Postoperative infections after surgical correction of Adolescent Idiopathic Scoliosis using polyester sublaminar bands

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White paper

Introduction

Surgical site infections (SSIs) are the most frequent adverse event requiring revision after spinal fusion for pediatric scoliosis. The incidence of SSI after Adolescent Idiopathic Scoliosis (AIS) surgery remains highly variable, currently ranging from 0.5 to 7% [1, 2, 3, 4]. Numerous risk factors have been investigated, but most of them are patient-related and therefore non-modifiable, such as previous surgery or underlying medical status. Recent literature has focused on deep wound infections management and described prevention strategies to decrease their occurrence, but the influence of the type of instrumentation used for surgical correction remains unknown [3]. All-pedicle screws constructs are currently the most popular, but several limitations have been reported lately, resuscitating interest for posteromedial translation techniques using hybrid instrumentation [5,6,7,8]. While implant distribution remains variable in all-screw constructs, there is a tendency to increase implant density in order to optimize the correction, and a trend towards intraoperative navigation and/or imaging control, both increasing operative time and risk of SSI [8,9]. In opposition, fewer implants are necessary when posteromedial translation is the chosen method for correction, especially with sublaminar bands [9], and intraoperative imaging is not necessary. However, the main concern to date corresponds to the risk of infection, and the ability of the pathogen to colonize the polyester plait, which could make SSI eradication more difficult. In addition, very little literature is available regarding SSI sequelae. As a matter of fact, bone graft is often partially removed during surgical debridement, thus altering the conditions for optimal fusion. In addition, the multiple procedures that can be necessary to eradicate the pathogen and the longer hospitalization stay might lead to poorer satisfaction. The goal of this study was therefore to report SSI rate after AIS surgery using sublaminar bands, describe their management, and examine the influence of deep wound infections on radiological and functional outcomes.

MATERIALS AND METHODS

Patients

After institutional review board approval, medical data of all patients operated for AIS in our institution between June 2006 and June 2014 were retrospectively reviewed. Patients with previous spinal surgery or medical conditions increasing the risk for infection were excluded. The cases of infections were first identified, using the recommended criteria, in order to determine the incidence rate of SSI associated with the sublaminar bands technique [10]. Patient-related and procedure-related parameters from the SSI group were then compared to a control group, matched for age, Lenke curve type and initial Cobb angle [11].

Preoperative care

On the day of surgery and on the day before, all patients took a shower with povidone-iodine scrub. The operative team systematically checked the back skin at the time of admission, and the procedure was postponed in case of significant acne. Skin preparation before incision included one surgical site povidone-iodine scrub, followed by two 5% alcoholic povidone-iodine paints performed by a nurse. The surgical field was recovered by an iodine-impregnated adherent plastic drape, and two plastic bags were placed laterally in order to protect the bands from falling down during the procedure (Figure 1).

Figure 1: *Lateral view of the installation, showing the position of the plastic bags placed on each side of the patient, in order to receive the extra spinal part of the sublaminar bands intraoperatively.*

The same blood saving strategy was applied during the entire study period. Patients were preoperatively treated by weekly injections of Erythropoietin (EPO), in order to reach a hemoglobin rate of 15 mg/dl, and antifibrinolytic (tranexamic acid) was systematically used during the procedure.

As recommended, antibiotic prophylaxis relied on cefamandol, with 2 grams (g) injected within one hour before incision, followed by a second injection of 1g 4 hours later, and antibiotics were stopped after wound closure [12].

Operative procedures

All patients underwent posterior segmental spinal correction and fusion using hybrid constructs, performed by one of the two senior surgeons of the department. Spinal cord monitoring was systematically performed. Fusion levels were selected following the same criteria during the study period [5]. In all cases, pedicle screws were placed at the distal extremity of the curve (from L4 to L1 or T12), while thoracic levels were instrumented with sublaminar bands (Jazz from Implanet, Bordeaux, France or Universal Clamps from ZimmerSpine, Bordeaux, France) on the concave side and at the apex on the convex side. The 2 upper thoracic levels, located at the proximal end of the construct, were bilaterally instrumented with autostable hooks (ZimmerSpine, Bordeaux, France), protected by 2 adjacent sublaminar bands (Figure 2).
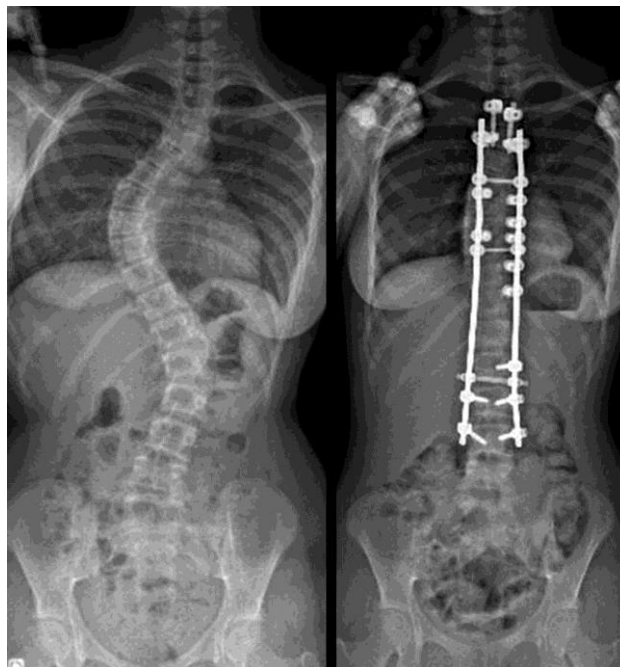

Figure 2: *Preoperative and postoperative frontal radiograph of a Lenke 1 AIS instrumented with a hybrid construct combining pedicle screws from L3 to L1, 7 sublaminar bands placed on the main thoracic curve, and 2 autostable claws placed on T3-T4.*

Correction was performed on both sides simultaneously, using 5.5 mm CoCr rods contoured according to the desired sagittal alignment. Both rods were first connected to lumbar screws, and derotation, compression/distraction and in situ contouring were applied. Once the lumbar curve was corrected and the last instrumented vertebra leveled, the rods were connected to the stable proximal anchor with the set screws left loose in order to allow distraction. The bands were then connected to the rods and multilevel tension was applied on the concave side in order to obtain a posteromedial translation of the scoliotic curve (Figure 3) [6]. After tensioning all bands and setscrews were revisited and the residual length of the bands were cut and removed. After decortication, autograft was used in combination with bioglass (Novabone, Novabone products, Alachua, Florida, USA), as previously reported [13].
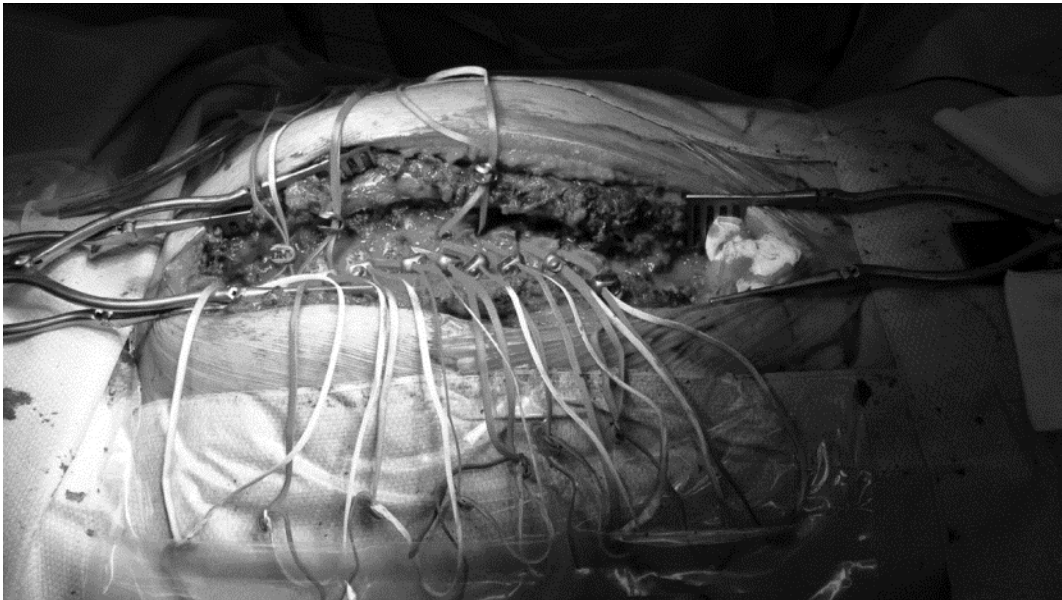

Figure 3: *Intraoperative view of the patient, with the extraspinal part of the bands placed and protected in the lateral plastic bags, before being cut and removed after curve correction and setscrews revisit.*

In addition, a convex thoracoplasty was performed when the patient and/or caregiver expressed concern over the prominence of the rib hump deformity. Wound closure was performed over 2 drains after irrigation (1000mL of sterile saline solution) and muscle debridement if necessary.

Postoperative care and SSI management

Wound dressings were changed on day 2 and 5 postoperative, with drains being removed on day 2. Patients started to stand on the second postoperative day with the physiotherapist, and worked in erect position twice a day during hospitalization stay. Patients were discharged from the hospital and

sent to a rehabilitation center (3 weeks period) between 6 and 7 days after surgery. When SSI was diagnosed, patients were treated according to the same standardized protocol, associating surgical debridement, wound closure without removal or change of the implants, and 15 days of intravenous antibiotherapy administrated through a central catheter placed during the revision procedure, followed by 2.5 months of oral antibiotics adapted to the pathogen. When necessary, serum dosage of antibiotics was performed before discharge. In all cases, the antibiotherapy was discussed and decided during a multidisciplinary meeting with the referent surgeon, a pediatrician and a microbiologist.

Evaluation at follow-up

In order to determine the influence of SSI on fusion and/or instrumentation failure, radiological analysis was performed preoperatively, postoperatively and at latest follow-up (minimum 1-year) using low-dose biplanar stereoradiographs (EOS imaging, Paris, France). In addition, the final functional outcomes were evaluated using SRS 30 and SF 12 questionnaires [14,15].

Statistical analysis

Demographic data, loss of correction and functional outcomes were compared between the SSI and the control groups using unpaired t-tests (Statview, SAS Institute Inc, Cary, NC, USA). A $p < 0.05$ was considered significant.

Results

Patients

Among the 524 patients who underwent AIS corrections using sublaminar bands during the study period, 28 (5.3%) were diagnosed with SSI. The average follow-up was 38 months (± 24). Early infections (within 45 days postoperative) were reported in 26 of the 28 SSI patients (93%), after a mean free interval of 18 days (± 8), while 2 late SSI occurred after 84 days and 674 days, respectively.

Demographic data of the SSI and control groups are reported in Table 1. No significant difference was found, except for the number of levels fused, which was significantly higher in the non-infected group.

	Infected group (N = 28)	**Control** Group (N = 28)	*p*
Age (years)	15.3 ± 2.1	14.8 ± 2.6	*0.219*
Sex ratio	26 girls / 2 boys	25 girls / 3 boys	*0.646*
Weight (Kg)	55.5 ± 8.0	54.1 ± 13.2	*0.64*
Height (cm)	166.3 ± 9	164.2 ± 9	*0.441*
BMI	20.1 ± 3.1	19.9 ± 4.0	*0.799*
Risser stage	3.8 ± 1	3.4 ± 1	*0.48*
Number of thoracoplasty	6	7	*0.755*
Number of levels fused	12.2 ± 1.3	13.7 ± 0.8	*<0.001*
Number of pedicle screws	5.8 ± 1.2	6.0 ± 0.9	*0.692*
Number of sublaminar bands	7.1 ± 1.8	6.9 ± 1.2	*0.492*

Table 1: *Demographic data of the two study groups (mean ± standard deviation).*

Pathogens

Pathogens were identified in all cases, using either direct examination and/or molecular biology (table 2). SSI was monomicrobial in 24 cases (86%) and polymicrobial in 4 cases (14%). Responsible bacteria are reported in Table 2. The most frequent pathogen was methicillin-sensitive Staphylococcus aureus (13 cases, 46%), followed by Propionibacterium acnes (8 cases, 29%), all with community profile. Skin germs (Staphylococcus (epiderdimis and aureus and Propionibacterium acnes) were responsible for the SSI in 86% of cases.

Management

All patients with SSI underwent surgical debridement within 24 hours after diagnosis. Initial wound closure was performed in all cases, over 2 or 3 drains that were removed after 5 days if the liquid culture was negative and no other clinical or biological sign of infection was present. Patients were initially treated by double probabilistic antibiotherapy, but an adapted oral antibiotherapy was possible after 15 days in all cases. More than one surgical debridement (2 to 3) was necessary in

seven cases (25%) to obtain definitive SSI healing, but no early band removal was performed.

Instrumentation removal was decided for the two patients with late infections, because the spine was considered fused at the time of SSI. The rod connectors were first unclipped, then easily taken out from the bands, which were removed from either the cephalic or the caudal part of the lamina. No intraoperative complication such as dural adhesion occurred when the sublaminar bands were pulled out.

	monomicrobial: **24 (86%)**	polymicrobial: **4 (14%)**
early SSI: **26 (93%)**	- **9** methicillin-sensitive Staphylococcus aureus - **6** Propionibacterium acnes - **4** Peptostreptococcus - **2** Gram-negative bacilli - **2** Staphylococcus epiderdimis	- **1** methicillin-sensitive Staphylococcus aureus + Gram-negative bacilli - **1** methicillin-sensitive Staphylococcus aureus + Peptostreptococcus - **1** Staphylococcus epiderdimis + Propionibacterium acnes
late SSI: **2 (7%)**	- **1** methicillin-sensitive Staphylococcus aureus	- **1** methicillin-sensitive Staphylococcus aureus + Propionibacterium acnes

Table 2: *Responsible pathogens for the SSI.*

Radiological and functional outcomes after SSI

The radiological analysis did not find any difference at follow-up between the infected and the control groups (Table 3). In particular, the SSI did not seem to impact fusion, since no significant difference was found regarding the mean loss of correction in both frontal and sagittal planes at latest examination (Figures 4 and 5).

However, one should note that the two patients with late infection, in whom implants were removed, respectively lost 8° and 14° on the main instrumented curve.

Similarly, functional outcomes were not affected by the occurrence of SSI (Table 4). SSI influenced neither postoperative pain, mental health nor the appearance of the scar, partly traduced by the self-image score. Satisfaction after surgery remained high, despite the infection and revision procedure, with 89% of patients claiming that they would do again the same treatment.

	Infected group (N=28)	**Control** group (N=28)	*p*
SRS 30 total score (/150)	**121.8 ± 7**	**123.5 ± 7**	***0.386***
function/activity (/35) (post surgery (/10))	27.0 ±3 (5.7 ± 2)	27.7 ± 2 (6.2 ± 2)	*0.372* *0.487*
pain (/30) (post surgery (/5))	26.1 ± 2 (4.2 ± 1)	26.9 ± 3 (4.5 ± 1)	*0.381* *0.423*
self image (/45) (post surgery (/15))	35.6 ± 3 (11.5 ± 2)	35.6 ± 3 (11.8 ± 2)	*0.926* *0.603*
mental health (/25)	20.4 ± 2	19.8 ± 2	*0.352*
satisfaction with management (/15) (post surgery (/5))	12.9 ± 2 (4.2 ± 1)	13.6 ± 1 (4.3 ± 1)	*0.071* *0.516*
positive answers (%) to the question: "would you do it again?"	89%	90%	*0.709*
SRS 30 post surgery score (/35)	25.6 ± 4	26.8 ± 5	*0.308*
SF 12 (physical score)	**47.5 ± 6**	**49.5 ± 5**	***0.206***
SF 12 (mental score)	**50.5 ± 6**	**50.7 ± 4**	***0.919***

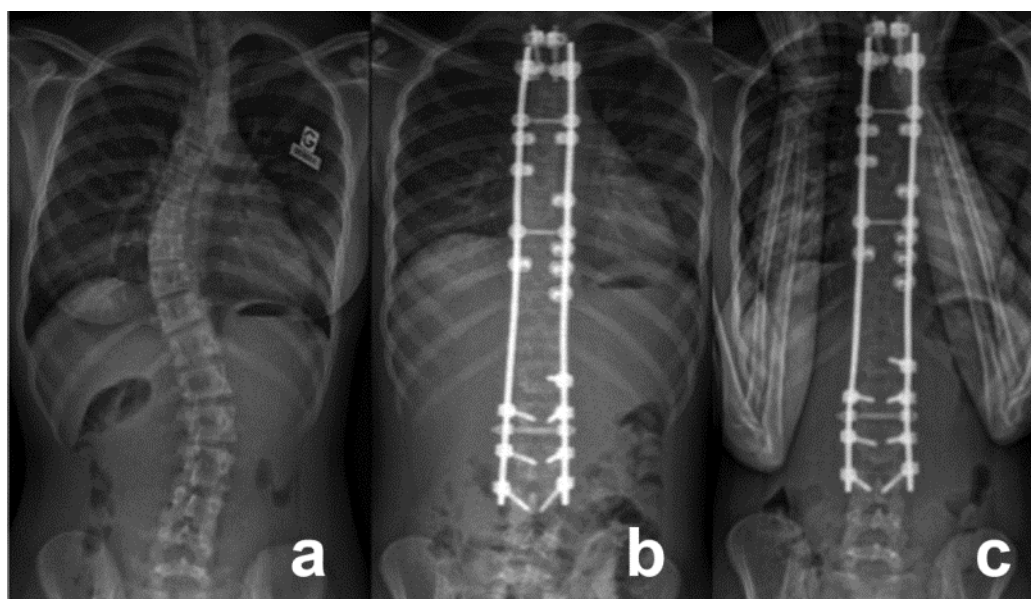**Table 3**: *Functional outcomes (SRS 30 and SF 12 scores) at follow-up.*

Figure 4: *Preoperative (a), immediate postoperative (b) and 2-year follow-up (c) frontal microdose radiographs of a 14 year-old girl AIS, who developed and early SSI (2 weeks postoperative) due to Staphylococcus aureus after posterior T2L3 fusion.*

Figure 5: *Preoperative (a), immediate postoperative (b) and 2-year follow-up (c) lateral microdose radiographs of a 14 year-old girl AIS, who developed and early SSI (2 weeks postoperative) due to Staphylococcus aureus after posterior T2L3 fusion.*

Conclusion

Results of the current study demonstrate that the use of sublaminar bands in AIS did not increase SSI rate. As a matter of fact, the 5.3% incidence found in this cohort is in accordance with literature, even though it stands in the upper range [1,2,3,4,16,17]. However, results are consistent with a previous study, performed by the same department, in which hooks were used in similar hybrid constructs [7]. Sublaminar bands can therefore safely replace pedicle screws or hooks at thoracic levels, in order to optimize sagittal correction, while reducing operative time, blood loss and radiation exposure [18,19,20]. Nevertheless, the use of lateral plastic bags is recommended, since sublaminar bands measure approximately 40cm long before being tensioned.

Results also show that a concern raised by some surgeons about a higher risk of implant colonization in case of SSI, due to the band structure, was not justified, and the management of SSI remained unchanged. As shown in vascular surgery literature about Dacron patches (similar constitution), the use of polyester did not increase SSI rate, and all infections healed after debridement and appropriate antibiotherapy, without necessitating band withdrawal [21,22]. On the other hand, in cases of late infections occurring after spinal fusion in which instrumentation removal was decided to

ease pathogen eradication, no adherence with the dura and no intraoperative complication was observed when bands were pulled out, unlike what had been reported with Luque wires [23]. The fact that 25% of the infected patients underwent multiple debridements (average 1.3 / patient) can seem high, but it is comparable to recent published studies, in which the mean number of debridement ranged from 1.6 to 2, in large series of pediatric deformities with multiple etiologies [24,25].

In conclusion, posteromedial translation with sublaminar bands does not increase SSI rate in AIS. The choice of implant material does not influence early morbidity and bands can be removed safely, even in case of delayed infection. Results of this series also show that the occurrence of SSI does not alter radiological or functional outcomes.

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