



Paravertebral regional blocks decrease length of stay following surgery for pectus excavatum in children^{☆,☆☆}



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ABSTRACT

Purpose: Management of postoperative pain following repair of pectus excavatum has traditionally included thoracic epidural analgesia, narcotics, and benzodiazepines. We hypothesized that the use of intercostal or paravertebral regional blocks could result in decreased inpatient length of stay (LOS).

Methods: We conducted a retrospective cohort study of 137 patients (118 Nuss and 19 Ravitch – Nuss and Ravitch patients were analyzed separately) who underwent surgical repair of pectus excavatum with pain management via epidural, intercostal, or paravertebral analgesia from January 2009–December 2012. Measured outcomes included LOS, pain scores, benzodiazepine/narcotic requirements, emesis, professional fees, hospital cost, and total cost.

Results: In the Nuss patients, LOS was significantly reduced in the paravertebral group ($p < 0.005$) and the intercostal group ($p < 0.005$) compared to the epidural group, but was paradoxically countered by a nonsignificant increase in total cost ($p = 0.09$). While benzodiazepine doses/day was not increased in the paravertebral group ($p = 0.08$), an increase was seen in narcotic use ($p < 0.005$). Despite increased narcotic use, no differences were seen in emesis between epidural and paravertebral use. Compared to epidural, pain scores were higher for both intercostal and paravertebral on day one ($p < 0.005$), but equivalent for paravertebral on day three ($p = 0.62$). The Ravitch group was too small for detailed independent statistical analysis but followed the same overall trend seen in the Nuss patients.

Conclusion: Our use of paravertebral continuous infusion pain catheters for pectus excavatum repair was an effective alternative to epidural analgesia resulting in shorter LOS but not a decrease in overall cost.

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Pectus excavatum is one of the most common congenital deformities of the chest wall and is commonly repaired by either cartilage resection with sternal wedge osteotomy (Ravitch procedure) or with minimally invasive implantation of an elevating custom contoured stainless steel bar (Nuss procedure) [1,2]. While the Nuss procedure is noted to be minimally invasive and has seen multiple improvements, it has been associated with increased postoperative pain and longer hospital stays [3,4]. Multiple attempts at managing postoperative pain, including various combinations of epidural and intravenous analgesia have been reported with varying outcomes [5–9]. Despite these multiple attempts postoperative pain management remains variable and poorly characterized, with a reported 91% of institutions continuing to use thoracic epidural as the primary analgesic modality [10] – despite the superiority of epidural analgesia over intravenous analgesia being questioned [11,12].

One metaanalysis of epidural analgesia versus intravenous patient-controlled analgesia (PCA) concluded that better studies are needed [1]. Moreover, there is minimal data comparing epidural analgesia to alternative regional catheter techniques, including bilateral paravertebral or intercostal catheters [13–16]. A single small case series recently showed no statistically significant differences between epidural and paravertebral analgesia when comparing opiate consumption and pain scores [14]. However that study did not assess length of stay or cost, and was limited to 20 patients.

We therefore sought to report our experience using epidural, intercostal, and paravertebral continuous infusion pain catheters for postoperative pain management of pectus excavatum. Because patients can be discharged home with paravertebral or intercostal catheters still in place, we hypothesized that these regional techniques might result in decreased inpatient length of stay (LOS), and by extension decreased costs.

1. Methods

After obtaining institutional review board (IRB #00061391) approval, we performed a retrospective cohort case review to compare hospital

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☆☆ Level of Evidence: III.

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Table 1

Comparison of patients by pain management methods. Length of stay outliers, identified by the modified Thompson tau technique, is listed for each subcategory. These outliers were eliminated from further analysis.

	Epidural	Intercostal	Paravertebral
Nuss 1 Bar	56 (2 outliers)	15 (1 outlier)	19 (4 outliers)
Nuss 2 Bars	11 (1 outlier)	10	7
Ravitch	13 (1 outlier)	4	2
Total Number of Patients	80 (4 outliers)	29 (1 outlier)	28 (4 outliers)

LOS following repair of pectus excavatum between epidural, intercostal, and paravertebral analgesia. Secondary outcomes included: nursing documented pain scores, episodes of emesis, benzodiazepine doses, narcotic doses, and total cost – including professional fees and hospital cost.

1.1. Inclusion criteria

All patients with pectus excavatum who underwent repair by Nuss or Ravitch procedures at Primary Children's Hospital between January 1, 2009 and December 31, 2012 (4 years) were included in this review regardless of age, sex, or ethnicity. No exclusions were made. The number of patients in the Ravitch group proved too small for statistically empowered analysis. The Nuss patients comprise the cohort of statistical focus and unless specified otherwise all data presented herein is from Nuss patients.

1.2. Patient stratification

Preoperatively, the patient and family selected the method of surgical repair (Ravitch vs. Nuss) and the method of postoperative analgesic after a detailed discussion of risks and benefits with their surgeon and anesthesiologist respectively. Patients were substratified by repair method to identify outliers of LOS within their respective groups and analysis of all secondary outcomes was done between epidural, intercostal, and paravertebral analgesia groups with continued substratification by repair method.

1.3. Definitions

Length of stay was defined as the number of postoperative days spent in the hospital after repair of pectus excavatum. The day of repair was defined as day zero. The day of discharge was defined as the last day of hospitalization. Nursing documented pain scores included all verbal self-reported patient pain scores based on a scale from 0–10, where 10 represented the most severe pain imaginable, and 0 represented no pain. Emesis was defined as the number of times per day matter was visibly expelled from the oropharynx. Benzodiazepines included both IV and PO diazepam, lorazepam, midazolam, and clonazepam. Narcotics included both IV and PO hydrocodone, hydromorphone, methadone, morphine, and oxycodone. Total cost was defined as the sum of the professional anesthesiology fee, the professional surgeon's fee, pain service management fees, operating room (OR) cost, postanesthesia care unit (PACU) cost, and children's surgical unit (CSU) cost. Total hospital cost was defined as the sum of OR, PACU, and CSU cost.

1.4. Statistical analysis

Outliers for LOS were identified using four iterations of the modified Thompson tau technique and eliminated from further analysis. Three-

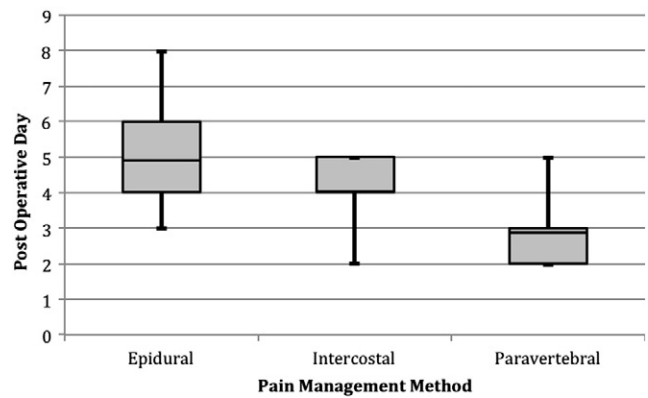


Fig. 1. Box plot comparing length of stay by pain management method for Nuss patients. ANOVA $p < 0.005$.

way analysis of variance (ANOVA) was used to compare epidural, intercostal, and paravertebral analgesia outcomes. Further comparison between groups was done with a two-sided t test of unequal variance. Significance for our conclusions was based on $p \leq 0.05$, however original p values were left in the tables for the readers to draw their own conclusions.

2. Results

From January 1, 2009 to December 31, 2012, 137 patients underwent surgical repair of pectus excavatum: 118 via a Nuss procedure, 19 via a Ravitch procedure. Nine total outliers (8 Nuss and 1 Ravitch) for length of stay were identified and removed from analysis in an attempt to control for the natural confounder of time-practice modification (further details can be found in the discussion section). Comparison of both Nuss and Ravitch patients by analgesia approach is shown in Table 1.

2.1. Length of stay for Nuss and Ravitch patients

For the Nuss patients LOS was significantly reduced in both the paravertebral group ($p < 0.005$, average LOS = 2.9 days), and the intercostal group ($p = 0 < 0.005$, average LOS = 4.0 days), compared to 4.9 days for epidural analgesia (Table 2 and Fig. 1). The number of patients in the Ravitch group was too small to perform a statistically empowered analysis. This small group was primarily for two reasons: first, our practice over time has transitioned to Nuss procedures for all patients except those with severe chest wall asymmetry; second, there is a potentially greater clinician bias in favor of the use of epidural catheters for the Ravitch procedure. Hence, we have only included the patients who underwent Nuss repair in the more detailed analysis.

2.2. Pain and emesis for Nuss patients

Compared to epidural analgesia, pain scores were higher for both intercostal and paravertebral analgesia on day one ($p < 0.005$), but equivalent for paravertebral on day three ($p = 0.62$) (Table 3). There was an increase in emesis/day for the intercostal group ($p = 0.02$) on postoperative day one. However, no differences were seen between the three groups on postoperative days two and three ($p = 0.18$ hospital day two, $p = 0.87$ hospital day three) (Table 3).

Table 2

Comparison of length of stay by pain management method postrepair of pectus excavatum with Nuss procedure. Ranges are listed in parentheses.

	Epidural	Intercostal	Paravertebral	ANOVA	Paravertebral vs. Epidural	Paravertebral vs. Intercostal	Epidural vs. Intercostal
Length of Stay (days)	4.9 (3–8)	4.0 (2–5)	2.9 (2–5)	$p < 0.005$	$p < 0.005$	$p < 0.005$	$p < 0.005$

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