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An intraoperative irrigation regimen to reduce the surgical site infection rate following adolescent idiopathic scoliosis surgery

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ABSTRACT

INTRODUCTION The aim of this study was to compare the efficacy of a gentamicin antibiotic intraoperative irrigation regimen (regimen A) with a povidone-iodine intraoperative irrigation regimen (regimen B) and to evaluate the ability of adjunctive local vancomycin powder (regimen C) to reduce the surgical site infection (SSI) rate following idiopathic scoliosis correction.

METHODS This was a retrospective, single centre, two-surgeon cohort study of paediatric scoliosis procedures involving 118 patients under the age of 18 years who underwent correction for idiopathic scoliosis over a period of 42 months. Patients' baseline characteristics, pseudarthrosis and rates of SSI were compared.

RESULTS Baseline characteristics were comparable in all three groups, with the exception of sex distribution. Over a quarter (27%) of patients with regimen B were male compared with 13% and 6% for regimens A and C respectively. Patients were mostly followed up for a minimum of 12 months. The SSI rate for both superficial and deep infections was higher with regimen A (26.7%) than with regimens B and C (7.0% and 6.3% respectively). The SSI rates for regimens B and C were comparable. No patients developed complications related to vancomycin toxicity, metalwork failure or pseudarthrosis.

CONCLUSIONS Wound irrigation with a povidone-iodine solution reduces SSIs following adolescent idiopathic scoliosis surgery. The direct application of vancomycin powder to the wound is safe but does not reduce the SSI rate further in low risk patients. Additional studies are needed to elucidate whether it is effective at higher doses and in high risk patient groups.

KEYWORDS
Scoliosis – Infection – Paediatric – Antibiotic – Iodine

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Surgical site infection (SSI) following scoliosis surgery causes significant patient morbidity and has considerable financial implications. Treatment of the infection traditionally requires long-term antibiotic therapy and metalwork removal, which can lead to a loss of deformity correction and the development of pseudarthrosis. SSI following spinal surgery in general reportedly costs between £814 and £6,626 per patient depending on the type of surgery and the severity of the infection,[1,2] and has been estimated to quadruple health care costs.[3] The Scoliosis Research Society has reported the mean SSI rate following paediatric scoliosis surgery as 2.9%[4] but rates of SSI after scoliosis correction vary greatly, ranging from 0.5% to 20%.[4–6]

Surgical technique, among other variables, is known to influence SSI rate and a number of intraoperative irrigation regimens, aimed at reducing postoperative SSI, have been described in the literature.[7–10] In an animal study, Yarboro *et al* have shown that injecting gentamicin solution directly into surgical wounds causes a greater reduction in bacterial levels than intravenous administration of gentamicin alone.[8] However, in vitro studies by Anglen *et al* have demonstrated that antibiotic irrigation, using bacitracin and neomycin, is no more effective than saline irrigation in removing *Staphylococcus epidermidis* from stainless steel screws.[11] Cheng *et al* found that wound irrigation during spinal surgery with a 0.35% povidone-iodine solution (a bactericidal agent effective against methicillin resistant *Staphylococcus aureus* [MRSA]) resulted in no SSIs compared with a 3.4% infection rate when using saline.[7]

The clinical effectiveness of intravenous vancomycin at reducing SSI is comparable with intravenous cephalosporins.[12,13] The intraoperative application of vancomycin powder to the wound following posterior instrumented thoracolumbar and cervical fusion surgery has recently been shown to reduce the SSI rate[14,15] but little is known about its safety and efficacy in paediatric scoliosis surgery.

This study compared the effect of three different irrigation regimens on SSI rate following paediatric idiopathic

scoliosis surgery. It also sought to evaluate the ability of adjunctive local vancomycin powder to reduce the SSIs following idiopathic scoliosis correction.

Methods

A single centre, two-surgeon cohort study was carried out of idiopathic paediatric scoliosis primary procedures over 42 months. Permission was gained from the spinal surgery unit at the hospital where the study took place. Both surgeons were fellowship trained, with one having ten years and the other seven years of experience of spinal deformity surgery at the start of the study. Data were collected retrospectively from the electronic patient records system. Patients 18 years of age and over, those growing rods, those who had revision procedures and all aetiologies other than idiopathic were excluded from the study.

Patients were divided into three groups depending on the intraoperative wound irrigation regimen used. Regimen A consisted of irrigation with six litres of saline followed by another litre of saline mixed with 80mg of gentamicin. For regimen B, three litres of saline were used, followed by one litre of a 1% povidone-iodine solution. This was left for three minutes before a second saline wash (also three litres) was commenced. Regimen C was the same as regimen B but irrigation was followed with vancomycin powder (1g) being applied locally to the wound.

Surgery was conducted in a laminar airflow theatre. All patients received a weight dependant intravenous dose of flucloxacillin and gentamicin on induction of anaesthesia (teicoplanin if allergic to penicillin), and a bolus dose of tranexamic acid. The skin was prepared using chlorhexidine. Wound irrigation was commenced once all the metalwork was in situ. Two epidurals and a Bellovac® drain (Astra Tech, Stonehouse, UK) were inserted at the end of the operation prior to wound closure. The wound was closed in layers using absorbable Vicryl® (deep) and Monocryl® (subcuticular to skin) sutures (both from Ethicon, Somerville, NJ, US). Additional flucloxacillin doses were given 8-hourly for 24 hours. The drain and epidurals were removed at 24 and 72 hours respectively.

Patients were mostly followed up for a minimum of 12 months. At one year, if there were no postoperative concerns, patients were discharged. Superficial infections were treated routinely with oral antibiotics. Deep infections were defined as those clinically warranting surgical intervention (washout and debridement followed by intravenous antibiotics). Statistical analysis for categorical variables was performed using a 3×2 contingency table and Fisher's exact test, and the two-tailed Student's t-test for numerical variables.

Results

A total of 118 paediatric patients had surgical correction for idiopathic scoliosis during the 42-month study period. Mean age, surgical approach and perceived medical risk factors (diabetes, obesity and smoking) were comparable across the three regimens (Table 1). Over a quarter (27%) of patients with regimen B were male. For regimens A and C, the percentages were lower (only 13% and 6% respectively). There were no significant differences in operative details (Cobb angle, levels fused and blood loss) (Table 2).

Regimen A had a total SSI rate of 26.7% compared with 7.0% and 6.3% for regimens B and C respectively (Table 3). However, this was not statistically significant. The trends were similar for both deep and superficial wound infections. Table 4 lists the bacteria isolated from the deep wound infections. The bacteria found on the swabs were common skin microbiotas and none of the bacteria cultured had antibiotic resistance. No patients developed complications related to vancomycin toxicity, metalwork failure or pseudarthrosis.

Table 1 Comparison of demographics

	Regimen A (*n*=15)	Regimen B (*n*=71)	Regimen C (*n*=32)
Mean age (range) in years	14.3 (12–17)	14.1 (5–17)	13.8 (7–17)
Male sex	2 (13.3%)	19 (26.8%)	2 (6.3%)
Diabetes	0	0	0
Body mass index >30kg/m^2	1 (6.7%)	1 (1.4%)	0
Smokers	0	0	0
Surgical approach			
Anterior	0	5 (7.0%)	0
Posterior	13 (86.7%)	48 (67.6%)	23 (71.9%)
Anterior + posterior	2 (13.3%)	18 (25.4%)	9 (28.1%)

Table 2 Operative details for the three irrigation regimens

		Non-infected	Infected	*p*-value
Regimen A (*n*=15)	Mean curve	54°	52°	0.718
	Mean number of levels fused	11	11	0.875
	Mean blood loss	740ml	700ml	1.000
Regimen B (*n*=71)	Mean curve	58°	72°	0.052
	Mean number of levels fused	11	12	0.238
	Mean blood loss	594ml	879ml	0.190
Regimen C (*n*=32)	Mean curve	55°	60°	0.670
	Mean number of levels fused	10	12	0.919
	Mean blood loss	412ml	394ml	0.166

Table 3 Comparison of surgical site infection rates

Infection	Regimen A (*n*=15)	Regimen B (*n*=71)	Regimen C (*n*=32)	*p*-value
Deep	3 (20.0%)	3 (4.2%)	1 (3.1%)	0.07
Superficial	1 (6.7%)	2 (2.8%)	1 (3.1%)	0.06
Total	**4 (26.7%)**	**5 (7.0%)**	**2 (6.3%)**	0.08

Table 4 Bacteria isolated from deep infections

Group	Patient	Organism
Regimen A (*n*=15)	1	Gram-positive cocci
	2	Anaerobic diphtheroids
	3	Anaerobic diphtheroids
Regimen B (*n*=71)	1	*Staphylococcus aureus*
	2	Anaerobic diphtheroids
	3	Anaerobic diphtheroids
Regimen C (*n*=32)	1	Anaerobic Gram-positive rods

Discussion

Improvements in sterile technique, the use of laminar airflow theatres and the administration of prophylactic antibiotics perioperatively have all helped reduce the risk of SSI. An increase in MRSA and other resistant organisms has seen the effectiveness of cephalosporins and penicillins in preventing SSIs decrease in orthopaedics, prompting the search for alternative antibiotic and wound irrigation regimens.[16]

Our study has shown that wound irrigation with a povidone-iodine preparation significantly reduces the total SSI rate by approximately 20 percentage points compared with a saline/gentamicin preparation alone, supporting the findings by Cheng *et al*.[7] However, in procedures where bony fusion is necessary, surgeons have historically been cautious about the use of povidone-iodine in wound irrigation owing to its toxic effect on fibroblasts and osteoblasts, and the theoretical increased risk of developing pseudarthrosis.[17] A number of studies now challenge this belief.[7,18] In our study, based on clinical judgement only, there were no revisions due to suspected pseudarthrosis and no significant loosening has been detected.

The application of vancomycin powder to the wound is an inexpensive means of getting a high local antibiotic concentration where it is most needed. Studies have shown that its application following spinal fusion surgery in adults significantly reduces SSIs rate[14,15] but there is currently no literature to support its use in paediatric scoliosis surgery. Our study has shown no additional benefits of adding vancomycin powder to the wound, with both superficial and deep infection rates for regimens B and C being comparable.

When the study commenced, little was known about effective dosing and the systemic absorptive effects of vancomycin powder when applied to the wound, particularly in paediatric patients. We used a lower dose of vancomycin (1g as opposed to 2g) than in the adult spinal fusion studies.[14,15] In 2013 Gans *et al* also evaluated the safety of adjunctive vancomycin powder (500mg) in paediatric spinal surgery and also concluded that it is safe.[19] Although no patients suffered from vancomycin toxicity in our study, the relatively low dosage could in part explain why there was no statistically significant difference in SSI rate between regimens B and C. Furthermore, it is not known whether the site of placement of the powder in the wound or whether mixing it with bone graft influences its effectiveness and additional studies are needed to elucidate this.

Study limitations

It is worth noting some limitations of our study. First, the retrospective design of the study resulted in differing numbers of patients assigned to each regimen. The high SSI rate for regimen A was noticed at the time by the operating surgeons and a decision was made to stop using this regimen, hence the low patient numbers with regimen A. However, the decision to switch regimens was made on clinical grounds when it was felt that infection rates had become unacceptably high. Second, a two-surgeon study potentially increases the bias introduced through operator technique. Nevertheless, in this study, it was felt necessary in order to have a large enough sample size. Third, although all patients had a minimum follow-up duration of eight months (with the majority being followed up for one year prior to discharge), a longer follow-up period would help detect delayed infections.

Finally, this study looked at SSIs in low risk patients. Further studies are needed to investigate higher risk groups such as children with neuromuscular scoliosis and adults with scoliosis.

Conclusions

Wound irrigation with a povidone-iodine solution reduces SSIs following adolescent idiopathic scoliosis surgery. Since this study, we have continued using regimen C (with 1g of vancomycin) and there have been no SSIs in 85 paediatric patients of varying aetiologies (including neuromuscular). The direct application of vancomycin powder to the wound is safe. Although it does not reduce the SSI rate further in low risk patients, it may be effective at higher doses and in high risk patient groups.

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