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Analgesic Efficacy of Quadratus Lumborum Block in Infants Undergoing Pyeloplasty

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Abstract: Post-operative analgesic management is challenging in infants and opioids have been the standard of care. However, they are associated with adverse effects which may negatively impact infants. In this retrospective cohort study, we sought to explore the postoperative analgesic efficacy of quadratus lumborum (QL) block in the infant population undergoing dorsal lumbotomy pyeloplasty. Chart review of 34 infants (≤12 months) who underwent dorsal lumbotomy pyeloplasty between 2016–2020 was performed. Post-operative pain was assessed using externally validated pain scales (CRIES & FLACC) and monitored hemodynamics (pulse and blood pressure). Opioid doses were standardized by using morphine milligram equivalency (MME). The Prescription Database Monitoring Program (PDMP) was utilized to determine if discharge opioid prescriptions were filled. Of 34 patients, 13 received the QL block. Mean age at the time of surgery was 6.2 months ± 3.2 months. The QL group received 0.8 MME postoperatively, whereas the non-QL group received 0.9 MME ($p = 0.82$). The QL group (20%) filled their discharge opioid prescription less frequently compared to non-QL group (100%) ($p = 0.002$). There were no observed differences between pain scale or hemodynamic variables. Further studies are warranted to explore QL block's efficacy for post-operative infant pain management.

Keywords: pediatric urology; pyeloplasty; nerve block; quadratus lumborum block

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Citation: Chisolm, P.F..; Singh, N.P..; Cummins, I.; Oster, R.A..; Cox, D.; Dangle, P.P.. Analgesic Efficacy of Quadratus Lumborum Block in Infants Undergoing Pyeloplasty. *Surgeries* **2021**, *2*, 278–285. https://doi.org/10.3390/surgeries2030028

Academic Editor: Cornelis F. M. Sier

Received: 23 June 2021
Accepted: 29 July 2021
Published: 2 August 2021

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1. Introduction

Surgical correction of ureteropelvic junction (UPJ) obstruction is a gold standard treatment for symptomatic patients [1,2]. Postoperative pain management in pediatric patients can be challenging, especially in infants (≤12 months). Non-steroidal anti-inflammatory drugs (NSAIDs) and opioids are the standard of care for breakthrough peri-operative pain management [3].

It is well established that opioid use early in life is detrimental to the developing nervous system [4]. Infants exposed to opioids demonstrate a higher volume of distribution, immature opiate metabolism, and variable elimination [5]. In addition, untreated infantile pain exposure can predispose patients to increased pain sensitivity, development of psychiatric sequalae, and poor cognitive function later in life [6]. Thus, appropriate pain control is key to the proper recovery of infants following pain exposure.

Utilization of multimodal analgesia and regional nerve block techniques can assist with post-operative pain. Neuraxial caudal block via epidural catheterization is an established alternative to general anesthesia for pediatric urological cases, explored to limit the exposure of neurotoxic effects of general anesthesia [7,8]. While the neurological complications of spinal anesthetics remain low, the risk of dural puncture and associated post-dural puncture headaches, as well as CNS infection do persist [9]. The quadratus lumborum (QL) block is a regional anesthetic which has demonstrated efficacy and safety in pediatric

patients undergoing lower abdominal and pelvic surgery [10,11]. A recent double-blinded randomized control trial by Genc et al. demonstrated that administration of regional QL block after completion of lower abdominal surgery for pediatric patients (age: 3–16) provided effective analgesia in comparison with IV analgesia [12].

However, studies investigating the efficacy of regional nerve blocks in infants are limited. To our knowledge, a comparison of post-operative pain management with and without QL blockade in infants' patients undergoing pyeloplasty for UPJ obstruction has not been performed. In the present study, administration of the QL blockade with ropivacaine was performed to explore its efficacy in pain management in this population. Ropivacaine is the principal local anesthetic drug for regional anesthesia in pediatric patients through much of the US, including infants and toddlers. Ropivacaine has an improved safety profile compared to bupivacaine with less cardiac and central nervous system toxic effects, less motor block and yet a similar duration of action of sensory analgesia as bupivacaine [13–15]. We hypothesize that perioperative type 2 QL block in infants is efficacious, minimizing post-operative pain and opioid utilization in infants undergoing dorsal lumbotomy pyeloplasty for symptomatic UPJ obstruction.

2. Materials and Methods

Institutional Review Board (IRB-160923001) approval was obtained, and the records of infants between 0–12 months who underwent dorsal lumbotomy pyeloplasty for symptomatic UPJ at our institution between August 2016 and November 2020 were retrospectively reviewed. Patients were excluded if they were older than 1 year or if they underwent other surgeries at the time of their pyeloplasty. A total of 34 patients were identified and included. One patient in the QL cohort had a right and left pyeloplasty as separate procedures and as such, was treated as two distinct cases. Surgeries were performed by one of two fellowship trained pediatric urologic surgeons. In the presence of a pediatric anesthesiologist, parents of patients were offered the option of QL block administration after discussing the pros and cons of the procedure.

2.1. Patient Related Variables

Demographic information such as gender, age, and race were collected. Operative and anesthetic notes were reviewed to determine peri-operative anesthetic and surgical information. All patients had scheduled serial follow-up following their procedure and records were reviewed for complications during this period. Nursing notes were reviewed to obtain hemodynamic measures including pulse and blood pressure (systolic and diastolic) as surrogate for pain. Pain scores following the CRIES Neonatal Pain Assessment (0–2 months) and the FLACC pain scale (2–12 months) were obtained. Inpatient drug administration was collected using an institution wide drug monitoring system. The Prescription Database Monitoring Program (PDMP) was used to ascertain if discharge opioid prescriptions were filled. Morphine milligram equivalency (MME) was used to standardized opioid doses using a conversion table provided by The Centers for Disease Control and Prevention [16].

2.2. Quadratus Lumborum Block Details

Type 2 QL blocks were placed by one of three pediatric anesthesiologists following an inhalation induction of general anesthesia before surgical incision (5 patients) or prior to emergence from anesthesia (8 patients). Fentanyl was administered on induction of anesthesia prior to intubation. Additional drugs administered on induction included propofol, non-depolarizing neuromuscular blockers, and antibiotics.

The patient was placed in lateral decubitus position with the operative side elevated. A high-frequency (13–6 MHz) linear ultrasound transducer (SonoSite S-nerve (San Diego, CA, USA)) was placed in Petit's triangle (iliac crest inferior, latissimus dorsi posterior, external oblique anterior) between the iliac crest and the subcostal margin just posterior to the midaxillary line. As the probe was moved posteriorly, the external and internal

obliques were traced as they coalesced into an aponeurosis with the appearance of the latissimus dorsi. Continuing posteriorly the quadratus lumborum was identified beneath the latissimus dorsi. This location was verified by identification of the transverse process of the lumbar vertebra and the erector spinae muscle with the quadratus lumborum located adjacent on the anterolateral border. A type 2 QL block was performed on the posterior side of the QL at the medial thoracolumbar fascia between the QL and erector spinae muscles using a 22 gauge, 50 or 80 mm Sonoplex (Pajunk, Germany) needle under direct ultrasound visualization (Figure 1). Following negative aspiration, ropivacaine 0.1% or 0.2% (0.5–1 mL/kg) was injected slowly with spread observed on ultrasound. Total time for the procedure averaged 5 min.

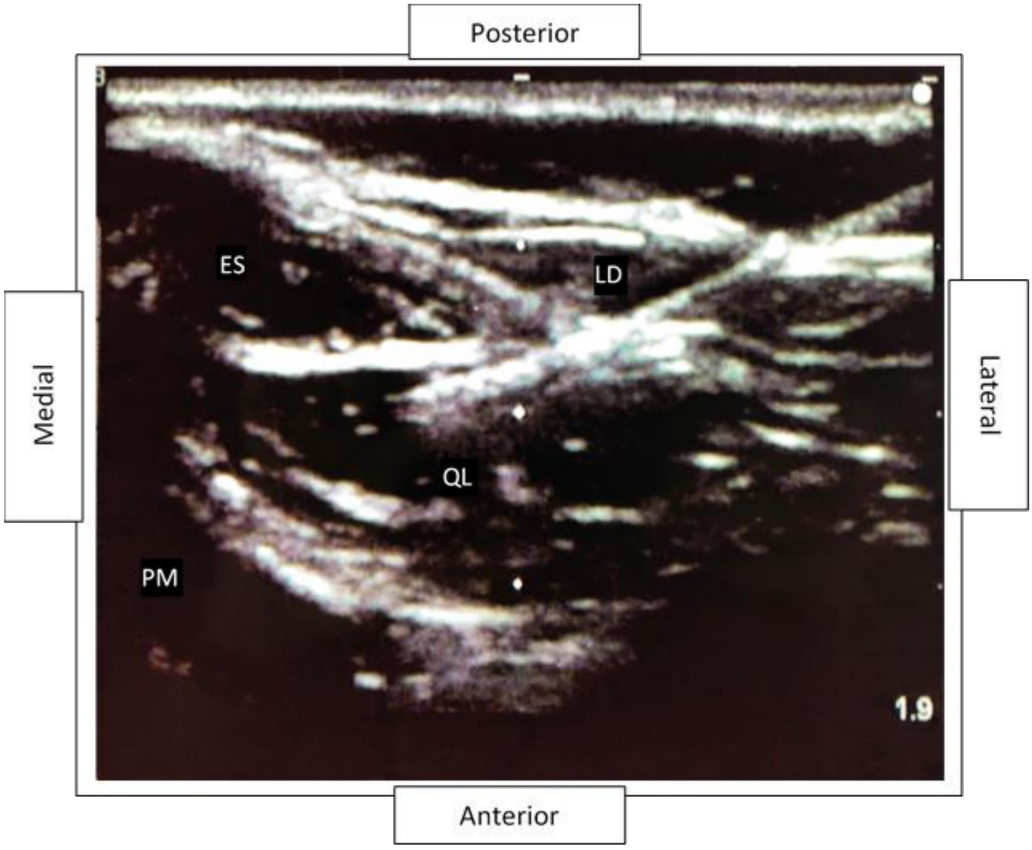

Figure 1. Ultrasound of block administration plan; QL—quadratus lumborum. LD—latissimus dorsi. ES—erector spinae. PM—psoas major.

2.3. Statistical Analysis

Descriptive statistics, such as means and standard deviations for continuous variables and frequencies and proportions for categorical variables, were obtained for patient characteristics, medication parameters, and pain criteria. Means and proportions of variables for the QL block group were compared to those of the non-QL block group. These comparisons were then repeated separately for males and females. Since some of the variables were not normally distributed, and due to the small sample sizes in the groups (and in the male and female sub-groups), we performed group comparisons of continuous variables using the nonparametric Wilcoxon rank-sum test and group comparisons of categorical variables using the chi-square test or Fisher's exact test when the assumptions for the chi-square test were not tenable. Statistical tests were two-tailed and were performed using a significance level of 5%. Statistical analyses were performed using SAS (version 9.4; SAS Institute, Cary, NC, USA).

3. Results

All 34 patients were included in the analyses. The mean age of the patients was 6.1 (±3.1) months; 24 (70.6%) were males and 27 (79.4%) were white. Demographic and clinical characteristics of patients are showcased in Table 1.

Table 1. Demographic and clinical characteristics of patients (*n* = 34).

Variables	All	QL Block	Non-QL Block	*p*-Value
	(*n* = 34)	(*n* = 13)	(*n* = 21)	
Male, *n* (%)	24 (70.6)	9 (69.2)	15 (71.4)	1.0
Age at presentation, mean (SD), months	6.2 (3.2)	5.8 (3.2)	6.4 (3.2)	0.62
Total OR Time, mean (range), minutes	256.6 (171–412)	279.4 (171–412)	243.6 (171–343)	0.09
Length of hospital stay, mean (range), days	2.32 (0–8)	2.16 (1–5)	2.42 (0–8)	0.66
Complications, *n* (%)				
Fever	1 (7.7)	1 (7.7)	0	
Emesis	1 (7.7)	0	1 (7.7)	

QL, Quadratus Lumborum; OR, Operating Room.

Across all cohorts, there were no significant differences seen in the amount of opioids administered intraoperatively or 24 h postoperatively (Table 2). The mean volume of ropivacaine administered to the QL-Block group was 7 mL (range: 2–15 mLs), for a mean dose of 1.5 ± 0.45 mg/kg. When comparing intra-operative opioid use between patients that received the block prior to incision (*n* = 3) versus prior to extubating (*n* = 10), the former had a mean MME utilization of 0.92, whereas the latter had a mean MME of 2.22 (*p* = 0.29). No significant differences were observed between groups for total amount of opioids received or discharge opioid prescriptions. The number of discharge opioid prescriptions filled was significantly different between QL and non-QL block patients. NSAID and acetaminophen usage and dosage were similar between both cohorts. No significant difference was observed pain criteria or hemodynamic variables (Table 3).

Table 2. Patient pain management outcomes (*n* = 34).

Variables	All	QL Block	Non-QL Block	*p*-Value
	(*n* = 34)	(*n* = 13)	(*n* = 21)	
MME Administered, mean (SD)				
Intraoperatively	2.0 (1.5)	1.8 (1.3)	2.1 (1.7)	0.68
Postoperatively	0.9 (1.8)	0.8 (1.4)	0.9 (2.0)	0.82
Discharge [a]	26.6 (5.0)	13.3 (-)	27.8 (3.2)	0.14
Acetaminophen- 24 Hours Post-operatively, milligrams, mean (SD)	184.4 (115.3)	233.1 (137.0)	154.2 (90.4)	0.09
NSAIDs- 24 Hours Post-operatively, milligrams, mean (range)	49.3(0–390)	84.0 (0–390)	25.5 (0–300)	0.12
Number of Pts. With Discharge Opioid Prescriptions Written, *n* (%)	17 (50)	5 (38)	12 (57)	0.29
Number of Written Opioid Prescriptions Filled, *n* (%)	13/17 (77)	1/5 (20)	12/12 (100)	0.002 *

MME, Morphine Milligram Equivalence. * Indicates statistical significance. [a] *n* = 13 for the entire group; *n* = 1 for the QL block group; *n* = 12 for the non-QL block group. The standard deviation could not be calculated for the QL block group since *n* = 1 patient.

Table 3. Pain Criteria and Hemodynamic Variables (*n* = 34).

Variables	All	QL Block	Non-QL Block	*p*-Value
	(*n* = 34)	(*n* = 13)	(*n* = 21)	
Pulse, mean (SD)	135.5 (13.9)	136.3 (15.9)	135.0 (13.0)	0.67
Systolic Blood Pressure, mean (SD)	108.3 (7.3)	107.5 (9.7)	108.8 (5.7)	0.56
Diastolic Blood Pressure, mean (SD)	59.0 (4.4)	59.3 (3.7)	58.8 (4.8)	0.86
CRIES Pain Score, mean (SD) [a]	1.0 (0.8)	0.9 (0.8)	1.1 (0.9)	0.53
FLACC Pain Score, mean (SD) [b]	1.0 (1.1)	0.8 (0.8)	1.1 (1.2)	0.79

[a] *n* = 13 for the entire group; *n* = 7 for the QL block group; *n* = 6 for the non-QL block group. [b] *n* = 20 for the entire group; n = 5 for the QL block group; *n* = 15 for the non-QL block group.

4. Discussion

Management of surgical pain in infants is challenging. There is a lack of understanding surrounding the severity or characteristics of pain encountered, resulting in assumptions about pain experienced [6,17]. Our findings were contrary to previous studies that demonstrate the utility of QL block in post-operative pain management in pediatric patients >1 year of age after lower abdominal and urologic surgery [10,12,18,19]. To our knowledge, this retrospective review represents the first assessment of QL block efficacy specifically in infants <1 year of age.

In our study, the total OR time was ~35 min longer in cases that administered a QL block than in those without. This was not significantly different from non-QL cases. Additionally, the length of hospital stay was not significantly different. Logistically, our study would support that the administration of this regional block in the setting of pyeloplasty is feasible and did not substantially prolong cases.

Behavioral assessments of pain such as the validated CRIES and FLACC scales can prove useful tools in the determination of an infant's pain status [20]. Employing externally validated scales such as these reduce observer bias. The CRIES and FLACC pain scales have previously been found to have high interrater reliability [21]. When implemented properly, these criteria are well established and reliable pain measurement tools for infants in the neonatal intensive care unit (NICU). Their validity is less known in other care environments such as non-intensive care units where our patients were cared for postoperatively [22]. The post-operative care team, which included urology residents and nurses, did have discretion to order or request opioids depending on the patient's status. Observational pain assessments made by these providers has a subjective component (i.e., persistent crying, irritability), but was more effectively limited by the implementation of these pain assessment tools [17]. There were no differences observed in pulse, blood pressure, and CRIES and FLACC pain scores. Multiple indices of infant pain status were utilized to have the most accurate observation possible and the lack of significance across these four variables support similar opioid use profiles between cohorts.

Other sources of crying, pain and/or irritability are also important to consider. All patients were stented, eliminating a potential confounder. Dorsal lumbotomy is a non-muscle cutting or splitting incision with direct access through the fascia to the retroperitoneum and is plausibly less painful than other muscle splitting or cutting incision [23]. While the QL block has been showcased to decrease post-operative opioid requirements in other populations [24], the procedure is not without risk. In QL block Types 1, the lateral aspect of the muscle in contact with the thoracolumbar fascia is targeted. Types 2 and 3 target the posterior space adjacent to the QL muscle and the anterior attachments to the L4 transverse process, respectively. Type 4 is a direct deposition of the anesthetic into the muscle [10]. The posterior QL block (type 2) likely performs its clinical effect by allowing spread of the injectate along the medial thoracolumbar fascia, covering the T12 and L1 nerve roots primarily responsible for the ilioinguinal, iliohypogastric, and subcostal nerves. Coverage may extend to cover T11 and possibly as high as T10 and as low as L2 [25,26]. The anterior QL block may offer greater coverage both cranially as high as T6-T7 and caudally as low as L3-L4 [27,28]. Injection site pain, infection, urinary retention and/or local anesthetic toxicity are potential sources of pain/disturbance that could be introduced to those patients receiving the regional block [29]. We did not observe a different rate of post-operative complications between the two cohorts.

Emergence delirium is another important postoperative consideration in pediatric patients, with an incidence range from 10–80% [30]. This condition is characterized by non-purposeful movement, restlessness, inconsolability, and unresponsiveness, and poses a particular challenge for the clinician caring for patients postoperatively. Therefore, this represents a potential source of observer bias that could alter pain management. We suggest future assessments incorporate additional validated scales such as the Pediatric Anesthesia Emergence Delirium (PAED) scale to further delineate the phenomenon from pain [31].

Nonsteroidal anti-inflammatory drug (NSAID) and acetaminophen (APAP) use and dosage were not significantly different across all cohorts, but there was a tendency towards higher utilization in the QL cohort. Limited cohort size does play a role in this observation; however, non-narcotic pain management via NSAIDs and APAP were primarily preferred for standard pain control rather than opioids. Surgeon discretion was the primary criteria utilized to determine if a patient needed an opioid prescription upon discharge. The significant difference observed in number of prescription opioids filled in all patients may be reflective of parental perception of pain combined with post-operative guidance. Families are informed about the block and its 24 h efficacy, as well as counseled on measures to reduce their infants' pain by the urologist (e.g., alternate anti-inflammatories, proper hydration). Since the caregivers were not blinded, this may have swayed decisions on filling pain prescriptions, a potential source of post-discharge treatment bias.

Certainly, the possibility exists that all or a percentage of the blocks were unsuccessful. Confirming whether a block was successful is certainly challenging in this age group. While the majority of patients did receive a small dose of IV fentanyl on induction prior to intubation, this dose was not standardized and not universally given, in part due to lack of an established protocol, and in part due to depth of anesthesia already established from volatile gases often related to time required to acquire IV access. While under anesthesia, the decision to re-dose opioids was made at the discretion of the anesthesiologist and nurse anesthetist performing the case and there were no formal guidelines. Once in the PACU and subsequently on the floor, as previously mentioned, it can be difficult to discern infant distress related to surgical discomfort versus hunger pain, separation anxiety, environment changes, abdominal flatus. Subsequent dosing of opioids by nursing staff was not standardized and opioid dosing certainly could have been administered without first addressing each of these other potential confounding variables. Of course, these same variables would have been present in the arm of the study not receiving the QL block.

This study was limited by its retrospective, single center design and small sample size. We did not experience loss to follow up since this study's main outcome was postoperative opioid utilization. A prospective, multi-institutional, randomized analysis in the infant population undergoing pyeloplasty would be recommended to increase statistical power. To limit observer and treatment bias, we would recommend the following: a uniform delivery of QL block (including standardization of block timing, anesthetic concentration); blinding of patients, parents, and care team; and increasing post-operative pain education to the care staff, including considerations for emergence delirium.

5. Conclusions

In this retrospective review, we found no significant differences in post-operative analgesic use or pain assessments in infant patients receiving a type 2 QL block compared to those without the block. These findings warrant further exploration of the utility and efficacy of the QL block in infants undergoing dorsal lumbotomy pyeloplasty.

Author Contributions: Conceptualization, P.P.D.; methodology, P.P.D.; software, R.A.O.; validation, R.A.O., P.P.D.; formal analysis, R.A.O.; investigation, P.F.C., N.P.S., I.C.; data curation, P.F.C., N.P.S., I.C.; writing—original draft preparation, P.F.C., N.P.S., D.C.; writing—review and editing, P.F.C., N.P.S., D.C.; visualization, P.F.C.; N.P.S.; supervision, P.P.D.; project administration, P.P.D., D.C.; funding acquisition, R.A.O. All authors have read and agreed to the published version of the manuscript.

Funding: Statistician's effort was supported by the following grant from the National Institutes of Health: UL1 TR003096.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of University of Alabama at Birmingham Institutional Review Board (IRB-160923001, (7 May 2020)).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data is contained within this article.

Conflicts of Interest: The authors declare no conflict of interest.

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