

CHINESE
MEDICAL SCIENCES
JOURNAL

SHORT COMMUNICATION

WOUND INFECTION AFTER SCOLIOSIS SURGERY:
AN ANALYSIS OF 15 CASES

Li Shugang* (李书纲), Zhang Jianguo (仇建国), Li Junwei (李军伟),
Lin Jin (林进), Tian Ye (田野),
Weng Xisheng (翁习生) and Qiu Guixing (邱贵兴)

Department of Orthopedics, Peking Union Medical College Hospital,
CAMS & PUMC, Beijing 100730

Key words scoliosis; infection

Objective. To discuss the causes and treatments of wound infections after scoliosis surgery.

Methods. Nine hundred and twenty-four cases of scoliosis were reviewed, and the clinical data of 15 cases of postoperative infection were analysed retrospectively.

Results. All 15 cases underwent spinal posterior fusion with autologous bone graft using instrumentations. Seven were diagnosed as early infection, and 8 were delayed infection. Radical debridement was performed in all 15 cases. The duration of antibiotics administration was 10 to 34 days with continuous closed irrigation for 2~4 weeks and primary closure for the wounds. All patients were followed up for an average of 3.5 years (2 to 7.5 years) with good outcomes and no recurrence.

Conclusion. Wound infection following surgical correction of scoliosis primarily results from intraoperative seeding, although host-related and operation-related factors may contribute to its development. Once the infections are diagnosed, good results can be achieved by prompt surgical debridement, irrigation and reasonably administered antibiotics. Removal of hardware may be necessary in deep infections.

Wound infection is one of the most significant complications of surgery. Wounds are at an increased risk of infection when metal implants are used in orthopedic surgery (1). Since 1982, following the CD system, many spinal posterior instrumentations, such as the TSRH,

ISOLA, Moss Miami and CD Horizon have been developed for correcting scoliosis (2, 3). Due to the greater amount of hardware involved, the application of these instrumentations increases the risk of wound infection, which is a major problem for patients undergoing posterior fusion with internal instrumentation (1). This article discusses the causes and treatments of wound infection after scoliosis surgery by analyzing 15 cases.

Received for publication June 20, 2001.

*Corresponding author.

MATERIALS AND METHODS

Clinical data. From 1984 to 1997, 924 cases of scoliosis (521 cases of idiopathic scoliosis and 403 cases of congenital scoliosis) underwent posterior fusion with instrumentation at the Peking Union Medical College Hospital. Fifteen cases (5 males and 10 females) developed postoperative infection. Of these 15 cases, 8 were idiopathic and 7 were congenital, and the average age was 17.5 years (range 11 to 32 years). Harrington plus Luque was used in 3 cases, Harrington in 8 cases, and CD in 4 cases (Table 1). All patients were treated with debridement irrigation and antibiotics, while hardware was removed in 8 patients.

Methods. Through a retrospective analysis of clinical data, we divided the patients into 2 groups: early infection group (onset during the first 3 postoperative months) and delayed infection group (onset > 3 months after operation). The data included age, sex, preoperative diagnosis, surgical pattern, duration of surgery, blood tests, infection signs, culture results, treatment and follow-up.

RESULTS

All 15 cases underwent spinal posterior fusion with

autologous bone graft using instrumentations (Table 1). Seven of the 15 were diagnosed as early infection on the average 15th postoperative day (range 3 to 40 days). Diagnostic characteristics of the infection were wound redness and swelling (3 cases), spontaneous drainage (6 cases including pus drainage in 2 cases), wound dehiscence (1 case), wound sinus formation (1 case), elevated temperature (3 cases), and wound dermis necrosis (1 case). For these patients, the WBC count ranged from $(7.3 \sim 18.6) \times 10^9/L$. Radical debridement was performed in all 7 cases, and the bone graft was also removed in 2 cases. Eight cases of delayed infection were identified at an average of 5.5 postoperative months (range 3 to 8 months). Characteristics were red and swelling wound (5 cases), local drainage (8 cases including pus drainage in 6 cases), sinus formation (2 cases), and elevated temperature (2 cases). Radical debridement was also performed: hardware was completely removed in 4 cases (1 patient died of respiratory dysfunction 30 days after the initial debridement), partially removed in 2 cases, and maintained in 2 cases. Dislodged hooks, broken rods, and loose instruments were absent during debridement (Tables 2, 3).

Table 1. General data of 15 cases

Cases	Sex	Age (years)	Diagnosis	Pattern	Duration (minutes)	Blood loss (ml)	Duration of perioperative antibiotics (days)	
Early	1	F	20	I	CD + PSF	205	400	10
	2	F	11	C	CD + PSF	170	300	14
	3	M	16	C	CD + PSF	200	400	12
	4	F	17	C	H + PSF	180	450	8
	5	M	16	C	H + L + PSF	225	450	6
	6	F	12	C	H + PSF	120	150	3
	7	F	25	I	H + L + PSF	240	800	11
	8	F	21	I	CD + PSF	260	500	7
Delayed	9	M	12	C	H + PSF	110	200	10
	10	F	18	C	H + PSF	120	250	7
	11	F	32	I	H + PSF	150	300	9
	12	M	15	I	H + PSF	140	200	11
	13	F	16	I	H + PSF	170	200	13
	14	F	14	I	H + L + PSF	240	400	7
	15	M	18	C	H + PSF	170	150	10

I for idiopathic; C for congenital; H for Harrington system; L for Luque system; PSF for posterior fusion; CD for CD instrumentation

Table 2. Data related to infection diagnosis

Cases	Time of infection identification (postoperative days)	Infection signs	Blood WBC count ($\times 10^9/L$)	Culture	
Early	1	40	redness; sinus; drainage	12.0	negative
	2	12	redness; dehiscence; drainage	9.46	negative
	3	25	redness; pus; fever	7.3	Staphylococcus aureus
	4	5	redness; swelling; pus; fever	15.6	Staphylococcus aureus
	5	6	redness; swelling; pus; fever	13.0	Staphylococcus epidermidis
	6	3	wound necrosis; fever	13.0	negative
	7	15	redness; swelling; drainage	18.6	negative
Delayed	8	6	redness; swelling; drainage	8.0	negative
	9	3	redness; swelling; pus drainage	10.4	Staphylococcus aureus
	10	4	sinus; pus drainage	11.2	negative
	11	6	redness; swelling; sinus; pus	18.0	Staphylococcus epidermidis
	12	8	sinus; pus drainage	6.0	negative
	13	6	redness; swelling; sinus; pus drainage	6.9	negative
	14	7	rupture; pus; fever	11.7	Staphylococcus epidermidis
	15	4	redness; swelling; drainage	7.2	Staphylococcus aureus

Table 3. Treatments of wound infection

Cases	Debridement (times)	Irrigation (week)	Hardware removal	Wound suture	WBC count ($\times 10^9/L$)*	Duration of antibiotics (days)	Follow-up (days)	
Early	1	1	2	no	Primary tension suture	8.2	10	48
	2	1	3	no	Primary closure	5.6	14	30
	3	1	3	total	Primary closure	4.7	14	24
	4	1	4	total	Primary tension suture	9.5	30	51
	5	1	3	no	Primary tension suture	8.3	17	54
	6	1	4	no	Primary closure	9.0	34	36
	7	1	2	no	Primary closure	10.0	10	24
Delayed	8	1	2	no	Primary tension suture	7.4	13	42
	9	1	2.5	compression rod	Primary closure	5.9	24	72
	10	1	2	no	Primary tension suture	8.7	18	36
	11	1	2	compression rod	Primary tension suture	8.1	10	30
	12	1	2.5	total	Primary closure	10.1	18	24
	13	2	4	total	Primary closure	5.5	31	90
	14	2	3.5	total	No healing			Die 30 days later
	15	1	3	total	Primary closure	7.0	24	36

*WBC count before using antibiotics.

All wounds were debrided, followed by continuous closed irrigation for an average of 2.8 weeks (2-4 weeks). No complications occurred. The cultures of specimens obtained during debridement were positive for Staphylococcus aureus in 4 patients; Staphylococcus epidermidis in 3; and negative in 8. Antibiotics were administered continuously for 10-34 days until 3 days after the WBC count became normal. No recurrent infection occurred during an average of 3.5 years (range 2 to 7.5 years) of follow-up.

DISCUSSION

Wound infection, which often occurs 4-6 weeks

postoperatively (early acute infection), is one of the common complications following posterior spinal fusion. A prevalent infection rate of 0.3-8.5% has been reported (4). Early detection and management directly affect surgical outcomes. Delayed infection after posterior fusion surgery for scoliosis is rare, presenting difficulties for diagnosis and explanation. In 1994, Dubouset reported a prevalence rate of 1% for late infection following CD surgery (5). Richards has reported 10 late infections following TSRH surgery that were not identified until the 11th postoperative month (6). Hegenoss reported 6 cases of late infection occurring 1 to 7 years after spinal fusion (7). The exact definition of late infection has not been set. In general, wounds will heal after 3 months if in-

fections do not occur. In our analysis, early infection was identified in 7 cases, and late infection in 8. There was an infection rate of 1.6% for all cases, 0.75% for early, and 0.86% for late.

Wound infection may result from 2 pathways: the first is intraoperative seeding, and the second is hematogenous seeding (3). Clark believed that there might be 2 mechanisms for late infection: one is that some low-virulence bacteria, normally skin flora, are carried into the wound during the operation, followed by a quiescent period (3). The bacteria then become active and proliferate after a long period, resulting in inflammation and infection. Dietz and Schofferman support this idea (8, 9). Dietz obtained deep specimens during second operations in patients who did not have evidence of infection and reported a 58% prevalence of positive cultures in a series of 48 patients. In 24% of the positive cultures, the isolated organism was *Propionibacterium acnes*; in 58%, it was coagulase-negative staphylococcus; and in the remaining 18%, it was other organisms. All organisms were normal skin flora and were reported to be related to infection following implantation (6).

Although these organisms are usually cleared by the normal defenses of the host, once seeded, they may adhere to the instrumentations and become encased in an adhere biofilm known as glucocalyx. Richard believed that micromovement occurs between soft tissue and metal implants, resulting in metal wear and debris. Moreover, gaps created between implants and vertebrae is filled with hematomas. The above 2 factors provide a favorable environment for the existence and proliferation of bacteria adhering to instrumentations.

Another pathway is hematogenous seeding from remote sites. Gristina, after reviewing many reports, believed that implants in arthroplasty increased the risk of postoperative infection (10). Once seeded, the bacteria may adhere to the instrumentation and become encased in an adherent biofilm-flycocalyx, which prevents antibiotics from infiltrating into the bacteria, decreases the macrophage power, and makes it difficult to get positive culture. This condition may also be involved in delayed infection following posterior spinal surgery with metal implants.

In our infection cases, 7 were early infections and

were diagnosed 3 ~ 40 days postoperatively. The cultures of specimens from debridement were positive for *Staphylococcus aureus* in 2 cases, positive for *Staphylococcus epidermidis* in 1 case, and negative for the remaining cases. Eight cases of delayed infections were identified 3 to 8 months postoperatively. Organisms isolated were *Staphylococcus aureus* in 2 cases, *Staphylococcus epidermidis* in 2 cases, and negative in 4 cases. Bacteria may have been carried into the wounds intraoperatively because no evidence of infection was found from the initial procedure to detect infections. None of the patients had other diseases that could have lowered body immune function. Clark believes that in addition to specificity of host, the activation and proliferation of bacteria may be related to decreased body immune response caused by surgical trauma and metal implants (3). Negative culture was found in 53% of the cases in our group. Clark has suggested that a higher positive rate can be achieved by prolonging the duration of culture. In general, peripheral blood counts of WBC, ESR and CRP can contribute to the early diagnosis of infection. Unfortunately, ESR and CRP were not recorded in the earlier clinical data, so further evaluation of these 2 references was impossible in the current study.

It has been reported that an operation duration of over 5 hours will increase the risk of early infection (11). In our cases, the duration of operation averaged 3 hours (110 to 260 min). Whether the type of instruments contributes to the incidence will not be discussed in this study, although Clark has reported that there was no difference (3). Of these 15 cases of infection, 11 had Harrington instrumentation. However, as the number of patients with this instrumentation was larger (667 versus 257 in the total sample), the infection results do not suggest that the infection rate of Harrington instrumentation is higher than that of others.

The treatment for early infection included early debridement (repeated if necessary) and antibiotics. Instrumentations were removed in 2 of the 7 early infection patients due to tissue necrosis adjacent to the metal implant and were reinserted after the infections had healed. Instrumentation was maintained in the other 5 patients. The duration of antibiotics administration was 10 to 34 days with continuous closed irrigation for 2 to 4 weeks and

primary closure for the wounds. All patients were followed up for an average of 3.2 years (24 to 54 months) with good outcomes and no recurrence. Glassman has reported that positive treatments such as repeated debridement and antibiotic beads are effective for deep infections and when instrumentations are retained (12). Antibiotic beads have also been used for treating the infections in our hospital and have proven to be effective. However, we did not include this method in this study due to the limited sample size.

Richard has reported that the removal of all components of instrumentations in order to eliminate bacteria-protective biofilm is an important step in the effective treatment of delayed infections (6). However, if the infection occurs before the bone has consolidated (less than one year postoperatively), the surgeon should consider leaving the hardware in place and suppressing the infection with antibiotics until osseous stability has been achieved. In the 8 cases of delayed infection, hardware was retained in 2 cases (No. 8, 10) with only superficial infection, partially removed in 2 (No. 9, 11) cases; and completely removed in 4 (1 died of breathing failure) cases. All infection signs disappeared in 1 case 1 month after debridement, and Harrington was inserted for a second time. Two cases were treated with a 4-month cast after the infection was cured. Antibiotics were administered for a period of 10 to 31 days in all cases. With the exception of 1 death, the remaining 7 cases were followed up for 2 to 7.5 years (24 to 90 months) with no recurrence or pseudoarthrosis formation in radiography and with good outcomes. From our experiences and the results of this study, we conclude that instrumentation should be kept for as long as possible in patients with early infection. Removal of the instrumentation could be considered when infection cannot be controlled after radical debridement and antibiotics administration. In this situation, reimplant should take place no earlier than 1 month after the infection is completely cured. Instrumentation could be removed in cases of delayed infection occurring more than one year after surgery; if the infection occurs within 1 year, the situation will need to be carefully considered. In short, in addition to the infection characteristics and identification time, the determination to remove all hardware requires the consideration of con-

trolling infection and pseudoarthrosis formation.

As for wound closure, Richard has reported good results for both primary closure and delayed primary closure. All wounds that were closed primarily healed uneventfully without complications.

Antibiotics were usually administered based on experience and considering possible negative results or delayed presentation of cultures. If an antibiotic is not effective after being administered for 5~7 days, it should be replaced immediately. Antibiotics proved effective in all patients, and there were no antibiotics-related complications.

For all patients, a suction-irrigation system was inserted for continuous irrigation with sterile saline solution of 10 000 to 20 000ml daily after debridement. The tubes were removed depending on a combination of drainage appearance, symptoms, laboratory tests and complications. The system was usually maintained for 2~4 weeks. Of the patients who had no complications related to the system, 13 underwent debridement once, and the remaining 2 cases underwent debridement twice after irrigation. We believe that this method has many advantages: continuous removal of bacteria and necrotic tissue; control of infection for early wound healing in patients with maintained instruments; and to a certain extent, lower costs by minimizing the amount of debridement procedures.

In summary, wound infection following surgical correction of scoliosis primarily results from intraoperative seeding, although host-related and operation-related factors may contribute to its development. Once the infections are diagnosed, good results can be achieved by prompt surgical debridement, irrigation and reasonably administered antibiotics. Removal of hardware may be necessary in deep infections. The role of antibiotic chains in controlling infection and maintaining instrumentation remains to be explored.

REFERENCES

1. Polly DW, Meter JJ. The effect of intraoperative blood loss on serum cefazolin level in patients undergoing instrumented spinal fusion. *Spine* 1996; 21: 2363-7.
2. Cotrel Y, Dubousset J, et al. New universal instrumentation in

- spinal surgery. *Clin Orthop* 1988; 227: 10 - 21.
3. Clark CE, Shufflebarger HL. Late-developing infection in instrumented idiopathic scoliosis. *Spine* 1999; 24: 1909.
 4. Viola RW, King HA, Adler SM, et al. Delayed infection after elective spinal instrumentation and fusion: a retrospective analysis of eight cases. *Spine* 1997; 22: 2444 - 50.
 5. Dubousset J, Shufflebarger HL, et al. Late "infection" with CD instrumentation. *Orthop Trans* 1994; 18: 121.
 6. Richards BS. Delayed infections following posterior spinal instrumentation for the treatment of adolescent idiopathic scoliosis. *J Bone Joint Surg (Am)* 1995; 77: 524 - 9.
 7. Hegeness MH, Esses SI, et al. Late infection of spinal instrumentation by hematogenous seeding. *Spine* 1993; 18: 492 - 6.
 8. Dietz FR, Koontz FP, et al. The importance of positive bacterial cultures of specimens obtained during clean orthopedic operations. *J Bone Joint Surg (Am)* 1991; 73: 1200 - 7.
 9. Schofferman HL, Zucherman J, et al. Diphtheroids and associated infections as a cause of failed instrument stabilization procedures in the lumbar spine. *Spine* 1991; 16: 356 - 9.
 10. Gristina AG, Kolkin J. Current concepts review: total joint replacement and sepsis. *J Bone Joint Surg (Am)* 1985; 67: 264 - 70.
 11. Massie JB, Heller JG, et al. Postoperative posterior spinal wound infections. *Clin Orthop* 1992; 284: 99 - 108.
 12. Glassman SD, Dimar JR, Puno RM, et al. Salvage of instrumented lumbar fusion complicated by surgical wound infection. *Spine* 1996; 21: 2163 - 9.

Association of HLA-DRB1 Alleles with Polymyositis/ Dermatomyositis in Northern Chinese Hans

Zhai Ning(翟宁), Zhang Qingrui(张庆瑞), Han Xiuping(韩秀萍) and Song Fangji(宋芳吉)

Department of Dermatology, The First Hospital of China Medical University, Shenyang 110001

The HLA system is a highly polymorphic antigen and genetic system in human, and different population has different distribution of HLA alleles. Polymyositis/dermatomyositis (PM/DM) are idiopathic inflammatory myopathies that are characterized clinically by proximal muscle weakness, elevations of serum muscle enzymes, especially creatine kinase (CK), and typical abnormal findings on electromyography. Significant association has been reported between PM/DM and HLA-DR3/DRB1*0301, DRB8/DRB1*08, DR6 and DR2.

In this study, we determined HLA-DRB1 by PCR-SSP methods in 52 patients with PM/DM and 168 controls in the Hans from north China. Fifty-two patients were clinically diagnosed as PM (n = 14) and DM (n = 38) using the criteria proposed by Bohan and Peter. Genomic DNA was extracted from the peripheral blood lymphocytes using improved slating-out method. The *Chi-square* test was used to determine statistical significance. The corrected *P* (*P_c*) value equals to the actual *P* value multiplied by the number of tested alleles. In the combined myositis group, HLA-DRB1*040x, DRB1*070x and DRB1*120x

were significantly higher ($X^2 = 29.8$, $RR = 6.61$, $P_c < 0.01$; $X^2 = 10.68$, $RR = 4.48$, $P_c < 0.05$; $X^2 = 22.22$, $RR = 5.82$, $P_c < 0.01$, respectively) than in controls. And the frequencies of these alleles were significantly increased only in DM patients compared with controls ($X^2 = 26.33$, $P_c < 0.01$; $X^2 = 20.82$, $P_c < 0.01$; $X^2 = 9.63$, $P_c < 0.05$), but not in PM patients. So these alleles played important role in DM. Among patients with concomitant interstitial lung disease (n = 10), a significantly increased frequency of HLA-DRB1*120x allele was found ($X^2 = 12.56$, $P_c < 0.01$).

There have been only a few small studies of HLA-class II alleles overseas and we are unaware of any similar investigations in Chinese patients with PM/DM. Our results showed that no common feature of DRB1 alleles shared by Chinese patients and any other ethnic groups, which suggests that there is significant genetic heterogeneity among patients with PM/DM, some potentially due to differences in HLA alleles, as well as racial differences.