Surgical Site Infection After Posterior Spinal Fusion for Paediatric Spinal Deformities: A Single-Centre Retrospective Observational Study

Dimitrios Christakos, Ioannis Benetos, Elias Vasiliadis, Panagiotis Karampinas, Angelos Kaspiris, Patra Koletsi, Ioanna Paspati, Spyridon Pneumaticos

3rd Department of Orthopaedic Surgery and Traumatology, KAT hospital, NKUA
Pediatric Intensive Care Unit, Penteli Children's Hospital
Department of Orthopaedics, Penteli Children's Hospital

INTRODUCTION

Surgical Site Infections (SSIs) are among the most common complications of Posterior Spinal Fusion (PSF) in children and adolescents. The rate of SSIs after PSF varies from 0.9% to 3% for idiopathic scoliosis and can be as high as 8.7% for neuromuscular scoliosis due to cerebral palsy. Major factors associated with SSIs include patient's underlying pathology and comorbidities, the complexity of the procedure, and many extrinsic factors such as the expertise of the surgeon, perioperative antibiotic prophylaxis, length of hospitalisation, and perhaps environmental factors in the operating theatre and the hospital infections rates of the centre at which the procedure is being performed. We sought to identify the overall rate of SSI and possible modifiable risk factors for SSI in children and adolescents treated with PSF in Penteli Children's Hospital.

METHODS

A total of 46 consecutive patients accounting for 67 surgeries performed between 2019 and 2024 were included in this retrospective observational study. Inclusion criteria were as follows: patient's age at the time of surgery less than 22 years, patients treated with PSF only, and more than 9 months postoperative observation. SSI was defined as infection occurring within 90 days of the index procedure.

RESULTS

The rate of deep SSI in our department was 6.0%. Older age at the time of surgery and a history of previous spine surgery were risk factors for developing an SSI.

DISCUSSION

- *Main Findings*

In our institution the overall rate of deep SSI was 6.0%. Taking into consideration the fact that our study included many high-risk patients, this rate is among the expected rates. History of prior surgery (p =0.031) and higher age at time of surgery (p =0.008) were identified as risk factors for developing an SSI. There was no difference between the mean age at time of surgery in patients who had a history of previous spine surgery and those who did not (13.4 ± 4.1, 95% C.I: 11.8–14.9 vs. 13.2 ± 3.3, 95% C.I: 12.1–14.3) (p = 0.853).

- *Comparison with the Prior Literature*

A study of Rudik TN. et al. in 9801 patients who underwent primary fusion for AIS, reported that obesity and male sex were significantly associated with postoperative infection. The 90-day incidence of SSI in that study was 2.7%. Another recent study in 4145 patients who underwent PSF for NMS and/or cerebral palsy between 2015 and 2020, with data from the American College of Surgeons National Surgical Quality Improvement Program (NSQIP), reported a 2.5% prevalence of deep SSI. Other recent studies reported SSI rates between 4.2% and 6.3%, which are close to the rates observed in our own study. Neuromuscular scoliosis, previous spinal surgery, sacral vertebrae fusion, use of allograft, no use of drain, blood transfusion, obesity, amount of intraoperative crystalloids, ventriculoperitoneal shunt, non-ambulatory status, pelvic instrumentation, procedure time ≥ 7 h, American Society of Anesthesiologists grade > 2, revision procedure, hospital spine surgical cases < 100/year, and abnormal haemoglobin levels were recognised as risk factors.

- *Management of SSI's*

In three (75%) of the cases with SSI in our institution, one microorganism was isolated while in the fourth, two microorganisms were isolated. The microorganisms were *P. aeruginosa* in 2/4 (50%) of cases, *S. aureus* in 1/4 (25%), *E. coli* ESBL in 1/4 (25%), and *Enterobacter* in 1/4 (25%). For every case all the efforts were directed towards retaining the implants, in accordance with the evidence published in the literature. Of our cases, two (50%) maintained the implants while the other two eventually needed partial or total implant removal.

- *Possible Mechanisms*

It must be noted that many of the microorganisms associated with SSIs tend to form a microbial biofilm. In fact, according to some reports, as many as 80% of SSIs may be related to the formation of a microbial biofilm. All four cases of deep SSI appeared in patients who underwent PSF after mid-2021 and were hospitalised in shared rooms. Despite the fact that this observation was not statistically significant, it is something that has to be taken into consideration. Further studies of the postoperative conditions and nursing care of patients who underwent PSF with larger samples are needed. No case of superficial SSI was observed in this study. This observation may be due to the fact that, in our department, patients with a superficial SSI are treated on an outpatient basis. Another factor that may contribute to this observation is the fact that superficial SSI causes mild symptoms and produces faint signs of infection, so it can be easily misdiagnosed.

- *Limitations*

Limitations of this study include the retrospective design, the single-centre scope, the small number of patients included, and the lack of adjustment for confounders, which limits the statistical power. Another limitation is the great variety of spinal deformity between the patients included in the study. All these limitations make it difficult to draw statistically significant conclusions that could be applied to the entire population.

CONCLUSIONS

Despite significant efforts, SSI remains a major complication after PSF for spinal deformities in children and adolescents. Between 2019 and 2024 four cases of deep SSI occurred in our institution, leading to a rate of 6.0% among all PSF for this specific time period. Higher age and a history of previous spine surgery were risk factors for SSI in this cohort of patients. All cases of deep SSI occurred in the time period after mid-2021, when a redistribution of patient wards took place resulting in patients being hospitalised in shared rooms instead of single-bed rooms. While this finding may be attributable to chance, it is an observation that needs further investigation.

.

Table 1: Patient Characteristics

Variable	Total Procedures (n = 67)
Age at procedure, mean (range), years	13.3 (5.0–22.0)
Female sex, n (%)	43 (64.2%)
Male sex, n (%)	24 (35.8%)
Diagnosis, n (%)	
Idiopathic spinal deformity	12 (17.9%)
Neuromuscular	34 (50.7%)
Syndromic	18 (26.9%)
Congenital	3 (4.5%)

Table 2: SSI vs no SSI risk factors

Variable	No SSI (n = 63)	SSI (n = 4)	p-Value
Age (mean)	13.0	17.9	**0.008**
Sex:			
Female	41	2	0.542
Male	22	2	
BMI (mean)	18.4	17.2	0.540
Length of surgery (mean, min)	370	310	0.375
Previous spine surgery	25	4	**0.031**
Intraoperative blood loss (mean, mL)	1040	782.5	0.567
Sacrum instrumentation	27	1	0.635
Type of deformity:			
Idiopathic	12	0	
Neuromuscular	31	3	0.694
Syndromic	17	1	
Congenital	3	0	
Admission in the ICU	52	4	0.361

Table 3: Patients with SSI

Patient	Organism	Days of Antibiotic Treatment	Operative Irrigation and Debridement	Retention of Implants
Patient 1	*P. aeruginosa*	22	1	Yes
Patient 2	*S. aureus*	20	1	Partial
Patient 3	*P. aeruginosa* *Enterobacter spp.*	45	0	No
Patient 4	*E. coli ESBL*	120	2	Yes

References

- Roberts, S.B.; Tsirikos, A.I. Paediatric spinal deformity surgery: Complications and their management. *Healthcare* 2022, *10*, 2519.
- Reames, D.L.; Smith, J.S.; Fu, K.M.G.; Polly, D.W., Jr.; Ames, C.P.; Berven, S.H.; Perra, J.H.; Glassman, S.D.; McCarthy, R.E.; Knapp, R.D.; et al. Complications in the surgical treatment of 19,360 cases of pediatric scoliosis: A review of the Scoliosis Research Society Morbidity and Mortality Database. *Spine* 2011, *36*, 1484–1491.
- Rudic, T.N.; Althoff, A.D.; Kamalapathy, P.; Bachmann, K.R. Surgical site infection after primary spinal fusion surgery for adolescent idiopathic scoliosis: An analysis of risk factors from a nationwide insurance database. *Spine* 2023, *48*, E101–E106.
- Badin, D.; Leland, C.R.; Matsumoto, H.; Roye, B.; Vitale, M.; Flynn, J.; Samdani, A.; Larson, A.N.; Yaszay, B.; Pahys, J.; et al. Best practice guidelines for surgical site infection in high-risk pediatric spine surgery: Definition, prevention, diagnosis, and treatment. *J. Pediatr. Orthop.* 2022, *42*, e1008–e1017.
- Master, D.L.; Connie, P.-K.; Jochen, S.-H.; Armstrong, D.G.; Thompson, G.H. Wound infections after surgery for neuromuscular scoliosis. *Spine* 2011, *36*, E179–E185.
- Sefcik, R.; Kreft, M.; Lundqvist, K.; Steiner, R.; Ritzman, T.; Floccari, L. Surgical site infection risk in neuromuscular scoliosis patients undergoing posterior spinal fusion. *Spine Deform.* 2025, *13*, 869–876.
- Bachy, M.; Bouyer, B.; Vialle, R. Infections after spinal correction and fusion for spinal deformities in childhood and adolescence. *Int. Orthop.* 2011, *36*, 465–473.
- Römling, U.; Balsalobre, C. Biofilm infections, their resilience to therapy and innovative treatment strategies. *J. Intern. Med.* 2012, *272*, 541–561.