Epidural Analgesia Decreases Narcotic Requirements in Low Level Spina Bifida Patients Undergoing Urologic Laparotomy for Neurogenic Bladder and Bowel

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Running Head (50 char): Epidurals in Pediatric Low Level Spina Bifida

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Abstract:

Purpose:
Concern of anatomical anomalies and worsening neurologic symptoms has prevented widespread use of epidural catheters in patients with low level spina bifida (LLSB). We hypothesize that thoracic epidural placement in the T9-T10 interspace is safe and decreases narcotic requirements in LLSB patients following major open lower urinary tract reconstruction (LUTR).

Materials and Methods:
We reviewed consecutive LLSB patients who had LUTR and epidurals for post-operative pain control. Controls were LLSB patients who received single shot transversus abdominis plane (TAP) blocks with similar procedures. Complications from epidural placement, including changes in motor and sensory status were recorded. Opioid consumption was calculated utilizing equivalent IV morphine doses. Mean and maximum pain scores on post-operative day (POD) 0-3 were calculated.

Results:
10 LLSB patients who had lower urinary tract reconstruction and epidurals were matched to 10 LLSB patients who had lower urinary tract reconstruction and transverse abdominis plane blocks. Groups were demographically similar. All had full abdominal sensation and functional levels at or below L3. No epidural complications or changes in neurological status were noted. The epidural group had decreased opioid consumption on POD 0-3 (0.75 mg/kg vs. 1.29 mg/kg, p=0.04). Pain scores were similar or improved in the epidural group.

Conclusions:
Thoracic epidural analgesia appears to be a safe and effective opioid sparing option to assist with post-operative pain management following lower urinary tract reconstruction in LLSB patients.

Introduction:

Treatment of post-operative pain has made significant advances due in part to the greater utilization of regional pain block techniques. Thoracic epidural anesthesia has been shown to be beneficial in the management of post-operative pain by decreasing respiratory complications, nausea and vomiting, time until return of bowel function, and hospital length of stay[1]. Although there are a few small case reports of epidural analgesia use in women with low level spina bifida (LLSB) during labor and delivery[2], its use for post-operative pain management has never been studied.

Concern of anatomical anomalies and worsening neurologic symptoms has prevented the utilization of epidural anesthesia in patients with neural tube defects[3]. Pre-existing neurological conditions, such as spina bifida (SB), might set the stage for a double-crush scenario, which maintains that patients with pre-existing neural compromise may be at increased susceptibility for subsequent nerve injury from a secondary insult[4]. This has historically led to recommendations not to perform regional anesthesia in this population[5]. Due to concern about their pain control and inspired by reports of success in case reports of epidural use in some patients during labor and delivery, we started placing epidurals in select patients with low level spina bifida.

We sought to determine if patients who received epidurals suffered any complication related to the epidural or epidural placement. Our primary aim was to assess safety and secondary aim was to assess efficacy (by narcotic use and pain scores). We firstly hypothesize that thoracic epidural placement in the T9-T10 interspace in LLSB patients is safe, and patients would not be observed to have any motor or sensory changes due to the epidural placement. We further hypothesize decreased narcotic requirements in LLSB patients receiving an epidural compared to LLSB patients who underwent similar procedures without an epidural for perioperative pain relief.

Materials and Methods:

Study Population

Institutional Review Board approval was gained for the conduct of the study prior to retrospective data analysis. Neurosurgeons at our institution approved placement of thoracic epidural in select patients without evidence of thoracic disease (Figure 1). All patients with LLSB (functional lesion diagnosed by the developmental pediatrician based on motor function as L3 or below) undergoing LUTR with an MRI showing no evidence of thoracic disease were offered a thoracic epidural. LLSB patients without an MRI in our system were excluded and were not offered epidurals. Following surgery, physical therapy and occupational therapy worked with the patient and evaluated the patient's neurological status daily as part of their care.

Matching

We retrospectively reviewed consecutive LLSB patients who had LUTR and received epidurals at our institution from April 2016 to October 2017. Due to the nature of lower urinary tract surgery, each patient had multiple procedures performed under one anesthetic. We performed a retrospective case control study and matched these patients to controls with LLSB based on similarity of procedures performed under the same anesthetic. Controls received single shot transversus abdominis plane (TAP) blocks, which were placed at the end of the procedure with ultrasound guidance. Prior to offering epidurals, TAP blocks were the current standard of care at our institution for such procedures. To most ideally select our control group based on procedures, controls were recruited from a wider time frame from December 2013 to October 2017. Operative time was used as a marker for complexity of the surgery performed and was measured as the time from surgery start to surgery stop.

Epidural Placement and Pain Management Strategies

All epidurals were placed in the T9-10 interspace (Figure 2) after the patient was intubated and sedated. Ropivacaine 0.2% was infused at a rate of 0.4 mg/kg/hr in epidurals. This is in line with recommended standard pediatric epidural infusions[5]. No patients in either group were given pre-operative opioid sparing analgesics. Additional opioid-sparing analgesics were not

administered intraoperatively in patients who received epidurals. Based on clinical situation, surgeon preference and anesthesia preference, some patients who received TAP blocks also received ketorolac and/or ketamine. Patients in both groups received prn diazepam, oral acetaminophen, ketorolac and either IV narcotics or a patient-controlled analgesia (PCA) pump based on clinical situation, surgeon preference, and anesthesia preference post-operatively. No patients received gabapentin or ketamine following their procedure. PCA availability was recorded and defined as whether a PCA was offered to a patient. If the patient was not offered a PCA, prn IV narcotics were available for pain relief.

Outcome Assessment

Our primary outcome was to determine the safety of epidural placement in patients with LLSB undergoing bladder reconstruction. We defined safety as not experiencing changes in neurological status. Epidural complications were defined as asymmetric block, dural puncture, excessive block height, suboptimal analgesia, rapid onset block, spinal catheter migration, increased number of attempts/difficulty locating the epidural space, and post-procedural neurological deficit. For our secondary outcome, we evaluated the efficacy of the epidural by comparing opioid consumption and patient reported pain scores with and without an epidural on post-operative days 0-3. Opioid consumption was calculated utilizing equivalent IV morphine doses. Nursing assessed pain scores 2 hours on a 0-10 scale.

Statistical analysis

Analysis involved Mann-Whitney U test for continuous data and Fisher's exact tests for categorical data. A critical $p \leq 0.05$ was used (Stata 10.1 StataCorp, College Station, TX, USA).

Results:
A total of 10 LLSB patients who underwent LUTS had epidurals placed during the study period were matched to 10 controls with LLSB who underwent similar procedures and had TAP blocks placed. Characteristics of the two groups, including age, gender, BMI, functional status, procedures performed, operative time, return of bowel function, number of antiemetic doses taken, or length of stay were not significantly different between groups (Table 1). There was no difference in VP shunt status between groups (epidural 10 vs. control 6, p=0.09). Of note, all patients who received an epidural had a VP shunt.

No epidural-related complications or changes in neurological status were observed. All patients in both groups had functional levels at or below L3 and reported full abdominal sensation prior to surgery. This was unchanged following their procedure.

The epidural group had decreased opioid consumption on POD 0-3 (0.75 mg/kg vs. 1.29 mg/kg, p=0.04). Median mean and max pain scores were the same or improved in the epidural group (Table 1). Of note, no patient was diagnosed with any chronic pain condition or was taking opioid medication prior to their surgical procedure.

There was no difference in post-operative complications not related to epidural placement between groups (p=0.33). In the epidural group, three Clavien 1 complications (all clostridium difficile colitis) and one Clavien 2 complication (ileus requiring TPN) were observed. In the control group, two patients had complications. One patient developed clostridium difficile colitis (Clavien 1) and the other developed an ileus not requiring TPN and required a blood transfusion for a slowly declining hematocrit (Clavien 2)[6].

Discussion:

This study represents the first description and report of thoracic epidurals used for perioperative pain control in patients with LLSB. Most importantly, no patient in our cohort developed any change in their baseline neurological function such as motor or sensory changes as a result of epidural placement. No complication related to epidural placement was observed. Thoracic epidural analgesia appears safe in patients with VP shunts, as all patients in the epidural group had VP shunts. Additionally, those with an epidural were noted to require almost half the narcotics as those without epidurals, while reporting similar or improved pain scores.

The use of epidural anesthesia in parturients with SB has been reported but is limited to anecdotal case reports[7-13] and small case series[14-17]. Most research has reported on outcomes of pregnant women with spina bifida during labor and delivery, with only one small case series describing epidural use for post-operative pain[18]. Overall, these series found epidural analgesia to be safe. Reported complications in the 52 reported epidurals included asymmetric block in 1 (1.9%)[14], dural puncture in 3 (5.8%)[7,13,14], excessive block height in 1 (1.9%)[14], suboptimal analgesia in 7 (13.5%)[9,14], rapid onset block in 1 (1.9%)[9], spinal catheter migration in 1 (1.9%)[12], increased number of attempts/difficulty locating the epidural space in 3 (5.8%)[2,17] and post-procedural neurological deficit in 1 (1.9%)[8]. There is a consensus, which was also supported by our study that if neuraxial analgesia is considered in patients with SB, the needle insertion should occur at a level above the vertebral abnormality[3,9].

There are several limitations to our study inherent to a retrospective cohort study. Firstly, we were unable to exactly match patients by procedure type given the individual complexity of each lower urinary tract reconstruction. However, we did match on bladder augmentation, bladder neck procedures and catheterizable bladder channel creation. Additionally, the opioid and non-opioid pain and adjunct medications offered were not uniform between patients due to clinical course, surgeon, or anesthesia preference. Finally, since this was a feasibility study, it was not adequately powered to evaluate for differences in other clinically relevant outcomes such as time to return of bowel function or hospital length of stay.

This study demonstrates the feasibility and potential benefits of thoracic epidurals used in carefully selected LLSB patients undergoing major abdominal surgery. Further research with a larger population is needed to corroborate and better evaluate other clinically relevant outcomes such as time to return of bowel function or hospital length of stay. Therefore, we are currently planning a prospective trial to further evaluate the safety and potential benefit of epidural anesthesia in this patient population.

Conclusions
In appropriately selected LLSB patients, thoracic epidural analgesia appears to be a safe and effective option to assist with opioid sparing approaches to post-operative pain management. Pain scores are similar or lower in patients with epidurals compared to TAP blocks following LUTR. No epidural complications were noted.

Table 1: Patient Characteristics

Figure 1: Two representative MRIs of patients who had epidurals placed. Arrows indicate the location the epidural was placed and the boxes highlight the neural tube defect

Figure 2: Two representative images of patients following epidural placement. Boxes highlight the scar from the closure of the neural tube defect

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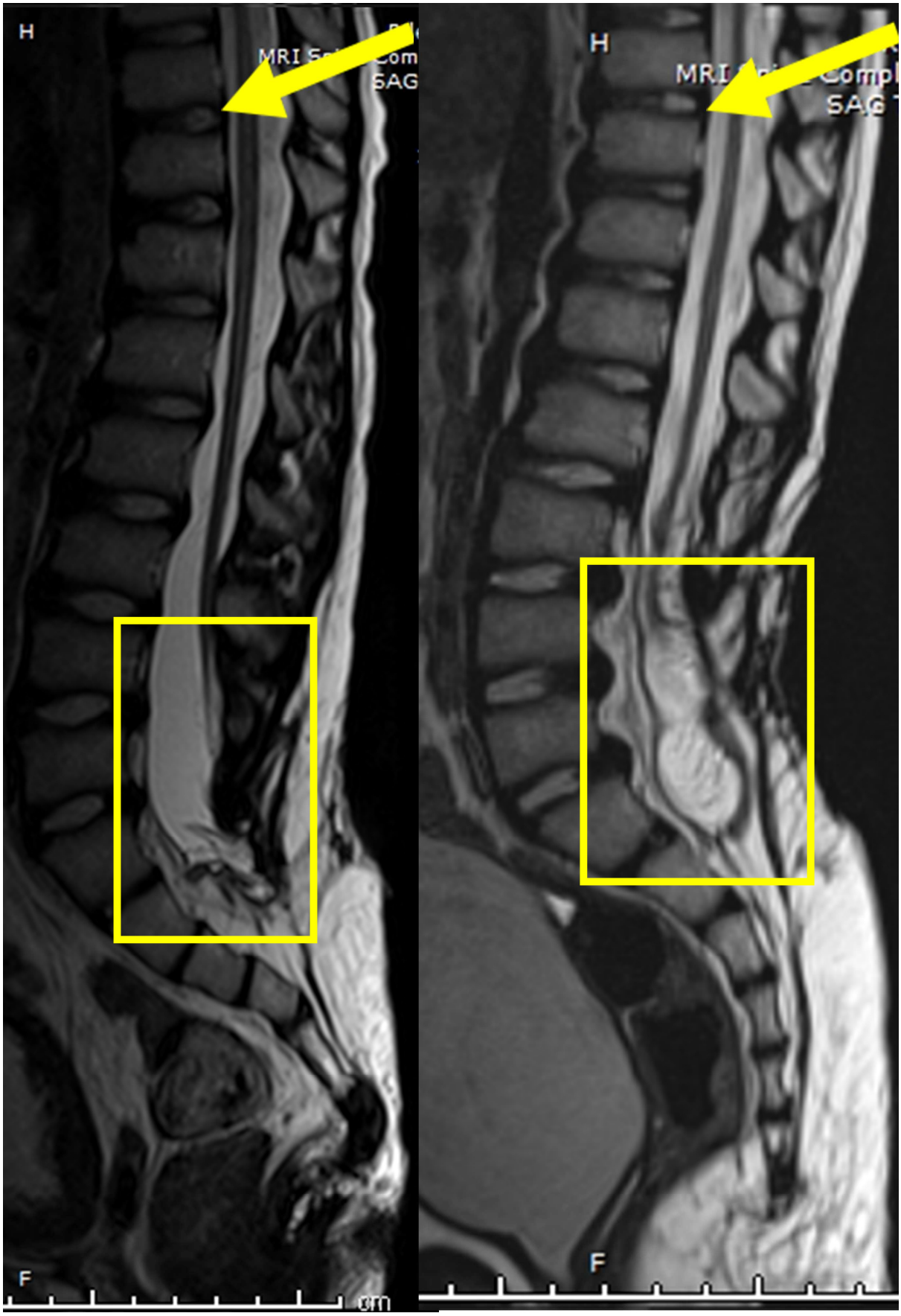
	Epidural Cohort (N=10)	Control Cohort (N=10)	p-value
Age in years, median (IQR)	6.5 (5.3-7.8)	7 (9.5)	0.45
Male patients, no. (%)	7 (70%)	4 (40%)	0.37
BMI in kg/m^2, median (IQR)	16.5 (14.6-18.1)	18.7 (15.8-21.6)	0.21
Presence of VP Shunt	10	6	0.09
Procedures Performed			0.97
Enterocystoplasty	5	5	
Bladder Neck Sling	3	3	
Bladder Neck Reconstruction	1	2	
Malone antegrade continence enema	5	8	
Catheterizable channel creation	7	9	
Operative Time in min, median (IQR)	385 (292.5-466)	308.5 (228.5-409.5)	0.19
Functional Level			0.56
L3, no. (%)	5 (50%)	3 (30%)	
L4, no. (%)	1 (10%)	3 (30%)	
L5, no. (%)	1 (10%)	2 (20%)	
S1, no. (%)	1 (10%)	0 (0%)	
S3, no. (%)	2 (20%)	3 (30%)	
Date of Epidural Removal			
POD2, no. (%)	1 (10%)	-	
POD3, no. (%)	4 (50%)	-	
POD4, no. (%)	4 (40.0%)	-	
POD5, no. (%)	1 (10.0%)	-	
PCA available to patient, no. (%)	4 (40%)	6 (60%)	0.66
Total IV Morphine Requirements on POD 0-3 (mg/kg), median (IQR)	0.75 (0.50-1.05)	1.29 (0.91-1.87)	0.04
Pain Scores			
Mean POD #0, median (IQR)	1.70 (1.06-2.5)	2.91 (2.05-3.65)	0.06
Max POD #0, median (IQR)	4.5 (3.0-5.75)	4.0 (4.0-5.0)	0.97
Mean POD #1, median (IQR)	1.67 (1.05-1.81)	2.13 (1.62-2.59)	0.11

Max POD #1, median (IQR)	6.0 (4.25-6.0)	5.5 (5.0-6.0)	0.97
Mean POD #2, median (IQR)	0.83 (0.37-1.42)	1.67 (1.10-3.46)	<0.05
Max POD #2, median (IQR)	3.5 (2.25-4.0)	6.0 (5.0-6.0)	0.01
Mean POD #3, median (IQR)	0.87 (0.58-1.23)	1.46 (0.32-2.24)	0.41
Max POD #3, median (IQR)	4.0 (3.25-5)	4.0 (2.5-6.75)	0.85
POD of Return of Bowel Function, median (IQR)	4.0 (3.25-4.75)	5.0 (4.0-5.75)	0.26
Antiemetics Taken on POD 0-3, median (IQR)	0.0 (0.0-2.75)	1.0 (0.0-1.75)	0.99
Length of Stay in Days, median (IQR)	7.0 (7.0-8.5)	6.0 (5.25-7.75)	0.27
Post-Operative Complications			0.8
Clavien grade 1	3	1	
Clavien grade 2	1	1	
Clavien grade 3	0	0	
Clavien grade 4	0	0	
Clavien grade 5	0	0	
Changes in neurological status	0	0	0.99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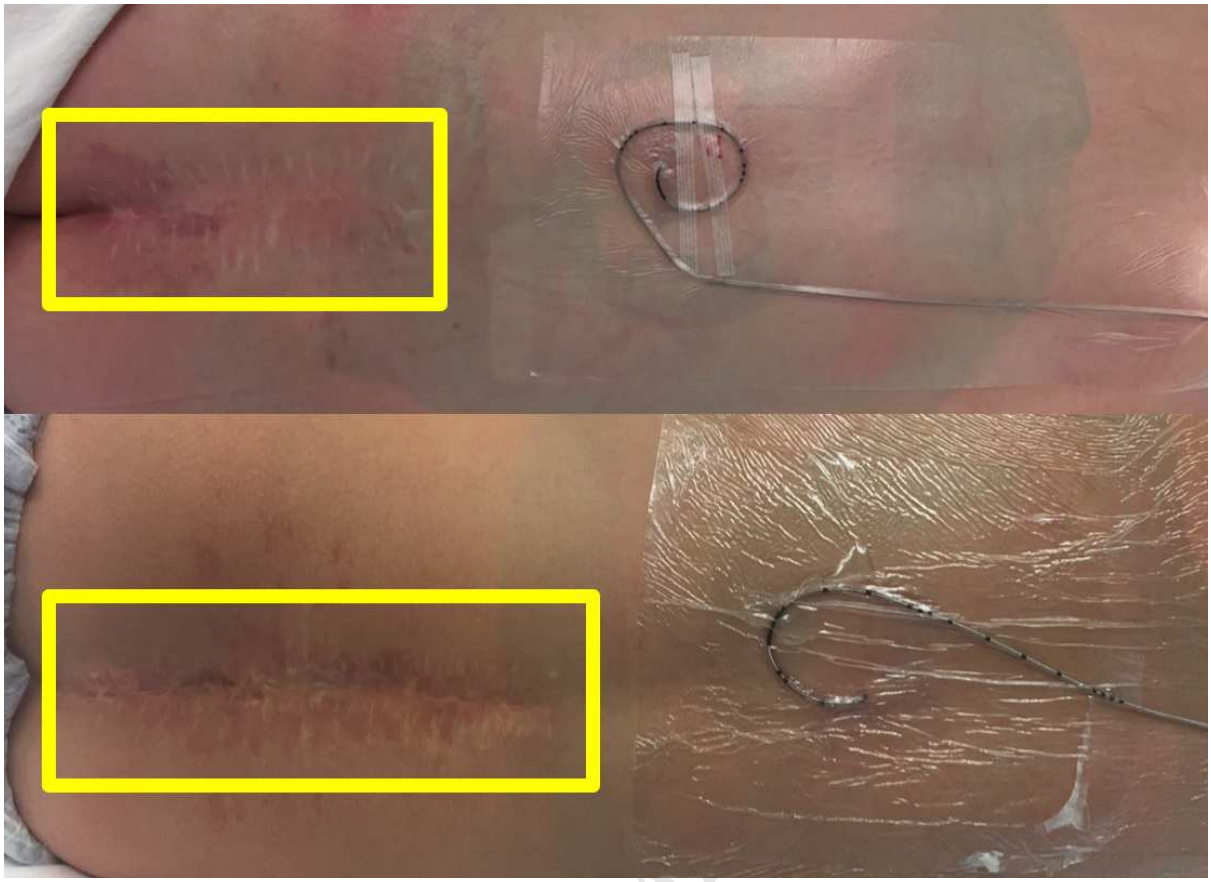

Abbreviations: LLSB: low level spina bifida, LUTR: lower urinary tract reconstruction, POD: post-operative day, PCA: patient controlled analgesia, TAP: transversus abdominis plane