The comparative effectiveness of quadratus lumborum blocks and paravertebral blocks in radical cystectomy patients

Austin J. Lee, BA,[1] Jonathan G. Yabes, PhD,[2] Nathan Hale, DO,[3] Ronald L. Hrebinko, MD,[3] Jeffrey R. Gingrich, MD,[3] Jodi K. Maranchie, MD,[3] Mina M. Fam, MD,[3] Robert M. Turner II, MD,[3] Benjamin J. Davies, MD,[3] Bruce Ben-David, MD,[4] Bruce L. Jacobs, MD[3]

[1]School of Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania, USA
[2]Department of Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania, USA
[3]Department of Urology, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, USA
[4]Department of Anesthesiology, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, USA

LEE AJ, YABES JG, HALE N, HREBINKO RL, GINGRICH JR, MARANCHIE JK, FAM MM, TURNER II RM, DAVIES BJ, BEN-DAVID B, JACOBS BL. The comparative effectiveness of quadratus lumborum blocks and paravertebral blocks in radical cystectomy patients. *Can J Urol* 2018;25(2):9255-9261.

Introduction: *Multimodal analgesia is an effective way to control pain and limit opioid use after surgery. The quadratus lumborum block and paravertebral block are two regional anesthesia techniques that leverage multimodal analgesia to improve postoperative pain control. We sought to compare the efficacy of these blocks for pain management following radical cystectomy.*

Materials and methods: *We performed a retrospective review of radical cystectomy patients who received bilateral continuous paravertebral blocks (n = 125) or bilateral single shot quadratus lumborum blocks (n = 50) between 2014-2016. The primary outcome was postoperative opiate consumption on day 0. Secondary outcomes included self-reported pain scores and hospital length of stay.*

Results: *Quadratus lumborum block patients had similar opioid use on postoperative day 0 compared with paravertebral block patients (29 mg versus 30 mg, p = 0.90). Pain scores on postoperative day 0 were similar between quadratus lumborum block and paravertebral block groups (4.0 versus 3.8, p = 0.72); however, the paravertebral block group had lower pain scores on days 1-3 compared with the quadratus lumborum block group (all p < 0.05). Hospital length of stay was similar between groups (6.6 days versus 6.2 days, p = 0.41).*

Conclusions: *There were no differences in opioid consumption among patients receiving bilateral single shot quadratus lumborum blocks and bilateral continuous paravertebral blocks after radical cystectomy. These data suggest that the quadratus lumborum block is a viable alternative for delivering multimodal analgesia in cystectomy patients.*

Key Words: cystectomy, analgesia, nerve block, pain, postoperative

Introduction

Multimodal analgesia is an effective way to improve pain control and limit opioid use after surgery. Regional analgesia is an important element of multimodal analgesia that has gained traction because it blocks nociceptive input from the surgical site to the spinal cord with minimal side effects. For this reason, regional analgesia may have important benefits for bladder cancer patients undergoing cystectomy since this surgery is associated with significant pain that delays recovery.[1] After this surgery, patients typically require substantial postoperative opioid administration to help patients control their pain. However, opioid analgesics have a range of dose-dependent adverse effects including ileus, nausea, vomiting, sleep disturbance, immunosuppression, and urinary retention.[2] Minimizing the pain and opioids use postoperatively through the use of regional analgesia for radical cystectomy would benefit patients

Accepted for publication January 2018

Address correspondence to Dr. Austin J. Lee, 5200 Centre Avenue, Suite 209, Pittsburgh, PA 15232 USA

by limiting opioid side effects and enhancing recovery.[3]

Several different techniques of regional analgesia have been found to target the abdominal region. The paravertebral block utilizes the paravertebral space and its open cephalo-caudad contiguity to introduce local anesthetic across multiple dermatomal levels to effect neural blockade for either thoracic or abdominal surgeries, depending on the thoracic level of block placement. It is a well-established technique thought to have at least equivalent analgesic efficacy as epidural analgesia.[4,5] Another novel regional anesthetic technique is the quadratus lumborum block, which was first described in 2007; it involves the injection of local anesthetics into the space that lies between the medial layer of the thoracolumbar fascia and the quadratus lumborum muscle.[6] Compared to the paravertebral block, the quadratus lumborum block may provide analgesia to more dermatomes.[7-9] Researchers have postulated that it acts as an indirect paravertebral block with local anesthetic spread medially into the paravertebral space.[10] Studies have suggested that its action remains more peripheral, blocking the radicular innervation from T6-L2 as the nerves course laterally along the transversalis and thoracolumbar fascia. Several case reports have shown the efficacy of the quadratus lumborum block in controlling pain following laparotomy.[11-13] To our knowledge, there are no direct comparisons between the paravertebral and quadratus lumborum blocks.

To compare the efficacy of these two techniques, we conducted a retrospective review comparing radical cystectomy patients who received either paravertebral block or quadratus lumborum block as part of their postoperative care. We evaluated the association of each regional analgesic technique with postoperative opioid use and self-reported pain scores. The purpose of this study is to better define the analgesic efficacy of the quadratus lumborum block for laparotomy and, more specifically, to examine its viability as a regional analgesia technique for radical cystectomy.

Materials and methods

Study population

We performed a retrospective review of 175 patients who underwent a radical cystectomy between May 2014 and June 2016 at our institution. Due to a protocol change in January 2016, radical cystectomy patients transitioned from receiving continuous bilateral paravertebral blocks to receiving bilateral single shot quadratus lumborum blocks. We identified 125 radical cystectomy patients who had received a paravertebral block and 50 radical cystectomy patients who had received a quadratus lumborum block, Figure 1. All patients were continuous. We excluded 7 paravertebral block patients and 3 quadratus lumborum block patients due a prior history of chronic pain or regular preoperative use of pain medications.

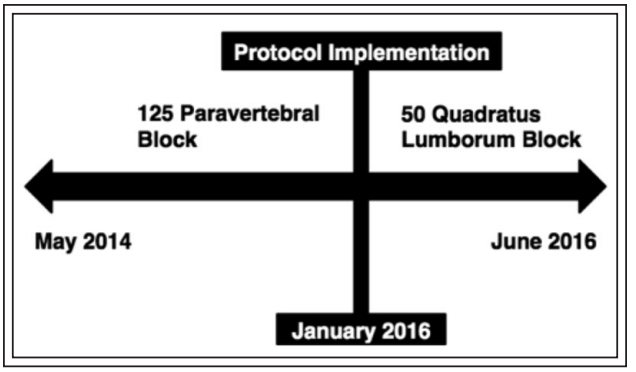

Figure 1. Paravertebral block patients (N = 125) were collected prior to January 2016. The protocol implementation in January 2016 represents change to quadratus lumborum blocks (N = 50).

Analgesia protocol

All patients received their blocks prior to surgery in a preoperative holding area. All blocks were conducted only after establishing intravenous access and application of standard monitoring. Patients typically received mild sedation with small doses of fentanyl and midazolam prior to the procedure. All blocks were conducted under sterile conditions. No other changes in pain adjuncts differed between the two groups other than the type of pain block provided.

Patients with a quadratus lumborum block received bilateral single shot injections. With the patient positioned supine and tilted laterally by placing a rolled blanket under the hip, a low-frequency curved array ultrasound probe with sterile sleeve was placed horizontally at the umbilicus and moved laterally over the triangle of Petit. A quadratus lumborum block was performed on each side using a 22-gauge, 8-cm Tuohy needle.[14] Needle positioning was confirmed by careful hydro-dissection with normal saline and, after negative aspiration, 20 mL of 0.5% ropivacaine + dexmedetomidine 30 mcg + dexamethasone 4 mg was injected and appropriate, posterior spread observed.

Patients receiving a paravertebral block were given a continuous, catheter-based infusion, which was discontinued on postoperative day 2. Lidocaine 1% was infiltrated subcutaneously 2.5 cm lateral bilaterally to the T9 or T10 spinous process. An 18-gauge, 9 cm Tuohy needle was introduced perpendicular to the

skin, finding contact with the transverse process. The needle was then readjusted in a caudal direction and reinserted inferior to the transverse process to a depth approximately 1 cm deep to the point of contact with bone. After proper siting of the needle and negative aspiration of blood or cerebrospinal fluid, 5 mL 0.5% ropivacaine was injected and a 20-guage closed tip catheter was inserted to a depth of 5 cm beyond the tip of the needle. An additional 10 mL 0.5% ropivacaine was then injected in 5 mL increments through the catheter to complete a total initial dose of 15 mL 0.5% ropivacaine. Postoperatively, these catheters were connected to infusion pumps infusing lidocaine 0.25% at rates varying between 7 mL/h-10 mL/h.

Following surgery, patients were given hydromorphone administered as patient controlled analgesia. These were discontinued when the patient was able to tolerate oral intake. For the duration of the hospitalization, patients were given oral opiates as needed.

Outcomes

Opioid consumption was tabulated for each postoperative day. Our primary outcome was oral morphine equivalents (OME) within the first 24 hours since that is the typical duration of the single shot quadratus lumborum blocks. Opioid use was converted to oral morphine equivalents (OME) using the following: 1 mcg fentanyl IV = 0.2 mg morphine PO; 1 mg oxycodone PO = 1.5 mg morphine PO 1 mg hydromorphone IV = 17.5 mg morphine PO; 1 mg hydrocodone PO = 5 mg morphine PO.[15] Pain scores were reported using a standard verbal analog scale

TABLE 1. **Demographic and operative characteristics of the study population**

Demographics	**Paravertebral block (n = 125)**	**Quadratus lumborum block (n = 50)**	**p value***
Age, years, mean (SD)	69 (9)	69 (11)	0.92
BMI, kg/m^2, median [IQR]	28 [25-31]	28 [24-31]	0.88
Sex (%)			0.58
Male	96 (77)	78 (78)	
Female	28 (23)	22 (22)	
Race (%)			0.15
White	120 (96)	45 (90)	
Non-white	28 (23)	5 (10)	
Marital status (%)			0.73
Married	90 (72)	34 (68)	
Non-married	35 (28)	16 (32)	
ASA comorbidity grade (%)			0.25
≤ 2	22 (18)	4 (8)	
3	90 (72)	39 (78)	
4	13 (10)	7 (14)	
Operative data			
Total operative time, mins, mean (SD)	278 (70)	285 (63)	0.51
Time of surgery completion, hours, mean (SD)	14.1 (1.7)	14.4 (1.9)	0.48
Length of stay, days, mean (SD)	6.6 (2.6)	6.3 (2.1)	0.41
Preoperative creatinine, mg/dL, mean (SD)	1.2 (0.6)	1.1 (0.4)	0.30
Postoperative creatinine, mg/dL, mean (SD)	1.1 (0.6)	1.1 (0.5)	0.44
Preoperative hemoglobin, mg/dL, mean (SD)	11.4 (1.8)	11.4 (1.8)	0.93
Postoperative hemoglobin, mg/dL, mean (SD)	9.7 (1.5)	9.8 (1.6)	0.93
Temperature at end of case, °C, mean (SD)	36 (1)	36 (1)	0.32

BMI = body mass index; IQR = interquartile range; SD = standard deviation; ASA = American Society of Anesthesiologists Physical Status Classification System

*p values for continuous variables generated from Student t tests or Wilcoxon rank sum tests and categorical variables generated from chi-square tests

at rest. This consisted of an 11 point (0-10) scale, with 0 representing no pain and 10 representing the "worst pain imaginable". Recorded pain scores throughout each day were averaged for each patient. Additional data collected included patient demographics, pathologic characteristics, and operative laboratory data.

Statistical analysis

Demographic, operative, clinical, and pathologic characteristics were compared between the radical cystectomy patients who received either the quadratus lumborum block or the paravertebral using a Student t test or Wilcoxon rank sum test for continuous variables, and chi-square or Fisher's exact test for categorical variables. Statistical analyses were performed using SPSS (version 22).[16] Statistical significance was set at $p < 0.05$. The University of Pittsburgh institutional review board approved the study protocol (PRO16040065).

Results

The demographic and operative characteristics of the study groups are summarized in Table 1. There were no differences in respect to age, body mass index, sex, marital status, and race. No significant differences existed between the groups in severity of existing comorbid diseases, which were measured via the American Society of Anesthesiologists physical status classification system. The groups had no differences in operative time, time of surgery completion, creatinine, and hemoglobin. The hospital length of stay was not significantly different between groups (6.3 days for the quadratus lumborum block group versus 6.6 days for the paravertebral block group, $p = 0.41$).

Pathologic characteristics of the study groups are summarized in Table 2. There were no differences in histology type, grade, T stage, N stage, margin, and venous/lymphatic vessel invasion.

Postoperative opioid use by day is summarized in Figure 2. The quadratus lumborum block and paravertebral block patients had similar opioid consumption on day 0 (30 mg versus 29 mg, $p = 0.90$) and no statistically significant differences on any postoperative day. There was also no significant difference in total cumulative postoperative opioid consumption.

TABLE 2. **Pathologic characteristics of the study population**

Pathologic characteristics	**Paravertebral block (n = 125)**	**Quadratus lumborum block (n = 50)**	**p value***
Histology type (%)			0.30
Urothelial carcinoma	119 (95)	45 (90)	
Non-urothelial	6 (5)	5 (10)	
Grade (%)			0.99
High	121 (97)	48 (96)	
Low	4 (3)	2 (4)	
T stage (%)			0.82
T1 or less	34 (27)	17 (34)	
T2	28 (22)	11 (22)	
T3	42 (34)	14 (28)	
T4	21 (17)	8 (16)	
N stage (%)			0.89
NX/N0	93 (74)	36 (72)	
N1+	32 (26)	14 (28)	
Margins (%)			0.10
Negative	104 (83)	47 (94)	
Positive	21 (17)	3 (6)	
Venous/lympathic vessel invasion (%)			0.11
Absent	83 (66)	26 (52)	
Present	42 (34)	24 (48)	

*p values for categorical variables generated from chi-square tests

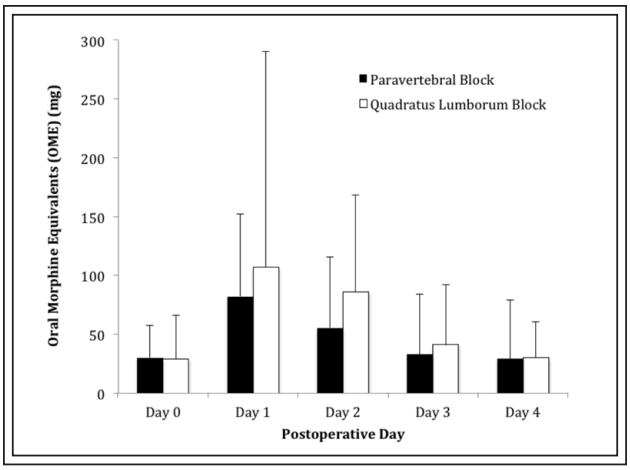

Figure 2. Mean postoperative opioid use on postoperative days 0 to 4. Error bars represent the standard deviation. No statistical differences between groups. Opioid use was converted to oral morphine equivalents (OME) through the following: 1 mcg fentanyl IV = 0.2 mg morphine PO; 1 mg hydromorphone IV = 17.5 mg morphine PO; 1 mg hydrocodone PO = 5 mg morphine PO15; Day 0 represents the day of the surgery and day 1 represents the first full postoperative day. P values for continuous variables generated from t tests.

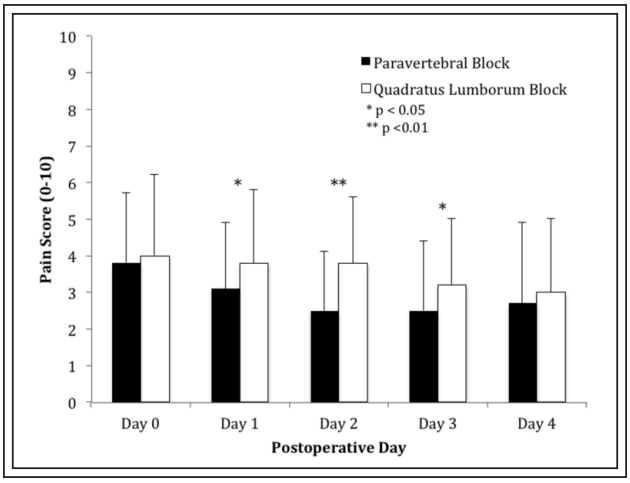

Figure 3. Mean pain scores on postoperative days 0 to 4. Error bars represent the standard deviation. Asterisks indicate significant differences between groups, * p <0.05, ** p <0.01. Pain scores are reported by use of a standard verbal analog scale, scale of 0 to 10, with a 0 represents no pain, 10 represents the "worst pain imaginable. Day 0 represents the day of the surgery and day 1 represents the first full postoperative day. P values for continuous variables generated from t tests.

Reported pain scores by day are summarized in Figure 3. Pain scores on postoperative day 0 were similar between quadratus lumborum block and paravertebral block groups (4.0 versus 3.8, p = 0.72). The quadratus lumborum block patients had higher pain scores on day 1, 2, and 3 compared to the paravertebral block patients (3.8 versus 3.1, p = 0.04; 3.8 versus 2.5, p = 0.001; 3.2 versus 2.5, p = 0.01).

Discussion

This retrospective review suggests that there were no differences between the bilateral single shot quadratus lumborum blocks and the bilateral continuous paravertebral blocks for postoperative analgesia following radical cystectomy. Specifically, there was no difference between groups in terms of opioid consumption on postoperative day 0 or in cumulative opioid consumption. Pain scores were equivalent on postoperative day 0 and hospital length of stay did not differ between groups.

It is well established that incorporation of regional analgesia into postoperative pain management protocols offers superior analgesia in comparison to opioid-based analgesia and leads to faster hospital discharge times.[17,18] In particular, several studies have examined the role of the paravertebral block in pain control for abdominal surgery. At our own institution, researchers found that paravertebral block in radical prostatectomy patients led to lower postoperative pain scores and lower total opioid use in comparison to a control group.[19] A meta-analysis of 20 trials of various abdominal surgeries found that paravertebral blocks led to lower postoperative pain scores and opioid use compared to patients receiving no blocks.[20] Thus, the pain scores and opioid use for our radical cystectomy patients receiving paravertebral blocks represent an improvement compared to patients not receiving blocks.

To our knowledge, this is the first study that compares the efficacy of the quadratus lumborum block and the paravertebral block for any surgery. Studies on the quadratus lumborum block are actually quite limited. In 2013, the first case report validated the quadratus lumborum block effect as a sensory block for use in major laparotomy.[12] Only one randomized controlled trial has investigated the clinical use of the quadratus lumborum block. It found that patients who had received a quadratus lumborum block during cesarean delivery had lower 24 hour postoperative opioid use and dynamic pain scores compared to patients who only received saline.[11] The results of the present study demonstrate that the quadratus

lumborum block and paravertebral block provide similar improvements in opioid use management in radical cystectomy patients.

It is important to note that this study compares a continuous regional technique with a single shot technique. In light of this fact, the similar outcomes between groups are rather surprising. Studies have previously established that intravenous lidocaine significantly reduces pain, opiate consumption, duration of ileus, and hospital length of stay following laparotomy.[21] The comparative pain scores on day 0 then increased pain scores on subsequent days until the continuous catheters are discontinued follow the expected pattern of pain control of the pain blocks. However, given this, one would have expected superior analgesia, reduced opioid consumption, and shorter hospital stay in the continuous paravertebral block group. That this did not occur speaks to the potential potency of the quadratus lumborum block technique in controlling opiate use.

Previous studies have found physiologic differences between the two blocks. The quadratus lumborum block may offer an advantage in its ability to broadly spread local anesthetic across many dermatomes. A single shot quadratus lumborum block can spread local anesthetics to dermatomes from the T6-L2 segments.[22] The paravertebral block covers no more than 3-6 dermatomes from the site of infusion.[8] Our data suggest that these physiologic differences do not translate to differences in clinical outcomes for radical cystectomy patients.

There are several limitations in this study. First, the study compares a continuous with a single shot technique. Thus, the most accurate comparison of the techniques would focus on postoperative outcomes within the first 24 hours following surgery. Second, the small sample size and retrospective nature of the study may limit detection of small differences between the two techniques and increases the risk of unrecognized confounding variables. Third, patients received the procedure from different surgeons, which may introduce variability in outcomes. However, the same surgeons performed these procedures for both treatment groups equally, thus limiting the potential of surgical differences among groups. Lastly, data acquisition through review of the electronic medical record may have underestimated the prevalence of side effects, such as ileus and nausea in either of these two patient groups.

Despite these limitations, the results of this study are important as they add to the limited body of literature indicating the potential use of the quadratus lumborum block in abdominal surgery. To our knowledge, this is the first study to report the use of the quadratus lumborum block in cystectomy patients and the first to compare it directly to the paravertebral block.

Conclusion

This study demonstrates that there were no differences in opioid requirement between the bilateral single shot quadratus lumborum blocks and bilateral continuous paravertebral blocks following radical cystectomy. These data suggest that the quadratus lumborum block is a viable alternative as a peripheral neural blockade component of multimodal analgesia in cystectomy patients. This study adds to the limited literature on the efficacy of the quadratus lumborum block in abdominal surgical procedures. Given its efficacy, further studies are warranted that both explore the potential cost savings of single quadratus lumborum blocks and the potential benefit of performing continuous quadratus lumborum blockade.

Disclosures

Austin J. Lee is supported in part by the National Institutes of Health T35 grant (T35DK065521-12).

Bruce L. Jacobs is supported in part by the National Institutes of Health Institutional KL2 award (KL2TR000146-08), the GEMSSTAR award (R03AG048091), the Jahnigen Career Development Award, and the Tippins Foundation Scholar Award. Dr. Jacobs is also a consultant for ViaOncology.

The remaining authors declare no conflict of interest. □

References

1. Novotny V, Hakenberg OW, Wiessner D et al. Perioperative complications of radical cystectomy in a contemporary series. *Eur Urol* 2007;51(2):397-402.
2. Benyamin R, Trescot AM, Datta S et al. Opioid complications and side effects. *Pain Physician* 2008;11(2):S105-S120.
3. Story SK, Chamberlain RS. A comprehensive review of evidence-based strategies to prevent and treat postoperative ileus. *Dig Surg* 2009;26(4):265-275.
4. Andreae MH, Andreae DA. Regional anaesthesia to prevent chronic pain after surgery: a Cochrane systematic review and meta-analysis. *Br J Anaesth* 2013;111(5):711-720.
5. Davies R, Myles P, Graham J. A comparison of the analgesic efficacy and side-effects of paravertebral vs epidural blockade for thoracotomy—a systematic review and meta-analysis of randomized trials. *Br J Anaesth* 2006;96(4):418-426.
6. Blanco R. Tap block under ultrasound guidance: the description of a "no pops" technique: 271. *Reg Anesth Pain Med* 2007;32(5):130.

7. Go R, Huang YY, Weyker PD, Webb CA. Truncal blocks for perioperative pain management: a review of the literature and evolving techniques. *Pain Manag* 2016;6(5):455-468.
8. Naja ZM, El-Rajab M, Al-Tannir MA et al. Thoracic paravertebral block: influence of the number of injections. *Reg Anesth Pain Med* 2006;31(3):196-201.
9. Murouchi T, Iwasaki S, Yamakage M. Quadratus lumborum block: analgesic effects and chronological ropivacaine concentrations after laparoscopic surgery. *Reg Anesth Pain Med* 2016;41(2):146-150.
10. Børglum J, Jensen K, Christensen AF, et al. Distribution patterns, dermatomal anesthesia, and ropivacaine serum concentrations after bilateral dual transversus abdominis plane block. *Reg Anesth Pain Med* 2012;37(3):294-301.
11. Blanco R, Ansari T, Girgis E. Quadratus lumborum block for postoperative pain after caesarean section: a randomised controlled trial. *Eur J Anaesthesiol* 2015;32(11):812-818.
12. Kadam VR. Ultrasound-guided quadratus lumborum block as a postoperative analgesic technique for laparotomy. *J Anaesthesiol Clin Pharmacol* 2013;29(4):550-552.
13. Visoiu M, Yakovleva N. Continuous postoperative analgesia via quadratus lumborum block–an alternative to transversus abdominis plane block. *Pediatr Anesth* 2013;23(10):959-961.
14. Blanco R, McDonnell J. Optimal point of injection: the quadratus lumborum type I and II blocks. *Anaesthesia* Available via: http://www. respond2articles. com/ANA/forums/post/1550. aspx. Accessed, 2014.
15. Nielsen S, Degenhardt L, Hoban B Gisev N. A synthesis of oral morphine equivalents (OME) for opioid utilisation studies. *Pharmacoepidemiol Drug Saf* 2016;25(6):733-737.
16. Corp I. IBM SPSS Statistics for Windows. Armonk, NY: IBM Corp. 2013.
17. Kettner S, Willschke H, Marhofer P. Does regional anaesthesia really improve outcome? *Br J Anaesth* 2011;107(Suppl 1):i90-i95.
18. Bulka CM, Shotwell MS, Gupta RK et al. Regional anesthesia, time to hospital discharge, and in-hospital mortality: a propensity score matched analysis. *Reg Anesth Pain Med* 2014;39(5):381-386.
19. Ben-David B, Swanson J, Nelson JB, Chelly JE. Multimodal analgesia for radical prostatectomy provides better analgesia and shortens hospital stay. *J Clin Anesth* 2007;19(4):264-268.
20. El-Boghdadly K, Madjdpour C, Chin K. Thoracic paravertebral blocks in abdominal surgery–a systematic review of randomized controlled trials. *Br J Anaesth* 2016;117(3):297-308.
21. Ventham NT, Kennedy ED, Brady RR et al. Efficacy of intravenous lidocaine for postoperative analgesia following laparoscopic surgery: a meta-analysis. *World J Surg* 2015;39(9):2220-2234.
22. Carney J, Finnerty O, Rauf J et al. Studies on the spread of local anaesthetic solution in transversus abdominis plane blocks. *Anaesthesia* 2011;66(11):1023-1030.