a high incidence of gram-negative aerobic bacilli and *Enterococcus* species.

There was also a significantly greater risk of infection in those patients whose fusions extended into the sacral area. The incision site in the sacral region was more accessible to fecal flora, which could explain the presence of anaerobes (*B. fragilis*) in two patients.

The high incidence of gram-negative aerobic bacilli is in contrast to the findings of previously published studies of the bacterial species isolated from the wounds, which included predominantly *S. aureus*. The high proportion of younger patients who were incontinent of urine and feces may have accounted for this. It is possible that the use of perioperative cephalosporin in the present study may have reduced the incidence of *S. aureus* infections. Lonstein et al. [5] had not used preoperative antibiotics in the earlier studies.

Prophylactic antibiotic therapy has been considered an important factor in preventing postoperative wound infections following spinal fusions [5, 9]. A first-generation cephalosporin has usually been recommended for prophylaxis in orthopedic surgeries involving instrumentation of any kind, primarily for coverage of *S. aureus* and *S. epidermidis*. It would seem reasonable to reevaluate current prophylactic antibiotics for incontinent patients undergoing posterior segmental instrumentation, in whom the procedure may extend into the sacral area, to include antibiotics with activity against gram-negative aerobic bacilli and enterococci.

Patients who had an allograft, as opposed to an autogenous graft, had an increased risk of infection. The use of small-bone allograft has been associated with zero or minimal evidence of an increase in infection rates [2, 10, 11]. The association of infection with allograft in our patients probably resulted from the greater use of allograft in patients with long fusions extending into the sacral region. These patients had little or no autogenous bone from the ilium available for grafting. Routine cultures of the donor allograft bone with each surgical procedure were consistently negative.

Postoperative wound infections were managed by surgical drainage and debridement and antibiotics. Bone graft was partially removed from only three patients. Patients responded well to antibiotics despite the infection/colonization of the remaining cancellous bone. Of greater significance, removal of the hardware was not necessary to control the infection in these patients.

The management of postoperative infections in patients who have undergone spinal instrumentation has sometimes resulted in conflicting opinions between orthopedic surgeons and infectious disease physicians. Although the importance of the removal of hardware to cure infection is commonly taught as a basic principle in the infectious disease field, this is neither wise nor necessary following the Luque procedure [3, 7]. Marked instability would result from the removal of the rods. The surgery of spinal fusion involves the initial resection of the ligamentum and release of the spine so that the spine can be realigned. The spine is unstable until bony fusion takes place.

Previous recommendations have been to leave the hardware in place until the arthrodesis is solid [8, 9]. Lonstein et al. [5] in 1973 reported that postoperative infections of wounds of spinal fusions with Harrington rods healed well after debridement and the use of appropriate antibiotics, and they emphasized the importance of leaving the rods in place.

The reason for the ease of treatment of these patients, despite the presence of the hardware, is not clear. Other factors, i.e., the age of the patients and the type of bacteria involved, may have also influenced the outcome of the treatment of these wound infections. A probable explanation for the good response to debridement is that the infection appears to involve the subcutaneous tissue and rarely the underlying bone. The rods and wires are adjacent to the bone and do not penetrate the bone unless there is pelvic fixation. Despite extensive exposure of the bone, we do not believe acute osteomyelitis developed in these patients, although the absence of superficial bone infection in these circumstances is difficult to document.

There have been no reports on studies of the duration of antibiotic therapy for postoperative infection following spinal fusion. Lonstein [9] recommended administration of parenteral antibiotics for 10–14 days and then oral antibiotics for 3–6 months. We believe that it is important to have adequate antibiotic coverage of organisms at the time of surgical drainage of the wound to prevent bacteremia and to treat the local infection. This therapy should be continued until fever and leukocytosis have resolved or for a minimum of 10 days. We did not use oral antibiotics routinely and do not believe recommendations for 3–6 months of oral antibiotic therapy following use of intravenous antibiotics can be justified.

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