Prevalence and risk factors for postoperative infection in pediatric orthopedic surgery: a study of 458 children


* Service d’Orthopédie Pédiatrique, Hôpital d’Enfants de Tunis, 1007 Tunis, Tunisie.
** Service d’Epidémiologie, CHU Farhat Hached de Sousse, 4000 Sousse, Tunisie.

ABSTRACT

Purpose of the study
The incidence of postoperative infection in pediatric surgery has been studied little in the literature. It would be lower than in adults. In the present work, we attempted to define the incidence of postoperative infection in orthopedic pediatric surgery and identify risk factors.

Material and methods
This was a retrospective analysis of 458 children who underwent surgery between 1998 and 1999 for the following conditions: talipes equinus, congenital hip dislocation, supracondylar fracture of the elbow, and femur shaft fracture. We noted the prevalence of infection of the surgical site, the type of infection and its course as well as the principal risk factors incriminated: age, condition, surgical modalities (emergency setting, hour, bleeding) and use of antibiotic prophylaxis.

Results
Mean age at surgery was 5.4 ± 3.5 years. The sex ratio was 1.6 boys/1 girl. Forty-two patients developed an infection of the surgical site, giving an incidence of 9.2% of the patients and 8.3% of the surgical sites. Postoperative infection was more frequent in the talipes equinus group (19.4% versus 5.8% for supracondylar fractures of the elbow, 2% for femur shaft fractures, and 0% for congenital hip displacement). In 78.6% of the cases, the infection was superficial. The analysis of risk factors showed that talipes equinus is an independent risk factor. The absence of antibiotic prophylaxis increased the risk of infection of the surgical site significantly only in the talipes equinus group (40.7% versus 14%).

Discussion
The incidence of infection of the surgical site in pediatric orthopedic surgery was high in our series, 8.3% versus 0.4% and 5.6% reported in the literature. Talipes equinus surgery exposes the child to a significant risk of infection. The principal risk factors related to surgery would be: ischemia, inflammation of cutaneous and subcutaneous tissue due to detachment, the tourniquet, and the absence of antibiotic prophylaxis.

Key words: Postoperative infection, pediatric surgery, orthopedic surgery, child, prophylactic antibiotics.

Reprints: O. KAABACHI, Service d’Orthopédie Pédiatrique, Hôpital d’Enfants de Tunis, 1007 Tunis, Tunisie.
INTRODUCTION

Aseptic procedures and antibiotic prophylaxis contribute significantly to reducing the incidence of wound infections, particularly in orthopedic surgery. Few studies have been devoted to measuring the amplitude of the problem in pediatric surgery [Bhattacharyya and Kosloske [1], Davenport and Doig [2], Horwitz et al. [3], Sharma and Sharma [4]], particularly in orthopedic units [Clavert et al. [5]]. Differences in individual situations, the nature of the underlying disease, and surgical techniques could be implicated in differences in the frequency of postoperative infections in pediatric surgery. In this retrospective analysis, we wanted to measure the incidence of wound infection in pediatric surgery patients and to identify the principal risk factors. This study was designed to obtain a first figure for the incidence of pediatric surgery wound infection for future epidemiological monitoring and adjustments of our antibiotic prophylaxis protocol.

MATERIAL AND METHODS

This retrospective study was conducted in the pediatric orthopedic surgery unit of the Tunis Children’s Hospital over a two-year period (1997-1998. We examined four disease states frequent in pediatric orthopedic surgery: talipes equinovarus, congenital hip dislocation, closed supracondylar fracture of the elbow, and closed fracture of the femur. The four procedures were Altemeier class I [Altemeier et al. [6]].

The following data were recorded for each procedure:
- age, gender, history, prior drug treatment including antibiotics, preoperative hospitalization more than 48 hours, recent infection;
- postoperative infection: type, time to onset, causal germs, treatment and outcome;
- risk factors: surgical (emergency procedure, hour and duration of procedure, intraoperative bleeding, type of disease, operative procedure, material and technique) and medical (antibiotic prophylaxis with type of drug, doses and duration).

Surgical management was performed in the setting of a short hospitalization. Patients were hospitalized the day before or the morning of surgery for scheduled procedures. Patients with a supracondylar fracture of the elbow underwent surgery 6 to 12 hours after injury. Fracture of the femur was considered a relative emergency and all patients underwent surgery within 24 to 48 hours. Postoperative hospital stay was often short, on average 2 to 4 days if there were no complications.

All procedures were conducted in an operative room reserved for non-septic orthopedic surgery.

The preoperative protocol was washing the operative site with an antiseptic solution (Asepsil), followed by a first disinfection with a 10% iodine-polyvidone solution then a second disinfection by the surgeon just before positioning the operative drapes. The disinfected limb was held in a sterile jersey just before incision.

A pelvic-pedious cast was fashioned postoperatively for congenital hip patients and a brachial-antebrachial cast for elbow fracture patients. Talipes patients were maintained with an orthosis one week before the first wound dressing than in a first plaster case on day 7 followed by a second at week 6. Casts were not used for fractures of the femur.

Surgical drains were removed within 48 hours.

The antibiotic protocol was based on oxacillin using an induction dose of 50 mg/kg, followed by two injections of 25 mg/kg during the first 24 hours (100 mg/kg/24 hours) as well as an intraoperative injection if the procedure lasted more than four hours.

Antibiotic prophylaxis was considered inappropriate when: absent, administered after installation of the tourniquet, different from the standard compound, incorrectly adapted to body weight, lack of reinjection during a long procedure and duration longer than 24 hours.

Infection of the operative or surgical site was defined according to the CDC criteria [Horan et al. [7]]: any infection not present or in an incubation phase at admission and occurring within the first 30 postoperative days for procedures without osteosynthesis or within the first postoperative year if oseosynthesis was performed. Three classes were defined:
- class I: superficial infection of the surgical site, limited to the skin and subcutaneous tissues,
- class II: deep infection of the surgical site, involving deep tissues (fascia and muscles),
- class III: infection of the surgical site involving an organ or a space (osteitis or arthritis).

We determined the frequency of postoperative infection defined as the number of infected patients divided by the number of operated patients, and the frequency of wound infection, defined as the number of sites infected divided by the number of operated sites.

Quantitative variables were expressed as mean ± SD and analyzed with ANOVA and Student’s t test. Qualitative variables were expressed in percentage and compared with the chi-square test and Fisher’s test as appropriate. Risk factor were determined from the relative risk and odds ratio with 95% interval of confidence. Epi Info 6 was used for the statistical analysis. Significance was set at p < 0.05.

RESULTS

We analyzed the files of 458 patients. Mean age was 5.4 ± 3.5 years. Twenty-four patients were aged less than two years, 38.2% between two and six years, and 37.8% more than six years. The sex-ratio was 1.6 boys/girls. Only 35 children (7.6%) had a medical history. For 10% of the files, there was no information concerning prior use of antibiotics or recent infection. The surgical sites (n = 503) are detailed in table I. Surgical techniques are summarized in
Antibiotic prophylaxis was instituted in 64.5% of patients but was not in conformity with the protocol in 60% of patients (n = 273) (Table III). Forty-two children developed an infection of the operative site, giving a rate of post-operative infection of 9.2% and a rate of wound infection of 8.3% (Table IV). Infection was superficial in 78.6% of the sites (Table V). In the seven patients with talipes equinovarus, the infection was a deep skin infection with cutaneous necrosis (class II). Two patients developed osteitis after treatment of a supracondylar fracture of the elbow. Mean time to onset of infection was 26 ± 16 days. Bacteriological samples were only obtained in class II and III infection (n = 9 patients) and revealed one case of Staphylococcus epidermidis infection (talipes patient) and two cases of Pseudomonas aeruginosa infection (both talipes patients). General antibiotic therapy was instituted in 33 patients. Outcome was favorable with local care in the majority of patients (78.5%). Implanted material had to be removed in nine patients. Surgical debridement with installation of an external fixator was required for two patients who had undergone surgical correction of talipes equinovarus. Later outcome was favorable in 93% of the cases and functional sequelae were observed in three patients: swollen foot (n = 1), repeated elbow fracture with healing in flexion (n = 1), lysis of the lateral condyle at two years (n = 1). Infections of the surgical site were significantly more frequent in the talipes group (19.4% of sites) (Table V). Age less than two years and prolonged surgery lasting more than two hours were found to be significant risk factors, respective odds ratios 5.33 [2.76-10] and 3.92 [1.87-8.23] (Table VI). Emergency procedures (fracture) (OR = 0.35),

Table II. Antibiotic prophylaxis was instituted in 64.5% of patients but was not in conformity with the protocol in 60% of patients (n = 273) (table III). Forty-two children developed an infection of the operative site, giving a rate of post-operative infection of 9.2% and a rate of wound infection of 8.3% (table IV). Infection was superficial in 78.6% of the sites (table V). In the seven patients with talipes equinovarus, the infection was a deep skin infection with cutaneous necrosis (class II). Two patients developed osteitis after treatment of a supracondylar fracture of the elbow. Mean time to onset of infection was 26 ± 16 days. Bacteriological samples were only obtained in class II and III infection (n = 9 patients) and revealed one case of Staphylococcus epidermidis infection (talipes patient) and two cases of Pseudomonas aeruginosa infection (both talipes patients). General antibiotic therapy was instituted in 33 patients. Outcome was favorable with local care in the majority of patients (78.5%). Implanted material had to be removed in nine patients. Surgical debridement with installation of an external fixator was required for two patients who had undergone surgical correction of talipes equinovarus. Later outcome was favorable in 93% of the cases and functional sequelae were observed in three patients: swollen foot (n = 1), repeated elbow fracture with healing in flexion (n = 1), lysis of the lateral condyle at two years (n = 1). Infections of the surgical site were significantly more frequent in the talipes group (19.4% of sites) (Table V). Age less than two years and prolonged surgery lasting more than two hours were found to be significant risk factors, respective odds ratios 5.33 [2.76-10] and 3.92 [1.87-8.23] (Table VI). Emergency procedures (fracture) (OR = 0.35),
absence of antibiotic prophylaxis (OR = 0.89) did not increase the risk of infection (table VI). Stratification by disease category demonstrated that talipes surgery was an independent risk factor: OR = 5.31 [2.75, 10.27] (table VII). The talipes patients accounted for 75% of the children aged less than two years and 68.5% of the procedures lasting more than two hours and 68% of the scheduled operations, three factors which considered together were found to constitute a risk factor in the different disease groups. The only factor which increased the risk of wound infection in the talipes surgery group was absence of antibiotic prophylaxis: 40% without prophylaxis versus 14.7% with prophylaxis OR = 4.22 [1.64-10.82].

**DISCUSSION**

There are very few data in the literature concerning the prevalence of postoperative infection in pediatric surgery patients. Most of the publications have evaluated the risk of parietal infection without detailing the Altmeier classification and the modalities of the antibiotic prophylaxis [Bhattacharyya and Kosloske [1], Davenport and Doig [2], Horwitz et al. [3], Sharma and Sharma [4]]. The risk of infection in pediatric orthopedic surgery appears to be to the order of 1%. In infantile traumatology, it is probably greater than 1%, but lower than 5% [Clavert et al. [5]]. It is estimated that the incidence of infection is between 0.5% and 3% for osteotomy of the femur, the pelvis or the leg. The frequency is higher for idiopathic scoliosis surgery (1-5%), and even higher for neuromuscular scoliosis (4-14%) [Clavert et al. [5]]. In a randomized study comparing the efficacy of oxacillin versus placebo in 420 patients undergoing surgery of the spine or hip or limb osteosynthesis, the frequency of postoperative infection was comparable to that reported in adults (5.6% in the placebo group versus 0.4% in the oxacillin group) [Bernière et al. [8]]. In our series of 458 children with 503 operative sites, the rate of wound infection was 8.3%, much higher than reported in other series of pediatric orthopedic surgery patients. In our series, talipes equinovarus surgery was found to be an important risk factor for infection, observed in 19.4%. Excluding this group the frequency ranged from 0% to 5.8% (369 sites, 358 patients), which is in the range reported in other pediatric series. Talipes surgery is generally not distinguished in the literature as a risk factor, but is associated with several risk factors cited in the literature: young age, duration of surgery, absence of antibiotic prophylaxis. The risk is considerably increased in neonates: 13.7% versus 2.9% in a series of 1325 children aged over five years [Sharma and Sharma [4]]; 20.7% for contamination surgery and 11.1% for non-contaminated surgery in 1094 neonates [Davenport and Doig [2]]. Environmental factors exposing children to a risk of bacterial colonization increase the risk of wound infection. The frequency of wound infection increases from 1% in patients hospitalized one day before surgery to 4% among those hospitalized for 14 days before surgery [Clavert et al. [5]]. Postoperative infections are more frequent in cerebral palsy children who carry a different bacterial flora because of repeated hospitalizations and surgical interventions and who also probably have an altered immunological defense [Kaps et al. [9]]. For scoliosis surgery patients, the disease itself is considered to be a risk factor for postopera-

---

**TABLE VI. – Risk factors for wound infection.**

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Rate (%)</th>
<th>OR</th>
<th>95%IC</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age ≤ 2 yr</td>
<td>21.7</td>
<td>5.33</td>
<td>2.76-10.29</td>
<td>0.0001</td>
</tr>
<tr>
<td>Female gender</td>
<td>6.25</td>
<td>1.85</td>
<td>0.91-3.79</td>
<td>NS</td>
</tr>
<tr>
<td>Male gender</td>
<td>10.2</td>
<td>0.57</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>ASA class II</td>
<td>12.0</td>
<td>1.38</td>
<td>0.39-4.81</td>
<td>NS</td>
</tr>
<tr>
<td>Emergency surgery</td>
<td>5.1</td>
<td>0.35</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Operative time ≥ 2 hr</td>
<td>22.0</td>
<td>3.92</td>
<td>1.87-8.23</td>
<td>0.001</td>
</tr>
<tr>
<td>Antibiotic prophylaxis</td>
<td>8.3</td>
<td>0.9</td>
<td>0.46-1.75</td>
<td>NS</td>
</tr>
</tbody>
</table>

ASA: American Society of Anesthesiologists.

**TABLE VII. – Risk of wound infection by disease group.**

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Rate (%)</th>
<th>OR</th>
<th>95%IC</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talipes equinovarus</td>
<td>19.4</td>
<td>5.31</td>
<td>2.75-10.27</td>
<td>0.0001</td>
</tr>
<tr>
<td>Supracondylar fracture of the elbow</td>
<td>5.8</td>
<td>0.49</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Femoral shaft fracture</td>
<td>2.0</td>
<td>0.21</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Congenital hip dislocation</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No antibiotic prophylaxis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ talipes equinovarus</td>
<td>40.7</td>
<td>4.22</td>
<td>1.64-10.82</td>
<td>0.001</td>
</tr>
<tr>
<td>+ supracondylar fracture of the elbow</td>
<td>2.4</td>
<td>0.25</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>+ femoral shaft fracture</td>
<td>8.3</td>
<td>0.32</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>
tive infection which increases from a range of 1-5% for idiopathic scoliosis to 4-14% for neuromuscular scoliosis [Clavert et al. [5]]. In our study, the choice of four types of osteosynthesis surgery was legitimate because of the higher risk of infection related to the presence of a foreign body. But surgery with osteosynthesis is not recognized as an independent risk factor as it is in adults [Petty et al. [10]]. Nevertheless, the relationship between the duration of the operation and the frequency of postoperative wound infections has been demonstrated in children [Bhattacharyya and Kosloske [1], Davenport and Doig [2], Horwitz et al. [3]]. In a study of 376 patients undergoing scoliosis surgery, operative time greater than five hours increased the risk of infection [Simchen et al. [11]]. The time retained for increased risk in adults is three hours [Martin et al. [12]]. Operative time longer than two hours was associated with a higher risk of infection in our series (7.8% versus 17.4%, p < 0.001). Prescription of antibiotic prophylaxis is associated with a significant reduction in wound infection [Fogelberg et al. [13]], [Nahata et al. [14]]. No specific guidelines have been put forward for pediatric surgery and routine practices vary greatly, generally adapted from recommendations set out for adults. Nevertheless, despite well defined guidelines, compliance with standardized protocols is less than perfect in adults [Martin and Pourriat [15]]. In a multicentric study of American pediatric patients, antibiotic prophylaxis was delivered in 81% of spinal procedures, 64% of hip procedures and 45% of knee procedures [Faden [16]]. Cephalosporins were given in 80% of cases, administered before the operation in 90% and continued for five days in 96%. The only randomized trial comparing the efficacy of antibiotic prophylaxis in pediatric surgery (oxacillin 72 hr versus placebo, 420 patients) demonstrated a significant reduction in the rate of infection (5.6% in the placebo group) versus 0.4% in the oxacillin group) [Bernière et al. [8]]. In our series, the antibiotic prophylaxis protocol was not delivered in 60% of the patients, versus administration in 83% of the congenital hip procedures and 80% in the talipes procedures. Considering the overall population, lack of application of the prophylaxis protocol did not increase the risk of infection (8% versus 9%). Conversely, when analyzed by disease group, prescription of antibiotic prophylaxis significantly reduced the risk of infection only in the talipes group (14% versus 40.7% (p < 0.001). For the three other types of surgery, the incidence decreased but not significantly (from 5.3% to 3%, p = 0.03). In our series, talipes surgery was associated with a high risk of wound infection. The talipes population has not been distinguished in the rare pediatric studies reported [Bernière et al. [8], Simchen et al. [11], Nahata et al. [14]]. Several hypotheses could be put forward to explain the high risk of wound infection in this type of surgery. The young age of the population, often more vulnerable neonates (75% of our population was aged less than two years and 98% less than five years). The long operative time. The complexity of the malformation which involves joints, soft tissue and vasclornervous elements.

Surgical cure required extensive damage to the soft tissues to achieve proper detachment, often leading to local inflammation which could become the bed of infection. Transient soft tissue ischemia (tourniquet) and possible prolonged intra- and postoperative ischemia due to vascular anomalies might also favor localized postoperative infection, a factor increasing the risk of wound infection.

In our series, the high frequency of wound infection in pediatric orthopedic surgery patients was associated with an abnormally high frequency of wound infections in the talipes surgery group. Talipes surgery could be considered as a risk factor requiring more rigorous application of antibiotic prophylaxis and postoperative surveillance.

References


