

Henry Ford Health System

Henry Ford Health System Scholarly Commons

Anesthesiology Articles

Anesthesiology

4-1-2021

Subcostal Anterior Quadratus Lumborum Block Versus Epidural Block for Analgesia in Open Nephrectomy: A Randomized Clinical Trial

Hesham Elsharkawy

Sanchit Ahuja

Daniel I. Sessler

Kamal Maheshwari

Guangmei Mao

See next page for additional authors

Follow this and additional works at: https://scholarlycommons.henryford.com/anesthesiology_articles

Authors

Hesham Elsharkawy, Sanchit Ahuja, Daniel I. Sessler, Kamal Maheshwari, Guangmei Mao, Wael Ali Sakr Esa, Loran Mounir Soliman, Sabry Ayad, Dilara Khoshknabi, Mohammad Zafeer Khan, Syed Raza, Sean DeGrande, and Alparslan Turan

Subcostal Anterior Quadratus Lumborum Block Versus Epidural Block for Analgesia in Open Nephrectomy: A Randomized Clinical Trial

Hesham Elsharkawy, MD, MBA, MSc, FASA,*† Sanchit Ahuja, MD,†‡ Daniel I. Sessler, MD,† Kamal Maheshwari MD, MPH,†§ Guangmei Mao, PhD, MPH,†|| Wael Ali Sakr Esa, MD, MBA, PhD,§ Loran Mounir Soliman, MD,§ Sabry Ayad, MD, MBA, FASA,† Dilara Khoshknabi, MD,† Mohammad Zafeer Khan, MD,¶ Syed Raza, BS,† Sean DeGrande, MD,# and Alparslan Turan, MD†§

BACKGROUND: Epidural block are often used for analgesia after open nephrectomy surgery. Subcostal anterior quadratus lumborum block may be an alternative. We therefore tested the hypothesis that the continuous subcostal anterior quadratus lumborum block is noninferior to epidural block for analgesia in patients having open partial nephrectomies.

METHODS: Adults having open partial nephrectomies were randomly allocated to epidural or unilateral subcostal anterior quadratus lumborum block. The joint primary outcomes were opioid consumption measured in morphine equivalents and pain measured on a numeric rating scale (0–10) from postanesthesia care unit (PACU) until 72 hours after surgery. The noninferiority deltas were 30% for opioid consumption and 1 point on a 0–10 scale for pain. Secondary outcomes included patient global assessment of pain management on the third postoperative day, the number of antiemetic medication doses through the third postoperative day, duration of PACU stay, and postoperative duration of hospitalization.

RESULTS: Twenty-six patients were randomized to anterior quadratus lumborum block and 29 to epidural analgesia. Neither pain scores nor opioid consumption in the quadratus lumborum patients were noninferior to epidural analgesia. At 72 hours, mean \pm standard deviation pain scores in subcoastal anterior quadratus lumborum block and epidural group were 4.7 ± 1.8 and 4.1 ± 1.7 , with an estimated difference in pain scores of 0.62 (95% confidence interval [CI], 0.74-1.99; noninferiority $P = .21$). The median [Q1, Q3] opioid consumption was more than doubled in quadratus lumborum patients at 70 mg [43, 125] versus 30 mg [18, 75] in the epidural group with an estimated ratio of geometric means of 1.69 (95% CI, 0.66-4.33; noninferiority $P = .80$). Patient global assessment and duration of PACU and hospital stays did not differ significantly in the 2 groups.

CONCLUSIONS: We were unable to show that subcostal anterior quadratus lumborum block are noninferior to epidural analgesia in terms of pain scores and opioid consumption for open partial nephrectomies. Effectiveness of novel blocks should be rigorously tested in specific surgical setting before widespread adoption. (*Anesth Analg* 2021;132:1138–45)

KEY POINTS

- **Question:** Is continuous subcostal anterior quadratus lumborum block noninferior to epidural block in terms of pain score and opioid consumption among patients undergoing open partial nephrectomy?
- **Findings:** Neither pain scores nor opioid consumption in the subcostal anterior quadratus lumborum group were noninferior to epidural analgesia.
- **Meaning:** We were unable to show that subcostal anterior quadratus lumborum block are noninferior to epidural analgesia for reducing pain scores and opioid consumption for open partial nephrectomies.

From the *Department of Anesthesiology, Pain and Healing Center, Case Western Reserve University, MetroHealth, Cleveland, Ohio; †Department of Outcomes Research, Cleveland Clinic, Cleveland, Ohio; ‡Department of Anesthesiology, Pain Management & Perioperative Medicine, Henry Ford Health System, Detroit, Michigan; §Department of General Anesthesiology and ||Department of Quantitative Health Sciences, Cleveland Clinic, Cleveland, Ohio; ¶Department of Anesthesiology, Augusta University, Augusta, Georgia; and #Department of Anesthesia, Seven Hills Anesthesia, Edgewood, Kentucky.

Copyright © 2021 International Anesthesia Research Society
DOI: 10.1213/ANE.0000000000005382

Accepted for publication December 8, 2020.

Funding: This study was funded by Cleveland Clinic Research Program Committees, Pajunk Company, and internal departmental sources.

The authors declare no conflicts of interest.

Clinical trial registry: ClinicalTrials.gov (NCT03110081).

Reprints will not be available from the authors.

Address correspondence to Hesham Elsharkawy, MD, MBA, MSc, FASA, Department of Anesthesiology, Pain and Healing Center, Case Western Reserve University, MetroHealth, Cleveland, OH 44106. Address e-mail to h_sharkus@yahoo.com.

GLOSSARY

ASA = American Society of Anesthesiologists; **BMI** = body mass index; **CABG** = coronary artery bypass graft; **CI** = confidence interval; **CONSORT** = Consolidated Standards of Reporting Trials; **N_{miss}** = the number of missing; **NI** = noninferiority; **NI-P** = noninferiority *P* value; **ORSDS** = Opioid-Related Symptom Distress Scale; **PACU** = postanesthesia care unit; **POD** = postoperative day; **QL** = quadratus lumborum; **QoR** = quality of recovery; **SD** = standard deviation; **TWA** = time-weighted average

Open nephrectomies cause substantial postoperative pain. Thoracic epidural analgesia is generally considered the best analgesia for abdominal wall surgeries, but use in renal surgery is limited due to hypotension and because it precludes use of postoperative anticoagulants which are often indicated.^{1,2} Analgesic management in patients recovering from renal surgery therefore remains challenging and often depends on opioids despite their well-known limitations and risks.³

Recently developed truncal interfascial blocks such as the quadratus lumborum (QL) block may reduce pain after open renal surgery.^{4,5} Compared to thoracic epidural analgesia, QL blocks do not cause a generalized lower body sympathectomy, and thus do not promote hypotension. Furthermore, the block is relatively safe even when patients are anticoagulated.⁵

Various local anesthetic injection sites have been described for QL blocks, and the injection site determines which dermatomes are covered.⁶ But injecting local anesthetic anterior to QL muscle presumably allows drug to spread into the thoracic paravertebral space, thereby blocking the somatic and thoracic sympathetic trunk of lower thoracic segments.⁶⁻⁹ Using a subcostal anterior approach appears to extend dermatomal coverage based on a cadaver study.¹⁰ In a pilot series of 22 patients, we observed T6-L2 dermatomal coverage that should be suitable for subcostal nephrectomy incisions.⁹ However, it remains unknown whether subcostal anterior QL block provide analgesia comparable to thoracic epidural block. We therefore tested the hypothesis that subcostal anterior QL block with a continuous catheter are noninferior to epidural analgesia on pain control and opioid consumption in patients having open partial nephrectomy.

METHODS

The trial was approved by the Cleveland Clinic Institutional Review Board (IRB #15-1291). The study was registered at ClinicalTrials.gov (NCT03110081; principal investigator: Hesham Elsharkawy; date: December 22, 2016) before the first patient was enrolled. This study followed good clinical practice quality standards and ethical guidelines described by the Declaration of Helsinki.¹¹ Written informed consent was obtained from all participating patients. This article adheres to the applicable Consolidated Standards of Reporting Trials (CONSORT) guidelines.

We included adults aged ≥ 18 years, who were scheduled for elective open unilateral partial nephrectomy surgery at Cleveland Clinic Main Campus and Fairview Hospital. Patients were excluded if they had intolerance or allergy to opioids, were pregnant, had contraindications to epidural analgesia or QL block, or had chronic pain characterized by opioid use for >30 consecutive days within the 3 preoperative months at a dose equivalent to at least 15 mg of morphine.¹²

Patients were randomized 1:1, stratified by trial site, to either a unilateral subcostal anterior QL catheter or an epidural catheter. Randomization was based on computer-generated random allocation sequences with random block sizes. Allocations were maintained on a secure website that was accessed just before performance of the procedure. Allocation was thus concealed to the extent practical.

Both epidural blocks and subcostal anterior QL blocks were performed by faculty anesthesiologists who had served on the acute pain management service for at least 4 years and had performed at least 40 QL blocks. Blocks were deemed failures if the expected dermatomal coverage was not apparent. Catheters were then repositioned or removed and reinserted.

We used a previously described approach to subcostal anterior QL block.⁹ In summary, the patients were positioned lateral decubitus. A curvilinear 2–5 MHz ultrasound transducer (SonoSite S-Nerve, Bothell, WA) was positioned posteriorly below the 12th rib in a parasagittal oblique plane at L1-2 level. The QL muscle was visualized and its point of insertion on the 12th rib identified. An 18-gauge Tuohy needle was advanced in the caudal-to-cranial direction between QL muscle and the psoas major muscle until a click could often be felt as the needle tip penetrated the anterior investing fascia of the QL muscle. After a negative aspiration, 20 mL of 0.25% bupivacaine was injected through the needle to help confirm the final needle tip position, anterior to the QL muscle at close proximity to the 12th rib.

Thereafter, a 19-gauge peripheral nerve catheter (InfiltraLong Catheter, PAJUNK, Geisingen, Germany) was advanced 2–4 cm past the needle tip. Five milliliters of bupivacaine 0.25% was injected through the catheter to ensure catheter location. The catheter was tunneled medially then secured by transparent dressing and an ambulatory electronic infusion pump (Moog Curlin Infusion Pump, Salt Lake City, UT) was attached to the

catheter. An infusion of ropivacaine 0.2% was started towards the end of surgery in the operating room at a rate of 8 mL/h. Postoperatively, a continuous infusion of ropivacaine 0.2% was given through the catheter at a basal rate of 8 mL/h with patient-controlled, on-demand boluses of 6 mL allowed every 30 minutes. The infusion continued for at least 48 hours, and longer if deemed necessary by the acute pain team.

Patients assigned to epidural analgesia had mid-thoracic catheters inserted preoperatively at T7-8, guided by anatomical surface landmarks. A 17-gauge Tuohy needle was inserted either midline or paramedian, and the epidural space was identified by loss-of-resistance to saline. The catheter was threaded through the needle and advanced 2–4 cm past the needle tip. The catheter position was tested by injecting 3 mL of a mixture of lidocaine 1.5% and epinephrine 1:200,000 through the catheter. The epidural catheter was secured by transparent dressing and an ambulatory electronic infusion pump was attached to the catheter hub.

An infusion of bupivacaine 0.1% was started towards the end of surgery in the operating room at an infusion rate of 5 mL/h, and continuously administered for at least 48 hours and longer if deemed necessary by the acute pain team. Patient-controlled epidural boluses of 6 mL every 30 minutes were permitted. Local anesthetic was infused through both the peripheral nerve catheter and epidural catheter at the end of the surgery and in the postoperative period via an ambulatory electronic infusion pump (Moog Curlin Infusion Pump).

Clinicians performing the blocks and patients were not blinded, but investigators evaluating the outcomes were blinded to randomization. Bandages were positioned over the catheter and the infusion pump such that it was not obvious which block patients were assigned to. Similarly, control panels for the infusion pumps and the drug bags were covered to blind investigators evaluating outcomes.

All patients received general volatile anesthesia for surgery per institutional routine. Only fentanyl was permitted intraoperatively. Wound infiltration with local anesthetics and nonsteroidal anti-inflammatory medications were not permitted. In the postanesthesia care unit (PACU), patients were given intravenous boluses of opioids as needed according to the surgical and pain teams.

Patients in both groups received an intravenous patient-controlled analgesia system for rescue analgesia if needed. The intravenous patient-controlled analgesia system was provided with fentanyl boluses of 25 µg at 6-minute intervals without a basal infusion. Patients were also given intravenous boluses of fentanyl (25–50 µg) or hydromorphone (0.2–0.4 mg) for breakthrough pain if needed. Patients were given 1000 mg of

intravenous acetaminophen in the PACU, followed by 1000 mg oral acetaminophen 3 times daily for 48 hours.

Measurements

Baseline characteristics, including age, sex, race, and body mass index were retrieved from electronic medical records. Medical history, American Society of Anesthesiologists physical status, duration of surgery, and smoking status were recorded by the investigators.

The primary outcomes were opioid consumption and pain scores in the first 72 postoperative hours. Total opioid consumption was estimated as intravenous morphine equivalents.¹³ Pain scores, based on nursing assessments on a numeric pain rating scale (0–10, with 10 being worst) were recorded at 4-hour intervals and summarized as time-weighted average value by trapezoidal method.

We recorded the quality of recovery (QoR)-15 score and patient global assessment of pain management on the third postoperative day, along with the total number of antiemetic medication doses through the third postoperative day. Duration in the PACU stay and of postoperative hospitalization were also recorded.^{14–17}

Safety and quality outcomes included 2 components: (1) adverse events related to opioid use measured with the Opioid-Related Symptom Distress Scale¹⁸ and (2) a collapsed composite of postoperative oxygen administration, naloxone administration, and discontinuation of the local anesthetic infusion within 72 hours due to hypotension or weakness interfering with physical therapy or mobility.

On an exploratory basis, a blinded investigator assessed the dermatomal sensory level ipsilateral to the surgical incision using ice on postoperative days 1–3. We also quantified ward hypotensive episodes through discharge, defined by mean arterial pressure <65 mm Hg, as measured by nurses at 4-hour intervals.

Statistical Analysis

We assessed balance of the randomized groups on baseline and procedural characteristics using absolute standardized difference, defined as the absolute difference in mean values, mean ranks, or proportions divided by the pooled standard deviation (SD). Baseline variables with absolute standardized difference >0.53 (ie, $1.96 \times \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$) were considered imbalanced.

In the primary analysis, we assessed noninferiority of QL catheters to epidural analgesia on pain scores and total intravenous morphine equivalent doses of rescue opioid (after a logarithmic transformation) until the third postoperative day with 1-tailed noninferiority *t* tests. Noninferiority was tested using the

confidence interval (CI) method, defined as not >30% higher in opioid consumption and not >1 point worse in pain score. Specifically, noninferiority would be claimed if the upper limit of the 95% 2-sided (corresponds to α of .025 on upper tail) CI for the ratio of geometric mean values of total opioid consumption was less than the noninferiority delta of 1.3, and for the difference in mean values of pain score was less than the noninferiority delta of 1 point. P values were obtained from a 1-tailed t test using a test statistic defined as $T_{NI} = \frac{\hat{\beta}_1 - \delta}{SE_{\hat{\beta}_1}}$, where $\hat{\beta}_1$ is the estimated treatment effect, $SE_{\hat{\beta}_1}$ is the standard error of the treatment effect, and δ is the noninferiority delta. The overall significance level for noninferiority is .025 and the significance criterion for each test is also .025. In this joint hypothesis testing scenario, no adjustment for tests on 2 outcomes was needed because both outcomes are required to be significant to claim that QL is noninferior (ie, this is an intersection-union test).¹⁹

Analyses were modified intent-to-treat and thus included all randomized patients who received some amount of study intervention. We planned 3 interim analyses to assess efficacy and futility of the primary outcome at every 25% of the planned enrollment using a group sequential design with a gamma-spending function ($\gamma = -4$ for efficacy and -2 for futility) and nonbinding futility boundaries. The overall significance level was maintained at .025 across the interim monitoring. At the secondary interim, the P value boundaries were $P < .0024$ for efficacy and $P \geq .36$ for futility for the primary outcomes. CIs for the primary outcomes are thus estimated using the z -statistic corresponding to the significance criterion at the second interim, making them 99.76% CIs. However, we refer to them as “95% CI” throughout since the 1-sided alpha level for the study was .025.

We compared the randomized groups for each secondary outcome using appropriate 2-tailed tests for superiority. Specifically, patient global assessment was compared using Wilcoxon rank sum tests. Any antiemetic medications and any episodes of hypotension were assessed using logistic regression. Length of hospital stay and PACU stay was assessed using linear regression. The significance level for the set of secondary outcomes is preserved at .05 overall using a criterion of $P < .05/5 = .01$ for each test (applying a Bonferroni correction for multiple testing of the 5 secondary outcomes). We used SAS version 9.4 for the analyses.

Sample Size and Power

Sample size was based on being able to detect noninferiority on both total opioid consumption and pain score in the first 72 hours with about 85% overall power at the overall .025 significance level. Based on pilot data, we assume that QL block provides equal

efficacy compared to epidural; time-weighted average pain scores have a mean of about 4 with a SD of 1.5; the opioid consumption with a coefficient of variation (SD/mean) of 0.45. For a single-analysis study, we would need about 100 patients to detect noninferiority for opioid consumption at the .025 significance level, assuming noninferiority delta of 1.3 in ratio of geometric means (ie, 30% increase in opioid consumption). At the same time, a total of 100 patients would give over 90% power to detect noninferiority in pain score with a delta of 1 point.

RESULTS

We enrolled patients from May 2017 to February 2019 at the Cleveland Clinic Main Campus and Cleveland Clinic Fairview Hospital. The second interim analysis was conducted after 50% of the planned patients were enrolled. Because futility boundaries ($P \geq .36$) were crossed at that time, the study was concluded per protocol after enrollment of 55 patients. No patient withdrew from this study, thus we included all of them in the analyses. A total of 26 patients were randomized to QL blocks and 29 to epidural analgesia (Figure 1). The absolute standardized difference of all potentially confounding baseline and procedural characteristics were within 0.53, so we did not adjust for any confounders in all analyses (Table 1). Dermatomal sensory block levels are shown in Figure 2.

Time-weighted average pain scores and total opioid consumption in the first 72 hours after surgery are summarized by treatment group in Table 2 and Figure 3. Mean \pm SD pain scores in subcostal anterior QL block and epidural group were 4.7 ± 1.8 and 4.1 ± 1.7 , with an estimated difference in pain scores of 0.62 (95% CI, 0.74-1.99; noninferiority $P = .21$). The median [Q1, Q3] opioid consumption was more than doubled in QL patients at 70 mg [43, 125] versus 30 mg [18, 75] in the epidural group with an estimated ratio of geometric means of 1.69 (95% CI, 0.66-4.33; noninferiority $P = .80$).

The secondary outcomes are summarized in Table 3. Length of PACU stay, length of hospital stays, QoR-15 score, the incidence of postoperative antiemetic medication, and patient global assessment on postoperative day 3 did not differ significantly in the QL and epidural groups. Safety and quality outcomes were summarized in Table 3. There were no clinically meaningful differences between the groups.

DISCUSSION

The trial was stopped per protocol at a planned interim analysis on the basis of futility. Specifically, the results were inconsistent with our hypothesis that subcostal QL block are noninferior to epidural analgesia on pain and opioid consumption. No significant difference in pain scores were noted with each

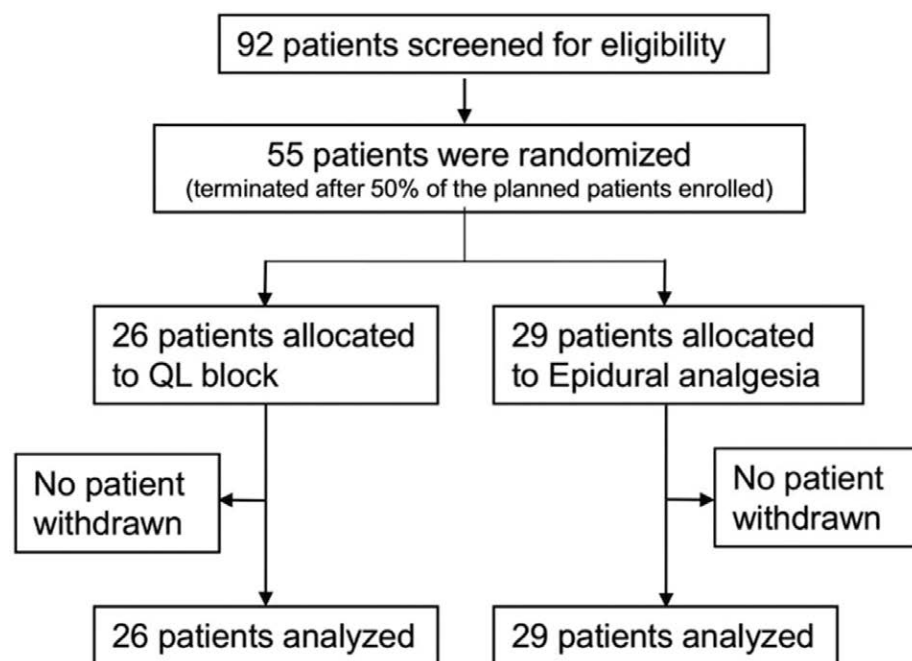


Figure 1. Flow chart. QL indicates quadratus lumborum.

Table 1. Patient Characteristics (N = 55)			
Factor	QL (N = 26)	Epidural (N = 29)	Standardized difference
Demographics			
Age (y)	63 ± 10	65 ± 12	-0.17
Sex (female versus male)	14 (54)	9 (31)	0.47
BMI (kg/m ²)	33 ± 8	33 ± 7	0.02
Race			0.05
White	22 (85)	25 (86)	
Black	3 (12)	3 (10)	
Other	1 (4)	1 (3)	
ASA physical status			0.26
II	2 (8)	1 (3)	
III	22 (85)	24 (83)	
IV	2 (8)	4 (14)	
Medical history			
Obstructive sleep apnea	6 (23)	4 (14)	0.24
Diabetes mellitus	7 (27)	5 (17)	0.24
Myocardial infarction	5 (19)	2 (7)	0.37
Ischemic heart disease (angina/stent/CABG)	2 (8)	6 (21)	-0.38
Chronic pain requiring opioids	0 (0)	2 (7)	-0.38
Current smoker	2 (8)	5 (17)	-0.29
Cancer	17 (65)	13 (45)	0.42
Duration of surgery (h)	5.3 ± 1.3	5.5 ± 0.9	-0.26
Length of PACU stay (h)	2.2 ± 1.0	2.2 ± 0.9	-0.01
Length of hospital stay (d)	5.0 ± 1.3	5.3 ± 1.4	-0.15

Summary statistics are presented as mean scores ± standard deviations or N (column %).

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; CABG, coronary artery bypass graft; PACU, postanesthesia care unit; QL, quadratus lumborum.

approach as is typical in such trials because patients use patient-controlled opioids to suitably block surgical pain. In contrast, patients randomized to QL blocks used more than twice as much opioid as those given epidural analgesia.

Our results contrast with 2 similar trials comparing QL block and epidural analgesia for nephrectomy

surgery.^{20,21} However, both restricted enrollment to patients having laparoscopic procedures whereas all our patients had open surgery, which is more painful. Furthermore, open nephrectomy incisions involve anterolateral abdominal wall innervation by T6-T12 thoracolumbar spinal nerves.²² The pain originating from kidney reaches the lower thoracic spinal cord via celiac and renal plexus, greater and lesser splanchnic nerves, and sympathetic and parasympathetic trunks with nerve root innervation from T4-L1.^{23,24} Adequate visceral coverage therefore requires blocks reaching to T4. Although cadaver studies indicate that injected contrast can spread cranially through the thoracic paravertebral space to T4, the actual extent of sensory dermatomal coverage in our QL patients was less and inconsistent, ranging from T6 to L2.^{8,10} In contrast, epidural blocks were more consistent and had wider dermatomal coverage, ranging from T4 to L2.

An additional factor is that open nephrectomy incisions often extend to the midline, an area better covered by the bilateral analgesia of epidural block.²⁴ And finally, visceral postoperative pain may also be better covered by epidural block. There are thus various reasons that epidural analgesia is preferable to QL block for open nephrectomy surgery—although previous work suggests that the block are suitable for laparoscopic nephrectomies. There was no significant difference in PACU duration and overall length of hospital stay in patients randomized to QL or epidural blocks, presumably because no evidence for a difference in pain scores was observed.

Our trial did not demonstrate reduced postoperative nausea and vomiting in the QL group. Midthoracic epidural effectively blocks sympathetic

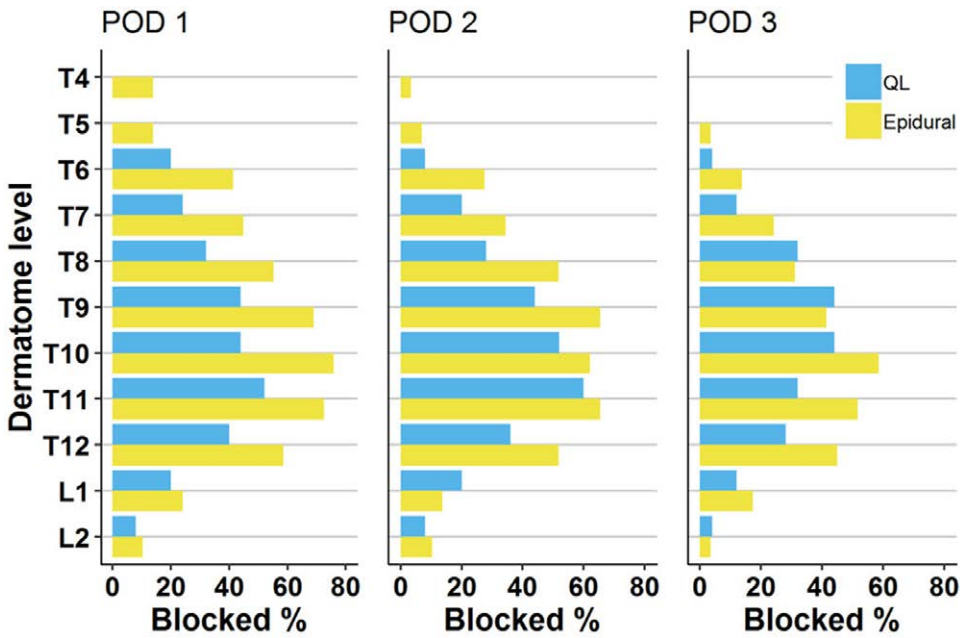


Figure 2. Dermatome coverage on PODs 1–3. PODs indicates postoperative days; QL, quadratus lumborum.

Table 2. Primary Outcome Analysis: Comparison Between QL Block and Epidural Analgesia on Pain Score and Opioid Consumption From the Time of Arrival to PACU until 72 h After Surgery

	QL (N = 26)	Epidural (N = 29)	NI delta	Effect size (95% CI) ^a	NI-P ^b
Pain score, mean ± SD ^c	4.7 ± 1.8	4.1 ± 1.7	1	Difference in mean values (QL – epidural) 0.62 (–0.74 to 1.99)	.21
Opioid consumption in mg, median [Q1, Q3] ^d	70 [43, 125]	30 [18, 75]	1.3	Ratio of geometric mean values (QL/epidural) 1.69 (0.66-4.33)	.80

Abbreviations: CI, confidence interval; NI, noninferiority; NI-P, noninferiority P value; PACU, postanesthesia care unit; QL, quadratus lumborum block; SD, standard deviation.

^a95% CI was adjusted for sequential design. We would claim NI if upper limit of 95% 2-sided CI < NI delta. They are called “95% CI” here and throughout since the 1-sided alpha level for the study was .025, even though the actual CIs at the second interim analysis were 99.8% using the efficacy boundary of P < .0024.

^bSignificant if P < .0024.

^cSummary statistics of pain scores are reported as mean ± SD of time-weighted average pain during the first 72 h. Difference in time-weighted average pain scores was assessed in a linear regression model.

^dTotal opioid consumption (milligrams as intravenous morphine equivalent) in the first 72 h after surgery was summarized as median [Q1, Q3]. Difference of opioid consumption between 2 groups was assessed using a linear regression model after logarithm transformation of opioid consumption.

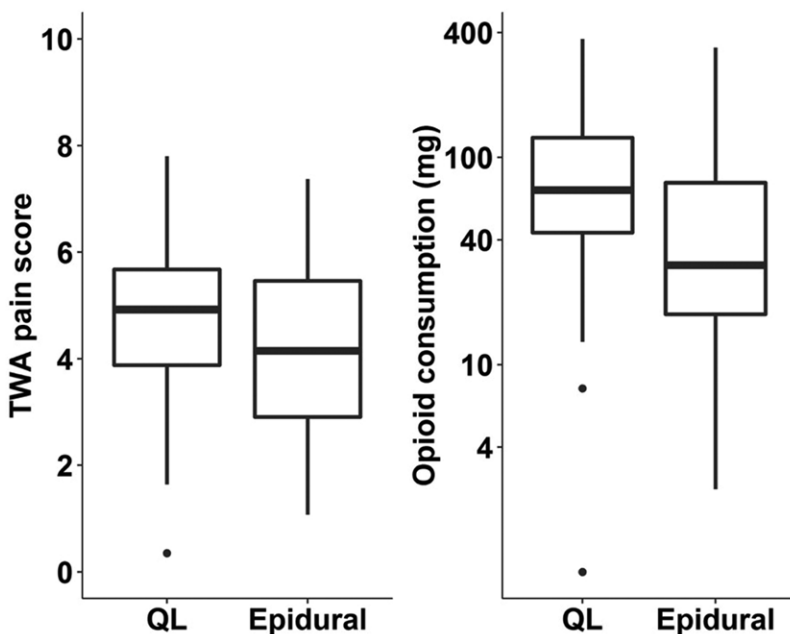


Figure 3. Pain and opioid consumption. Left panel shows the TWA of pain score in the first 72 h after surgery. Right panel shows the cumulative opioid consumption as intravenous morphine equivalent in the first 72 h after surgery (y-axis is on log scale). The whiskers are the 2 lines outside the box that extend to the highest and lowest observations. QL indicates quadratus lumborum; TWA, time-weighted average.

Table 3. Comparison Between QL Block and Epidural Analgesia on Secondary, Safety, and Exploratory Outcomes

	QL (N = 26)		Epidural (N = 29)		Effect size (95% CI)	P
	N _{miss}	Summary	N _{miss}	Summary		
Secondary outcomes^a						
Length of PACU stay (h) ^b	0	2.2 ± 1.0	1	2.2 ± 0.9	0.1 (-0.6, 0.8)	.81
Length of hospital stay (d) ^b	0	5.0 ± 1.3	0	5.3 ± 1.4	-0.2 (-1.2, 0.7)	.54
QoR-15 score ^b	1	109 ± 19	0	102 ± 21	7.2 (-7.4, 22)	.19
Any antiemetic medication ^c	1	3 (12%)	0	8 (28%)	0.4 (0.04, 2.2)	.16
Patient global assessment ^d	1		1			.63
Poor		3 (12%)		5 (18%)		
Fair		8 (32%)		7 (25%)		
Good		11 (44%)		8 (29%)		
Excellent		3 (12%)		8 (29%)		
Safety and quality outcomes^e						
ORSDS ^b	1	0.44 ± 0.26	0	0.49 ± 0.28	-0.15 (-0.34 to 0.04)	.11
POD 1	1	0.49 ± 0.31	0	0.54 ± 0.44		
POD 2	1	0.53 ± 0.33	0	0.48 ± 0.36		
POD 3	1	0.30 ± 0.30	1	0.45 ± 0.37		
Any hypotension ^c	1	5 (20%)	0	4 (14%)	1.6 (0.4-7.1)	.54
Collapsed composite of postoperative oxygen administration, naloxone administration, and stopping of local anesthetic infusion ^c	1	15 (60%)	0	14 (48%)	1.6 (0.6-4.8)	.39

Abbreviations: CI, confidence interval, N_{miss}, the number of missing; ORSDS, Opioid-Related Symptom Distress Scale; PACU, postanesthesia care unit; POD, postoperative day; QL, quadratus lumborum; QoR-15, quality of recovery-15.

^aSignificance level for each secondary outcome is $P < .01$, adjusted for multiple comparisons on 5 outcomes (ie, .05 of 5, Bonferroni correction). Correspondingly, 99% CIs were reported.

^bContinuous outcome summarized as mean ± standard deviation. Estimated difference between QL versus epidural group was estimated from a linear regression model. ORSDS is a 4-point scale measured on POD 1–3. The score on each day and the average score over 3 d were summarized as mean ± standard deviation.

^cCategorical outcome is summarized as N (%). The estimated odds ratio of having any antiemetic medication was reported as the effect size.

^dPatient global assessment, summarized as N (%). P was from Wilcoxon test.

^eSignificance level for safety and quality outcomes is $P < .05$, not adjusted for multiple comparisons.

outflow to gastrointestinal tract (T5-T12), resulting in an unopposed parasympathetic tone, leading to gut hyperperistalsis and accompanying nausea. Continuous nerve blocks, on the other hand, results in less sympathectomy and have an opioid-sparing effect—thus potentially reducing postoperative nausea and vomiting via both mechanisms. Nonetheless, nausea and vomiting were nonsignificant in our cohort, with the caveat that our trial was too small to evaluate this outcome. While the overall outcomes were in favor of epidural block in open nephrectomy, interfascial blocks such as QL block may be an alternative in patients where adverse effects of sympathectomy such as hypotension outweigh the overall benefits of epidural block.

Our trial was assessor-blinded, but patients knew their group allocations and may have believed that one modality or the other was preferable, resulting in biased pain assessments. There is no consensus on the best type, volume, or concentration of local anesthetics for QL blocks. But it is plausible that QL blocks require larger volumes to spread appropriately in the relatively large inter-muscle plane. Results may therefore have differed if we injected more local anesthetic for the plane block. In our study, we used different local anesthetics and concentration in the 2 randomized groups; 0.2% ropivacaine (QL block) versus 0.1% bupivacaine (epidural block), might influence

analgesia. The comparative potency ratio of mean effective dose of ropivacaine and bupivacaine previously noted to be 75%.²⁵ Other factors, importantly the vascularity of interfascial spaces and systemic absorption might influence the resulted analgesia.

In summary, we were unable to show that subcostal anterior QL block are noninferior to epidural analgesia in terms of pain score and opioid consumption. No evidence for a difference in pain scores was observed. However, patients randomized to QL block required more than twice as much opioid over the initial 3 postoperative days. Nonetheless, the quality of recovery and hospital lengths of stay were comparable with each approach. The efficacy of subcostal QL block should be rigorously investigated in specific surgical settings before widespread adoption. ■■

ACKNOWLEDGMENTS

The authors appreciate the efforts of research fellows and all medical staff of the Department of Outcomes Research and the Acute Pain Team at Cleveland Clinic. The authors also thank the Department of Urology, especially Dr Amr Fergany and Steven Campbell.

DISCLOSURES

Name: Hesham Elsharkawy, MD, MBA, MSc, FASA.

Contribution: This author helped design the trial, acquire, and interpret the data; draft, revise, and approve the final manuscript.

Name: Sanchit Ahuja, MD.

Contribution: This author helped design the trial, acquire, and interpret the data; draft, revise, and approve the final manuscript.

Name: Daniel I. Sessler, MD.

Contribution: This author helped design the trial, acquire, and interpret the data; draft, revise, and approve the final manuscript.

Name: Kamal Maheshwari MD, MPH.

Contribution: This author helped revise and approve the final manuscript.

Name: Guangmei Mao, PhD, MPH.

Contribution: This author helped design the trial, acquire, and interpret the data, and revise the manuscript.

Name: Wael Ali Sakr Esa, MD, MBA, PhD.

Contribution: This author helped revise and approve the final manuscript.

Name: Loran Mounir Soliman, MD.

Contribution: This author helped revise and approve the final manuscript.

Name: Sabry Ayad, MD, MBA, FASA.

Contribution: This author helped revise and approve the final manuscript.

Name: Dilara Khoshknabi, MD.

Contribution: This author helped acquire the data, revise, and approve the final manuscript.

Name: Mohammad Zafeer Khan, MD.

Contribution: This author helped acquire the data, revise, and approve the final manuscript.

Name: Syed Raza, BS.

Contribution: This author helped acquire the data, revise, and approve the final manuscript.

Name: Sean DeGrande, MD.

Contribution: This author helped acquire the data, revise, and approve the final manuscript.

Name: Alparslan Turan, MD.

Contribution: This author helped design the trial, acquire, and interpret the data; draft, revise, and approve the final manuscript.

This manuscript was handled by: Honorio T. Benzon, MD.

REFERENCES

- Rigg JR, Jamrozik K, Myles PS, et al; MASTER Anaesthesia Trial Study Group. Epidural anaesthesia and analgesia and outcome of major surgery: a randomised trial. *Lancet*. 2002;359:1276–1282.
- Manion SC, Brennan TJ. Thoracic epidural analgesia and acute pain management. *Anesthesiology*. 2011;115:181–188.
- Alper I, Yüksel E. Comparison of acute and chronic pain after open nephrectomy versus laparoscopic nephrectomy: a prospective clinical trial. *Medicine (Baltimore)*. 2016;95:e3433.
- Elsharkawy H, El-Boghdadly K, Barrington M. Quadratus lumborum block: anatomical concepts, mechanisms, and techniques. *Anesthesiology*. 2019;130:322–335.
- Elsharkawy H, Pawa A, Mariano ER. Interfascial plane blocks: back to basics. *Reg Anesth Pain Med*. 2018;43:341–346.
- Elsharkawy H. Quadratus lumborum block with paramedian sagittal oblique (subcostal) approach. *Anaesthesia*. 2016;71:241–242.
- El-Boghdadly K, Elsharkawy H, Short A, Chin KJ. Quadratus lumborum block nomenclature and anatomical considerations. *Reg Anesth Pain Med*. 2016;41:548–549.
- Dam M, Moriggl B, Hansen CK, Hoermann R, Bendtsen TF, Børglum J. The pathway of injectate spread with the transmuscular quadratus lumborum block: a cadaver study. *Anesth Analg*. 2017;125:303–312.
- Elsharkawy H, Ahuja S, DeGrande S, Maheshwari K, Chan V. Subcostal approach to anterior quadratus lumborum block for pain control following open urological procedures. *J Anesth*. 2019;33:148–154.
- Elsharkawy H, El-Boghdadly K, Kolli S, et al. Injectate spread following anterior sub-costal and posterior approaches to the quadratus lumborum block: a comparative cadaveric study. *Eur J Anaesthesiol*. 2017;34:587–595.
- Carlson RV, Boyd KM, Webb DJ. The revision of the declaration of helsinki: past, present and future. *Br J Clin Pharmacol*. 2004;57:695–713.
- Dowell D, Haegerich TM, Chou R. CDC guideline for prescribing opioids for chronic pain—United States, 2016. *JAMA*. 2016;315:1624–1645.
- Gammaitoni AR, Fine P, Alvarez N, McPherson ML, Bergmark S. Clinical application of opioid equianalgesic data. *Clin J Pain*. 2003;19:286–297.
- Stark PA, Myles PS, Burke JA. Development and psychometric evaluation of a postoperative quality of recovery score: the QoR-15. *Anesthesiology*. 2013;118:1332–1340.
- Gornall BF, Myles PS, Smith CL, et al. Measurement of quality of recovery using the QoR-40: a quantitative systematic review. *Br J Anaesth*. 2013;111:161–169.
- Myles PS, Weitekamp B, Jones K, Melick J, Hensen S. Validity and reliability of a postoperative quality of recovery score: the QoR-40. *Br J Anaesth*. 2000;84:11–15.
- Rothman M, Vallow S, Damaraju CV, Hewitt DJ. Using the patient global assessment of the method of pain control to assess new analgesic modalities in clinical trials. *Curr Med Res Opin*. 2009;25:1433–1443.
- Apfelbaum JL, Gan TJ, Zhao S, Hanna DB, Chen C. Reliability and validity of the perioperative opioid-related symptom distress scale. *Anesth Analg*. 2004;99:699–709.
- Mascha EJ, Turan A. Joint hypothesis testing and gatekeeping procedures for studies with multiple endpoints. *Anesth Analg*. 2012;114:1304–1317.
- Aditioningsih D, Pryambodho, Anasy N, Tantri AR, Mochtar CA. A randomized controlled trial on analgesic effect of repeated quadratus lumborum block versus continuous epidural analgesia following laparoscopic nephrectomy. *BMC Anesthesiol*. 2019;19:221.
- Zhu M, Qi Y, He H, Lou J, Pei Q, Mei Y. Analgesic effect of the ultrasound-guided subcostal approach to transmuscular quadratus lumborum block in patients undergoing laparoscopic nephrectomy: a randomized controlled trial. *BMC Anesthesiol*. 2019;19:154.
- Chapman E, Pichel AC. Anaesthesia for nephrectomy. *BJA Education* 2016;16:98–101.
- Casteleijn NF, Visser FW, Drenth JPH, et al; DIPAK Consortium. A stepwise approach for effective management of chronic pain in autosomal-dominant polycystic kidney disease. *Nephrol Dial Transplant*. 2014;29(suppl 4):iv142–iv153.
- Anastasiou J, Karatzas T, Felekouras E, et al. Radical nephrectomy with transperitoneal subcostal incision for large and locally advanced tumors of the right kidney. *Anticancer Res*. 2012;32:5023–5029.
- Ngan Kee WD, Ng FF, Khaw KS, Lee A, Gin T. Determination and comparison of graded dose-response curves for epidural bupivacaine and ropivacaine for analgesia in laboring nulliparous women. *Anesthesiology*. 2010;113:445–453.