ASPA 2024

Controversies for Regional Anaesthesia in Children:
Paravertebral Catheters or Intercostal Nerve Cryoablation for Nuss Bar Pectus Repair

Prof. M.K. Karmakar, MD, FRCA
The Chinese University of Hong Kong
Hong Kong, China

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CU Medicine HONG KONG

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1

ASPA 2024

Controversies for Regional Anaesthesia in Children:
Paravertebral Catheters or Intercostal Nerve Cryoablation for Nuss Bar Pectus Repair

DISCLOSURE

Nothing to Declare

2

Paravertebral Catheters Or Intercostal Nerve Cryoablation for Nuss Bar Pectus Repair

DISCLOSURE

Nothing to Declare

3

3

Pectus Deformities

4

Pectus Deformities

- Pectus Excavatum and Carinatum – 95% Presenting for Surgery
- Pectus Excavatum (85%) - Funnel Chest / Sunken Chest
- Pectus Carinatum (5%) – Pigeon Chest
- Combination of the Two – Very Rare
- Incidence: 1:400 – 1:1000 Births
- Gender: Male > Female (4-5:1)
- Predominantly Idiopathic / Connective Tissue Disorder

Ghafoor T et al. BJA Edu. 2020; 20(8): 287-293

5

Pectus Excavatum

Posterior Incursion of Sternum & Adjacent Costal Cartilage

Nuss D et al. J Pead Surg. 1998; 33(4): 545-552
Ghafoor T et al. BJA Edu. 2020; 20(8): 287-293

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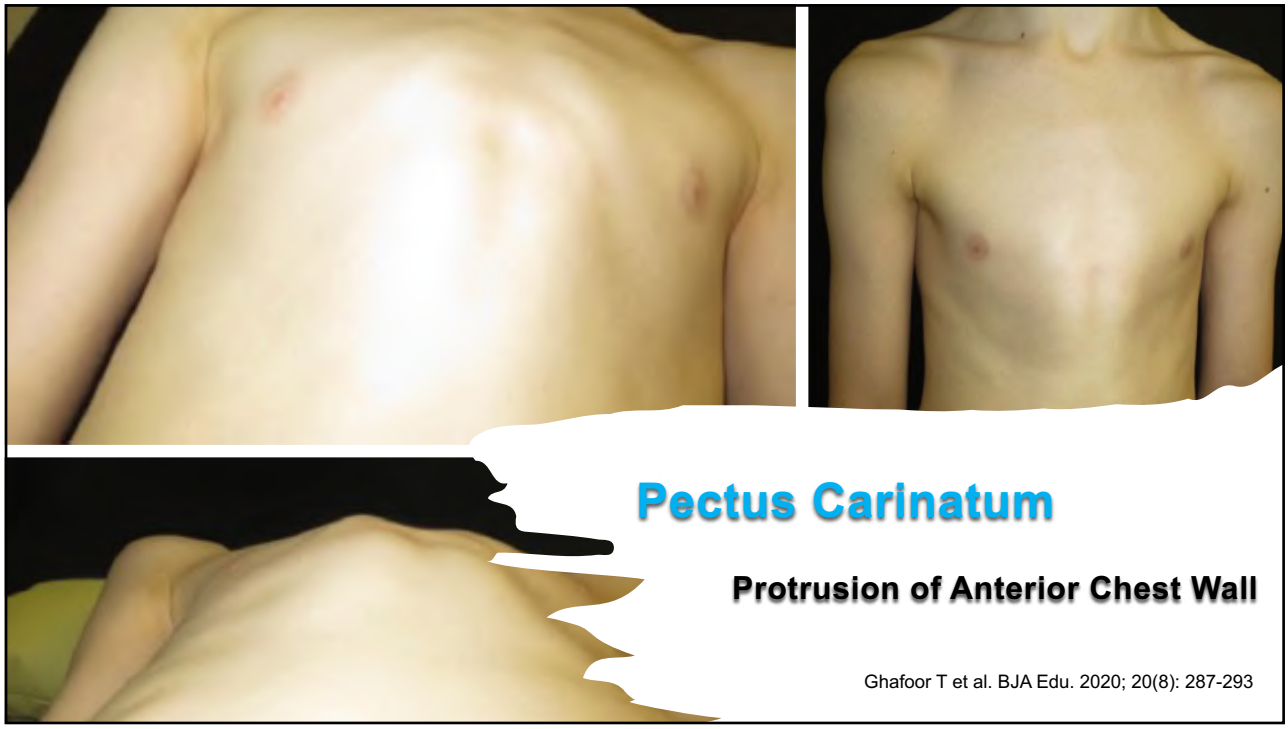


Pectus Carinatum

Protrusion of Anterior Chest Wall

Ghafoor T et al. BJA Edu. 2020; 20(8): 287-293

7

Pectus Deformities

- Presents at the Pre Teen and Teen years
- Worsens with Growth
- Psychological Distress About Body Image
- Pectus Carinatum – Higher Psychological Distress
- Few Clinical Symptoms
- Pectus Excavatum – Cardiac / Lung Compression

Ghafoor T et al. BJA Edu. 2020; 20(8): 287-293

8

A 10-Year Review of a Minimally Invasive Technique for the Correction of Pectus Excavatum

By Donald Nuss, Robert E. Kelly, Jr, Daniel P. Croitoru, and Michael E. Katz
Norfolk, Virginia

Nuss D et al. J Pead Surg. 1998; 33(4): 545-552

Purpose: The aim of this study was to assess the results of a 10-year experience with a minimally invasive operation that requires neither cartilage incision nor resection for correction of pectus excavatum.

Methods: From 1987 to 1996, 148 patients were evaluated for chest wall deformity. Fifty of 127 patients suffering from pectus excavatum were selected for surgical correction. Eight older patients underwent the Ravitch procedure, and 42 patients under age 15 were treated by the minimally invasive technique. A convex steel bar is inserted under the sternum through small bilateral thoracic incisions. The steel bar is inserted with the convexity facing posteriorly, and when it is in position, the bar is turned over, thereby correcting the deformity. After 2 years, when permanent remolding has occurred, the bar is removed in an outpatient procedure.

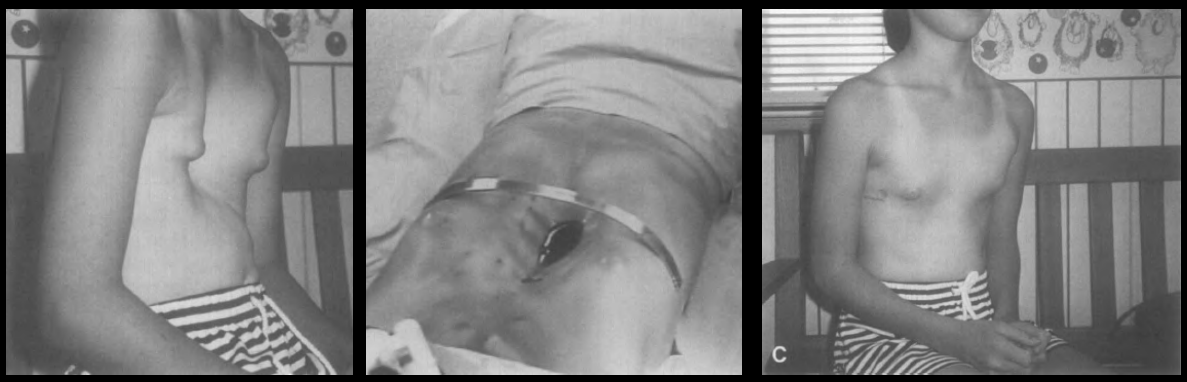
Results: Of 42 patients who had the minimally invasive procedure, 30 have undergone bar removal. Initial excellent results were maintained in 22, good results in four, fair in two, and poor in two, with mean follow-up since surgery of 4.6 years (range, 1 to 9.2 years). Mean follow-up since bar removal is 2.8 years (range, 6 months to 7 years). Average blood loss was 15 mL. Average length of hospital stay was 4.3 days. Patients returned to full activity after 1 month. Complications were pneumothorax in four patients, requiring thoracostomy in one patient; superficial wound infection in one patient; and displacement of the steel bar requiring revision in two patients. The fair and poor results occurred early in the series because (1) the bar was too soft (three patients), (2) the sternum was too soft in one of the patients with Marfan's syndrome, and (3) in one patient with complex thoracic anomalies, the bar was removed too soon.

Conclusions: This minimally invasive technique, which requires neither cartilage incision nor resection, is effective. Since increasing the strength of the steel bar and inserting two bars where necessary, we have had excellent long-term results. The upper limits of age for this procedure require further evaluation.

INDEX WORDS: Pectus excavatum, minimally invasive surgery, computed tomography scans in chest disease, thorax abnormalities.

9

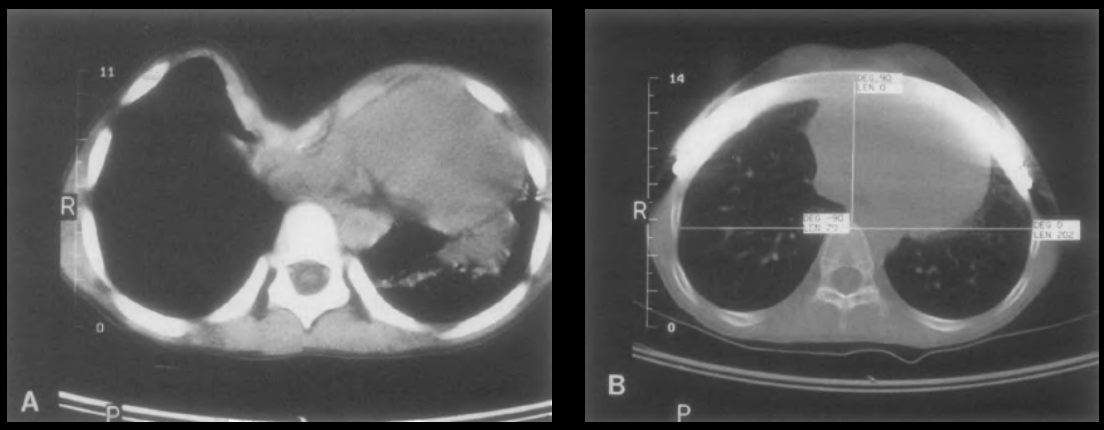
Surgical Correction
MIRPE / NUSS Procedure



Nuss D et al. J Pead Surg. 1998; 33(4): 545-552

10

Surgical Correction
MIRPE / NUSS Procedure



Nuss D et al. J Pead Surg. 1998; 33(4): 545-552

11

ORIGINAL STUDY

Twenty-One Years of Experience With Minimally Invasive Repair of Pectus Excavatum by the Nuss Procedure in 1215 Patients

Robert E. Kelly, Jr, MD, Michael J. Goretsky, MD, Robert Obermeyer, MD, Marcia Ann Kuhn, MD, Richard Redlinger, MD, Tina S. Haney, RN, MSN, Alan Moskowitz, MStat, and Donald Nuss, MB, ChB

Conclusions: The minimally invasive repair of pectus excavatum has been performed safely and effectively in 1215 patients with a 95.8% good to excellent anatomic result in the primary repairs at our institution.

(*Ann Surg* 2010;252:1072–1081)

12

NUSS Procedure
Pain Management

13

Nuss Procedure
Pain Management

- Described Being a Minimally Invasive Surgery
- Postoperative Pain Still a Major Problem
- Prolonged pain – 2-3 days Postoperative
- Effective Pain Management KEY to – Recovery / Patient Satisfaction
- No Consensus on the Optimal Analgesic Regimen
- Multiple Modalities Are Frequently Used

Aydin G et al. J LaparoEndo & Advan Surg Tech. 2020; 30(1):81-86

14

Pediatric Anesthesiology
Section Editor: James A. DiNardo

Perioperative Management and In-Hospital Outcomes After Minimally Invasive Repair of Pectus Excavatum: A Multicenter Registry Report From the Society for Pediatric Anesthesia Improvement Network

Wallis T. Muhly, MD,* Ralph J. Beltran, MD,† Alan Bielsky, MD,‡ Robert B. Bryskin, MD,§ Christopher Chinn, MD,‖ Dinesh K. Choudhry, MD,¶ Giovanni Cucchiaro, MD,#

- **Meaning:** Our data indicate that most patients undergoing the minimally invasive repair of pectus excavatum generally tolerate the procedure well and have mild-to-moderate pain post-operatively regardless of analgesic strategy.

RESULTS: Data were collected on 348 patients and categorized based on primary analgesic strategy: EC (122), PVC (57), WC (41), NR (120), and intrathecal morphine (8). Compared to EC, daily median pain scores were higher in patients managed with PVC (POD 0), WC (POD 0, 1, 2, 3), and NR (POD 0, 1, 2), respectively ($P < .001$–$.024$ depending on group). Daily opioid requirements were higher in patients managed with PVC (POD 0, 1), WC (POD 0, 1, 2), and NR (POD 0, 1, 2) when compared to patients managed with EC ($P < .001$).
CONCLUSIONS: Our data indicate variation in pain management strategies for patients undergoing MIRPE within our network. The results indicate that most patients have mild-to-moderate pain postoperatively regardless of analgesic management. Patients managed with EC had lower pain scores and opioid consumption in the early recovery period compared to other treatment strategies. (Anesth Analg 2019;128:315–27)

15

Nuss Procedure
Pain Management Strategies

- Thoracic Epidural Analgesia
- IV Patient Controlled Analgesia - Opioids
- Intercostal Nerve Block
- Intercostal Nerve Cryoanalgesia
- Thoracic Paravertebral Block
- Wound LA Infiltration
- Erector Spinae Plane Block

16

Nuss Procedure
Multimodal Pain Management

- Opioids – IVPCA: Morphine, Sufentanyl
- NSAID – Ketorolac, Ibuprofen
- Paracetamol – Acetaminophen
- Anxiolytics – Diazepam (pre and post operative)
- Gabapentin, Pregabalin
- Ketamine - low dose infusion
- Lidocaine infusion

17

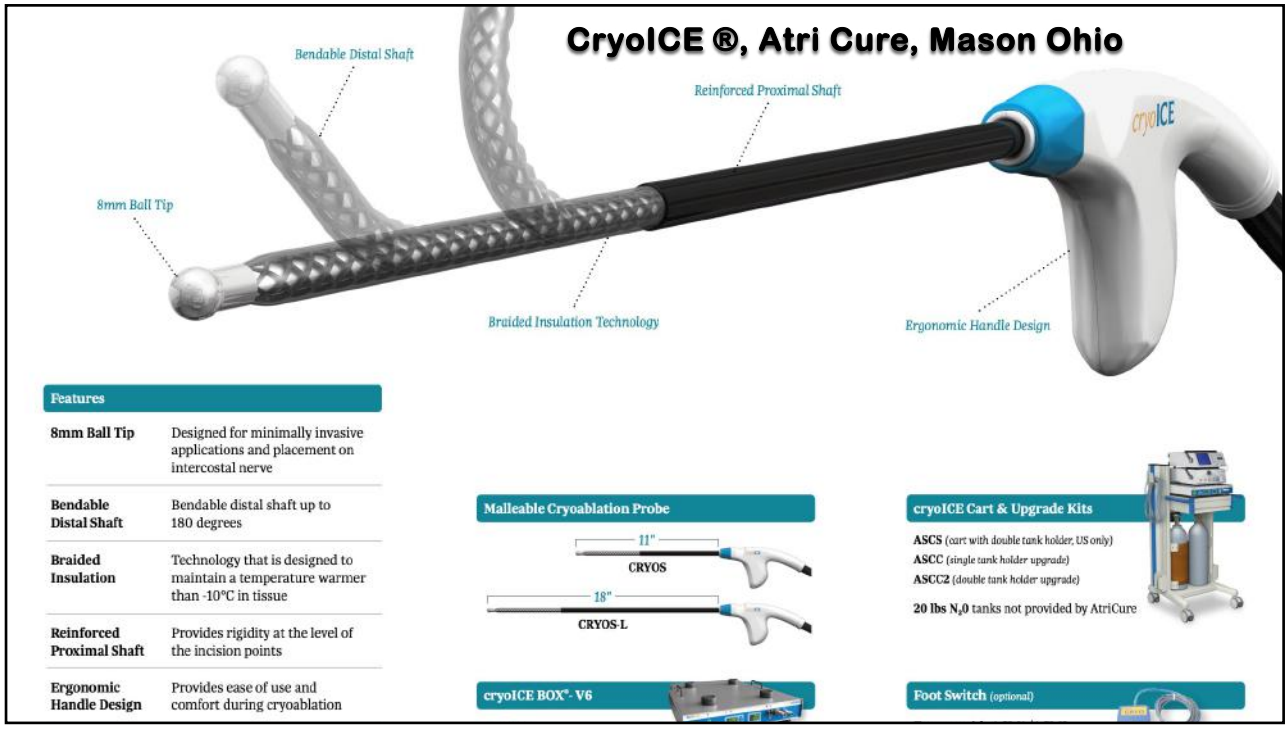
NUSS Procedure
Intercostal Nerve Cryoablation Vs Paravertebral Catheter
OUTCOMES

18

Intercostal Nerve Cryoablation
Surgical Intervention

- Cryoanalgesia is used to treat Pain Syndromes
- Been used for Post-thoracotomy Analgesia
  - Improved Analgesia
  - Improved Respiratory Function
- 2015 FDA (Food and Drug Administration) Approved the Use of Commercially Available Cryoablation Probe for Peripheral Nerves

19



20

Intercostal Nerve Cryoablation
Surgical Intervention

- Intercostal Nerve Ablated (T3-T7) – Hypothermic Exposure
- Temperature: - 60C for 2 minutes/nerve
- Wallerian Degeneration Occurs
- Temporary Nerve Injury
- Analgesia is Not Immediate – Evolves over 12-24 H
- Soma Intact - So Nerves Regenerate
- Nerve Function Resumes after several months (6-12 months)

21

Journal of Pediatric Surgery 51 (2016) 2033–2038

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

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

Background: Multimodal pain management strategies are used for analgesia following pectus excavatum repair. However, the optimal regimen has not been identified. We describe our early experience with intercostal cryoablation for pain management in children undergoing the Nuss procedure and compare early cryoablation outcomes to our prior outcomes using thoracic epidural analgesia.

Methods: A multi-institutional, retrospective review of fifty-two patients undergoing Nuss bar placement with either intercostal cryoablation ($n = 26$) or thoracic epidural analgesia ($n = 26$) from March 2013 to January 2016 was conducted. The primary outcome was hospital length of stay. Secondary outcomes included telemetry unit monitoring time, total intravenous narcotic use, duration of intravenous narcotic use, and postoperative complications.

Results: Patients who underwent intercostal cryoablation had a significant reduction in the mean hospital length of stay, time in a monitored telemetry bed, total use of intravenous narcotics, and the duration of intravenous narcotic administration when compared to thoracic epidural patients. Cryoablation patients had a slightly higher rate of postoperative complications.

Conclusion: Intercostal cryoablation is a promising technique for postoperative pain management in children undergoing repair of pectus excavatum. This therapy results in reduced time to hospital discharge, decreased intravenous narcotic utilization, and has eliminated epidurals from our practice.

Level of evidence: Retrospective study – level III.

22

Purpose: Minimally-invasive repair of pectus excavatum by the Nuss procedure is associated with significant postoperative pain, prolonged hospital stay, and high opiate requirement. We hypothesized that intercostal nerve cryoablation during the Nuss procedure reduces hospital length of stay (LOS) compared to thoracic epidural analgesia.

Design: This randomized clinical trial evaluated 20 consecutive patients undergoing the Nuss procedure for pectus excavatum between May 2016 and March 2018. Patients were randomized evenly via closed-envelope method to receive either cryoanalgesia or thoracic epidural analgesia. Patients and physicians were blinded to study arm until immediately preoperatively.

Setting: Single institution, UCSF-Benioff Children's Hospital.

Participants: 20 consecutive patients were recruited from those scheduled for the Nuss procedure. Exclusion criteria were age < 13 years, chest wall anomaly other than pectus excavatum, previous repair or other thoracic surgery, and chronic use of pain medications.

Main outcomes and measures: Primary outcome was postoperative LOS. Secondary outcomes included total operative time, total/daily opioid requirement, inpatient/outpatient pain score, and complications. Primary outcome data were analyzed by the Mann–Whitney U-test for nonparametric continuous variables. Other continuous variables were analyzed by two-tailed t-test, while categorical data were compared via Chi-squared test, with alpha = 0.05 for significance.

Results: 20 patients were randomized to receive either cryoablation (n = 10) or thoracic epidural (n = 10). Mean operating room time was 46.5 min longer in the cryoanalgesia group ($p = 0.0001$). Median LOS decreased by 2 days in patients undergoing cryoablation, to 3 days from 5 days (Mann–Whitney U, $p = 0.0001$). Cryoablation patients required significantly less inpatient opioid analgesia with a mean decrease of 416 mg oral morphine equivalent per patient ($p = 0.0001$), requiring 52%–82% fewer milligrams on postoperative days 1–3 ($p < 0.01$ each day). There was no difference in mean pain score between the groups at any point postoperatively, up to one year, and no increased incidence of neuropathic pain in the cryoablation group. No complications were noted in the cryoablation group; among patients with epidurals, one patient experienced a symptomatic pneumothorax and another had urinary retention.

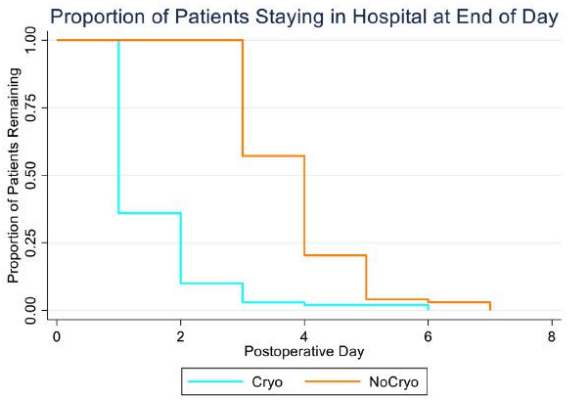
Conclusions and relevance: Intercostal nerve cryoablation during the Nuss procedure decreases hospital length of stay and opiate requirement versus thoracic epidural analgesia, while offering equivalent pain control.

23

Journal of Pediatric Surgery 58 (2023) 34–40

Contents lists available at ScienceDirect

Journal of Pediatric Surgery



g. 2. Kaplan-Meier curve showing proportion of patients remaining the hospital at the end of each postoperati

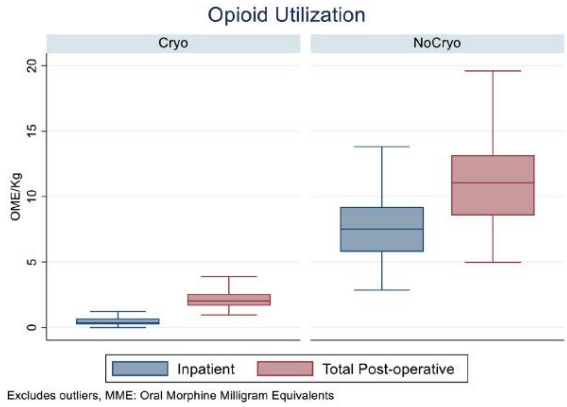


Fig. 3. Inpatient and total postoperative opioid utilization comparison between the two groups.

24

Pediatric Surgery International (2020) 36:317–324
https://doi.org/10.1007/s00383-019-04602-1

ORIGINAL ARTICLE

Check for updates

The incidence of neuropathic pain after intercostal cryoablation during the Nuss procedure

Abstract

Purpose Intercostal nerve cryoblation during the Nuss procedure for pectus excavatum decreases pain, opiate requirement, and hospital length of stay (LOS) compared to thoracic epidural analgesia. However, long-term complications of cryoablation, including neuropathic pain development, are not well studied.

Methods We conducted a multi-institutional retrospective review of patients following intercostal nerve cryoablation during Nuss bar insertion (11/2015–7/2018). Patients completed the Leeds Assessment of Neuropathic Symptoms and Signs, a validated questionnaire for detecting neuropathic symptoms. Primary outcome was neuropathic pain development. Secondary outcomes included duration of chest numbness and LOS. *T* test was performed; $p < 0.05$ is significant.

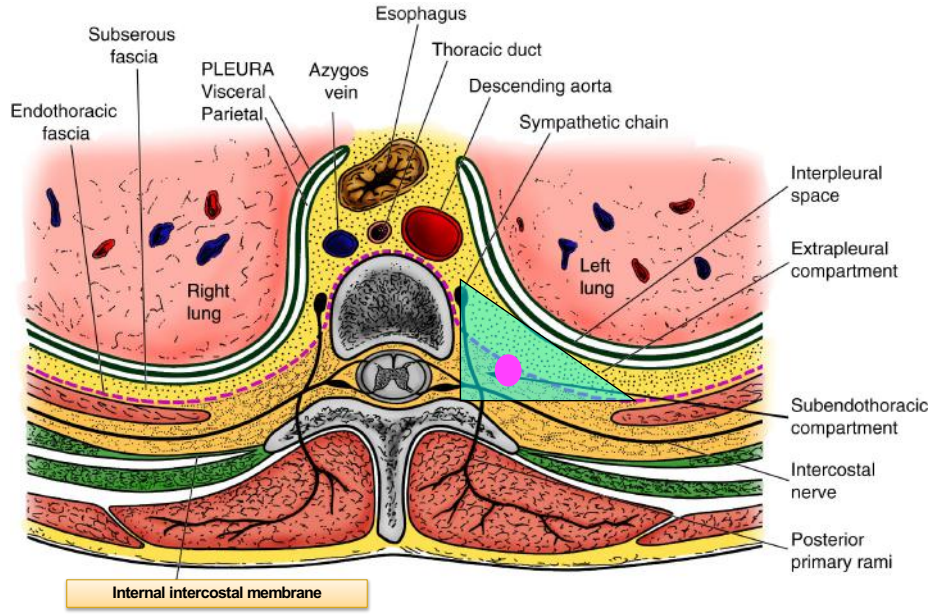
Results 43 patients underwent intercostal cryoablation during the Nuss procedure. Ages at repair ranged 11–47 years (median 16). Patients were grouped by age: ≤ 21 years (30 patients) or older (13 patients). Mean LOS was shorter for the younger group, 2.0 versus 3.9 days ($p = 0.03$). No patients in the younger group, and three in the older, experienced neuropathic pain. Mean time to numbness resolution was shorter for the younger group, 3.4 versus 10.8 months ($p = 0.003$).

Conclusion In pediatric patients, intercostal cryoablation provides effective analgesia following the Nuss procedure with minimal risk of post-operative neuropathic pain. Adult patients are at greater risk of experiencing neuropathic pain and prolonged numbness.

25

Pectus Excavatum
Pain Management Strategies
Bilateral Thoracic Paravertebral Block

26



Karmakar MK. Anesthesiology 2001;95(3):771-780

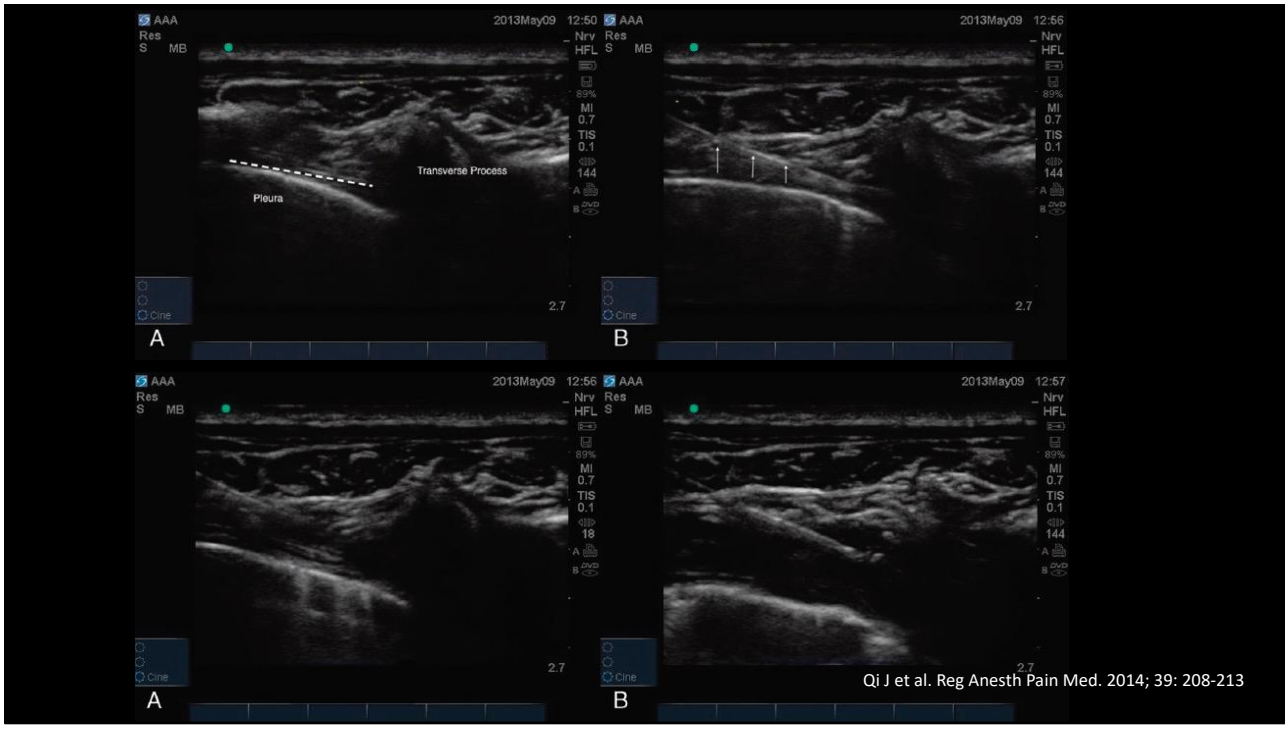
27

Thoracic Paravertebral Block

Multi-dermatomal Ipsilateral Somatic and Sympathetic Nerve Blockade

Cheema S et al. Anaesthesia 1995; 50: 118-121

28



29

ORIGINAL

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Denise M. H

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Summary

Introduction: Thoracic epidurals (TE) have been advocated as a superior method for controlling postoperative pain after repair of pectus excavatum with a Nuss procedure. However, three recent reports of permanent neurologic injury after the Nuss procedure with concurrent TE analgesia have raised concerns about the safety of this combination. Paravertebral nerve blocks (PVNB) are used successfully for analgesia of the chest, but no studies are available comparing TE and PVNB catheters for postoperative analgesia in this patient population. This study was conducted to compare the efficacy of PVNB catheters with TE catheters for postoperative analgesia in pediatric patients undergoing the Nuss procedure.

Methods: We retrospectively reviewed the medical records of 20 adolescent males undergoing a thoracoscopic Nuss procedure with either bilateral PVNB catheters (n = 10) or TE catheter (n = 10) and compared postoperative opiate consumption and pain scores.

Results: There were no statistically significant differences between the groups with respect to demographics, opiate consumption measured in morphine equivalents, and pain scores.

Discussion: In this small series, bilateral PVNB catheters resulted in equivalent opioid consumption and pain scores when compared to TE for postoperative pain management in pediatric patients undergoing the Nuss procedure. Large prospective studies are needed to further compare the efficacy, incidence of side effects, and complications of TE and PVNB catheters for postoperative analgesia in this pediatric population.

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ia 2014; 24: 516–520

30

A Prospective R… tudy to Assess
Postoperative … ound-Guided
Bilateral T… Children
U…

*Jiashan Qi, MD … ilin Lu, MD,**

Background and Objectives: This prospective, randomized, single-blinded study evaluates the effectiveness of the ultrasound-guided bilateral thoracic paravertebral (BTPV) block for providing postoperative pain control in children undergoing the Nuss procedure.

Methods: Thirty American Society of Anesthesiologists I–II children with pectus excavatum, scheduled for the Nuss procedure, were enrolled at West China Hospital of Sichuan University. The patients were randomly allocated into the BTPV block group or the control group. In the BTPV group, 0.25% ropivacaine 0.5 mL/kg with 1:200,000 epinephrine was injected under ultrasound guidance on each side at the level of the fifth thoracic vertebra. Postoperative pain was evaluated in both groups for the first 48 hours. Total opioid administered and cumulative attempts on the patient/parent-controlled intravenous analgesia (PCA) pump were recorded. Postoperative negative behavioral changes in the children were evaluated on postoperative days 1, 7, and 30, respectively, using the post-hospital behavior questionnaire.

Results: The pain scores were significantly reduced in the postanesthesia care unit and for the first 48 hours postoperatively in the BTPV group compared to the control group ($P < 0.01$). The sufentanil use in the postanesthesia care unit was significantly greater in the control group [mean (SD), 0.2 (0) mcg/kg] compared to the BTPV group [mean (SD), 0.05 (0.06) mcg/kg] ($P < 0.01$). The postoperative sufentanil use was significantly higher in the control group during the first 24 hours ($P < 0.01$). Numbers of attempts on the PCA pump were significantly greater in the control group ($P < 0.01$). The posthospital behavior questionnaire score was lower in the BTPV group on day 1, day 7, and 1 month, respectively ($P < 0.01$).

Conclusions: Ultrasound-guided BTPV block provides improved postoperative analgesia for children undergoing the Nuss procedure as compared with intravenous PCA and decreases the incidence of postoperative behavioral disturbance.

31

Pediatric Surgery International (2023) 39:159
https://doi.org/10.1007/s00383-023-05429-7

ORIGINAL ARTICLE

Abstract

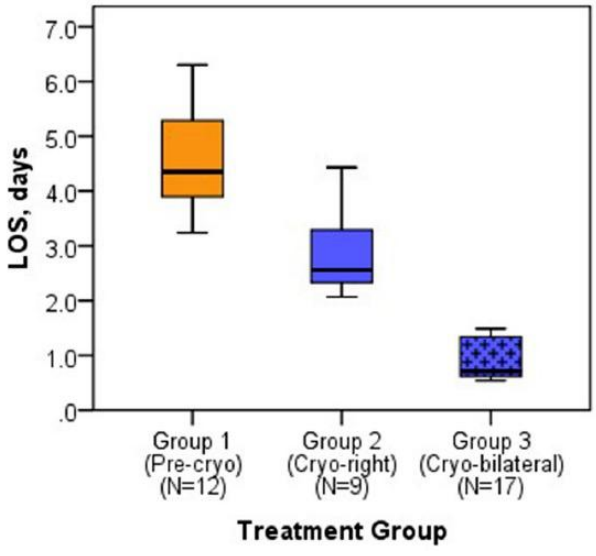
Background Despite adva… , Nuss procedure, postop-
erative pain control remain… l single-shot paravertebral
block (PVB) and bilateral … ificant reduction in length
of stay (LOS) and high rate…

Methods This is a compar… Nuss procedure at a single
center from 2016 through 2… ment of pectus excavatum
at a single center. Patients … lateral PVB with infusion
and right-side cryoablation… on (Group 3, $n = 17$). The
primary outcome was LOS… ecreased opioid usage.

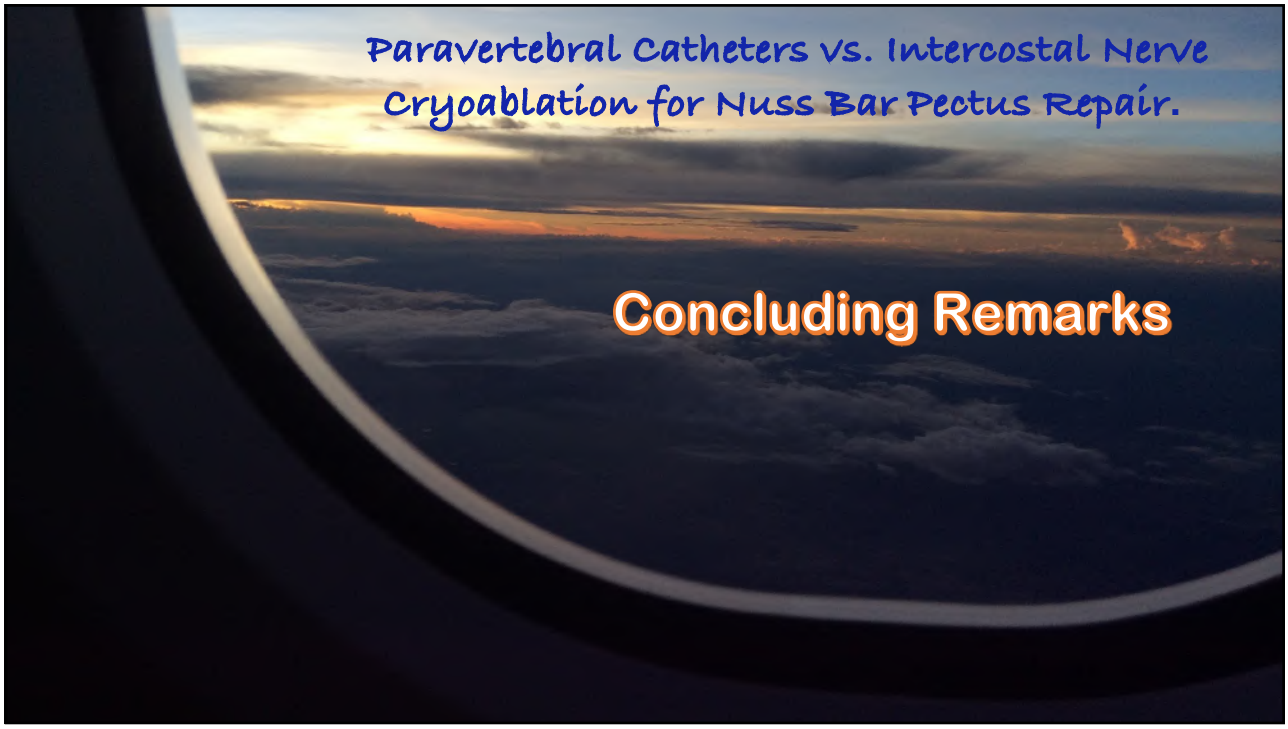
Results Eleven of 17 patie… tion) were discharged the
same day as surgery. The … o complications or inter-
ventions. Compared to Gr… vs. 0.7 days, respectively,
$p < 0.001$) and significantly… .47 mg/kg, $p = 0.006$).

Conclusion Findings dem… discharge after the Nuss
procedure. Future multisite… stablished methods.

Level of Evidence III.



32


Paravertebral Catheters vs. Intercostal Nerve Cryoablation for Nuss Bar Pectus Repair.
Concluding Remarks

33