Journal of Pediatric Surgery 53 (2018) 1226–1229

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

Multivariate analysis of risk factors for Nuss bar infections: A single center study

Robert J. Obermeyer [a,b,*], Nina S. Cohen [b], Sheema Gaffar [b], Robert E. Kelly Jr [a,b], M. Ann Kuhn [a,b], Frazier W. Frantz [a,b], Margaret M. McGuire [a,b], James F. Paulson [a,b,c]

[a] Children's Hospital of the King's Daughters, Norfolk, VA
[b] Eastern Virginia Medical School, Norfolk, VA
[c] Old Dominion University, Norfolk, VA

ARTICLE INFO

Article history:
Received 22 February 2018
Accepted 27 February 2018

Key words:
Pectus excavatum
Infection
Elastomeric pump
Nuss procedure

ABSTRACT

Background/Purpose: Our previously published data suggested several risk factors for infection after the Nuss procedure. We aimed to further elucidate these findings.
Methods: An IRB-approved (14–03-WC-0034), single institution, retrospective review was performed to evaluate the incidence of postoperative Nuss bar infections associated with seven variables. These were subjected to bivariate and multivariable analyses. A broad definition of infection was used including cellulitis, superficial infection with drainage, or deep infection occurring at any time postoperatively.
Results: Over 7 years (4/1/2009–7/31/2016), 25 (3.2%) of 781 patients developed a postoperative infection after primary Nuss repair. Multivariable analyses demonstrated an increased risk of infection with perioperative clindamycin versus cefazolin for all infections (AOR 3.72, $p = .017$), and specifically deep infections (AOR 5.72, $p = .004$). The risk of a superficial infection was increased when antibiotic infusion completed >60 min prior to incision (AOR 10.4, $p = .044$) and with the use of peri-incisional subcutaneous catheters (OR 8.98, $p = .008$).
Conclusion: Following primary Nuss repair, the rate of deep bar infection increased with the use of perioperative clindamycin rather than cefazolin. The rate of superficial infection increased when perioperative antibiotic infusion was completed more than 60 min prior to incision and with the use of peri-incisional subcutaneous catheters. Further studies are needed to better understand these findings.
Type of study: Retrospective chart review.
Level of evidence: Level III treatment study.

1. Background

Pectus excavatum is most commonly repaired by the minimally invasive repair initially described by Nuss et al. [1–4]. Following a presumed increase in postoperative infections after the Nuss procedure, our previously published study reviewed Nuss bar infections over 25 years at our institution to identify potential risk factors for developing an infection. This univariate analysis suggested perioperative clindamycin rather than cefazolin and the use of peri-incisional subcutaneous catheters increased the incidence of postoperative Nuss bar infections [5]. In the current study, we expanded our analysis to include other previously inaccessible variables to perform multivariable and bivariate analyses focused on superficial and deep infections.

2. Methods

An IRB-approved (14-03-WC-0034), single institution, retrospective chart review of 781 patients over 7 years (4/1/2009–7/31/2016) was conducted to evaluate the incidence of postoperative Nuss bar infections associated with perioperative antibiotic choice (cefazolin versus clindamycin), antibiotic infusion completed greater than 60 min prior to incision, duration of postoperative antibiotics less than 48 h, operative time greater than 120 min, use of chlorhexadine skin wipes preoperatively, use of betadine versus chlorhexadine surgical skin preparation, and use of peri-incisional subcutaneous catheters to administer local anesthetic via elastomeric pumps. Patients who completed antibiotic infusion >60 min before incision were compared to the group who received antibiotics on time and late. Revision Nuss repairs were excluded.

We defined an infection in both studies to include any case treated with antibiotics for cellulitis, superficial infection with active drainage, or deep infection involving hardware, regardless of the time of presentation. This definition is purposefully broader to capture more cases

* Corresponding author at: Children's Hospital of the King's Daughters, 601 Children's Lane, Norfolk, VA 23507. Tel.: +1 757 668 7703; fax: +1 757 668 8860.
E-mail address: Robert.Obermeyer@chkd.org (R.J. Obermeyer).

https://doi.org/10.1016/j.jpedsurg.2018.02.090
0022-3468/

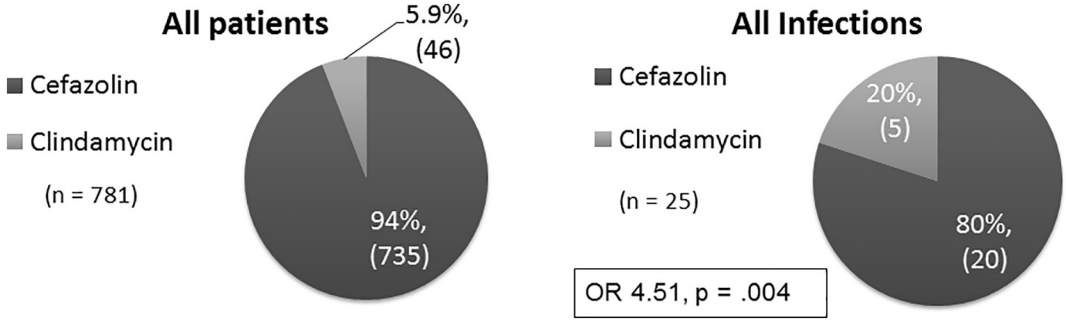

Fig. 1. Percentage of cefazolin and clindamycin use in all patients versus those with an infection.

than would be included using the CDC (Centers for Disease Control and Prevention) and National Healthcare Safety Network (NHSN) definition, which does not include cellulitis or infections 90 days after surgery. Descriptive statistics and frequencies were calculated. Fisher's Exact test and both bivariate and multivariable logistic regressions were performed to determine risk factors for a Nuss bar infection. Owing to sample size and overfitting concerns, bivariate predictors with $p > .10$ were excluded from multivariable adjusted models. All analyses were conducted using SPSS version 19 statistical software.

3. Results

Using our more inclusive definition of postoperative Nuss bar infection, 25 (3.2%) of 781 patients developed a postoperative infection after primary Nuss repair. Clindamycin was used as the perioperative antibiotic in 46 (5.9%) of all patients and in 5 (20%) of the 25 patients who developed an infection (OR 4.51, $p = .004$) (Fig. 1). Antibiotic administration was inappropriately completed more than 60 min before incision in 15 (1.9%) patients overall, and in 2 (8%) patients who developed an infection (OR 5.20, $p = .037$) (Fig. 2). Only 10 (1.3%) patients received their antibiotics late, but none of these developed an infection. Therefore, for statistical analysis these patients are included with the group of patients that received their antibiotics on time. Peri-incisional subcutaneous catheters were used in 210 (26.9%) patients and in 12 (48%) of the 25 patients who developed an infection (OR 2.82, $p = .031$) (Fig. 3). All three of these variables were more common in patients who developed an infection and achieved statistical significance in the univariate analyses. Only perioperative clindamycin rather than cefazolin was associated with a higher risk of infection in the multivariable analysis (AOR 3.72, $p = .017$) (Table 1). To further characterize these findings, bivariate and multivariable analyses were performed on deep and superficial infections separately. The bivariate and multivariable analyses demonstrated an increased risk of deep infection with perioperative clindamycin versus cefazolin (OR 5.72, $p = .004$). In this multivariable model in which the unique variance explained by each variable was tested, clindamycin use explained substantial variation in infection outcomes, with no statistically significant residual variance being explained by other predictors. In the bivariate analysis for superficial infections, the use of peri-incisional subcutaneous catheters for local anesthetic infusion was a significant risk factor (OR 8.46, $p = .009$). The completion of antibiotic infusion >60 min before incision (AOR 10.4, $p = .044$) and the use of peri-incisional subcutaneous catheters (AOR 8.94, $p = .008$) met criteria for inclusion in the multivariable analysis for superficial infections, where they both reached statistical significance (Table 1).

The rate of infection was then compared for the variables determined to be risk factors for a Nuss bar infection in the univariate and multivariable analyses. Patients who received clindamycin (5 of 46 patients) had a higher infection rate than those that were given cefazolin (20 of 735 patients) (10.9% vs 2.7%, $\chi^2(1) = 9.277$, $p = .002$). The rate of infection in patients who inappropriately received their antibiotics more than 60 min before incision (2 of 15 patients) was higher than the rate of infection for those who received their antibiotics on time or late (23 of 766) (13.3% vs 3.0%, $\chi^2(1) = 5.17$, $p = .023$). Patients treated with a peri-incisional subcutaneous catheter (12 of 210 patients) experienced a higher infection rate than those that did not receive a catheter (13 of 571 patients) (5.7% vs 2.3%, $\chi^2(1) = 5.855$, $p = .016$) (Fig. 4).

4. Discussion

Our previous study reported that perioperative clindamycin was associated with a higher infection rate than cefazolin (19% vs 3.0%, $p < .001$) over 25 years when evaluated with univariate analyses. The current study included a multivariable and bivariate analysis and demonstrated that clindamycin was a risk factor for any infection, but particularly deep bar infections. Although this study included a shorter time

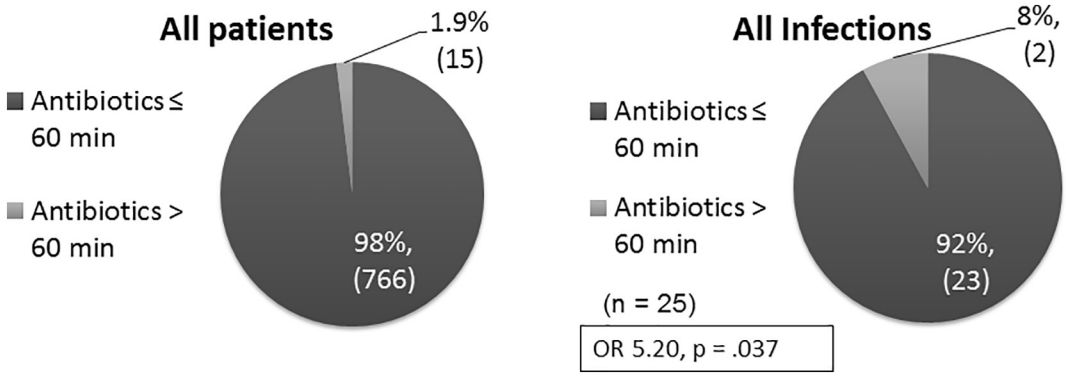

Fig. 2. Percentage of patients completing antibiotic infusion >60 min prior to incision in all patients versus those with an infection.