Comparison of intraoperative hemodynamic stability between quadratus lumborum and epidural block in patients who underwent laparoscopic nephrectomy

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Abstract. Laparoscopic nephrectomy has become the standard procedure for living donor renal transplant in Indonesia. The anesthesia technique used for this procedure is general anesthesia combined with regional anesthesia. Among many techniques available, epidural block is often performed. This study aims to compare hemodynamic stability between Quadratus Lumborum (QL) block, as a new alternative block, and epidural block for laparoscopic nephrectomy. Patients were randomized to receive epidural block (n=13) or QL block (n=13) for intraoperative analgesia during laparoscopic nephrectomy. Patients in epidural group received continuous bupivacaine 0.25% infusion 6 ml/hours and patients in QL group received 20 ml of bupivacaine 0.25% bilaterally. Hemodynamic variables consisting of mean arterial pressure (MAP), heart rates (HR), as well as fentanyl consumption between the two groups were compared. There were significant differences in intraoperative MAP between epidural block group and QL block group (p = 0.001). However, there were no significant differences in HR (p = 0.114) and fentanyl consumption (p = 0.593) between two groups. QL block produced a relatively steadier MAP compared to epidural block; however intraoperative HR and fentanyl consumption between two groups had no significant difference.

1. Introduction
Laparoscopy surgery has become preferred procedure over laparotomy because of its superiority. Some of the advantages of laparoscopy are shorter hospital stay, early ambulation, and smaller scar. Laparoscopic nephrectomy has become the best standard procedure for living donor renal transplant in Indonesia. Although laparoscopic surgery induces less tissue damage than laparotomy, the procedure will still activate stress response thus affecting hemodynamic stability [1-3].

Regional anesthesia is often combined with general anesthesia as an alternative analgesia technique with many benefits; reduce intraoperative opioid consumption, intraoperative stress response, and as means of providing postoperative analgesia. Among many techniques available, epidural block is often performed. Placement of thoracic epidural catheter before the start of surgery will prevent intraoperative stress response to surgery in the upper abdomen [4,5]. One of the regular implementations is laparoscopic nephrectomy for renal transplant donor. Recently, with the advances of ultrasound imaging, interfascial regional anesthesia techniques have increased in popularity as an alternative analgesia technique supplementing general anesthesia. Among those techniques are Transversus abdominis plane (TAP) block, PECS block, Erector Spinae block, and Quadratus
Lumborum (QL) block. Studies performed worldwide comparing these techniques to the traditional epidural and to one another. One of the recent block, the QL block was first described by Blanco in 2007 and has gained researchers’ interest as an alternative analgesia for abdominal surgery. The effectiveness of this block has been proved in several studies [6,7].

The aim of this study to evaluate the intraoperative hemodynamic stress response between QL block and epidural block in patient who underwent laparoscopic nephrectomy, through hemodynamic parameters: mean arterial pressure (MAP) and heart rate (HR). We also evaluate the total consumption of intraoperative fentanyl.

2. Methods
This is a randomized controlled trial. Originally this study will be conducted in 36 patients, by the time this paper is released; we already have conducted this study in 26 patients. Subjects of this study are patients who underwent laparoscopic nephrectomy for renal transplant donor who fulfilled the criteria of kidney donor determined by the hospital transplant team in Cipto Mangunkusumo National General Hospital. This study was approved by the Ethics and Research Committee of University of Indonesia (0211/UN2.F1/ETIK/2018) and has been registered in ClinicalTrials.gov (ID: NCT03520205). Exclusion criteria were known allergy to local anesthetics, anaphylactic reaction, failure of epidural block, failure of QL block and contraindication to central or peripheral nerve block (local skin infection or coagulation disorder).

Patients were then randomized using computerized generating table of random numbers (www.randomizer.org) into two groups of 13 patients. All patients received general anesthesia, anesthetic induction was performed using propofol 2 mg/kg BW, fentanyl 2 µg/kg BW, and atracurium 0.5 mg/kg BW. Anesthesia was maintained using sevoflurane 1-2% in a mixture of oxygen and air, the ventilation mode was set with tidal volume 8ml/kg BW, PEEP 5 cmH2O and the respiratory rate was adjusted with the target of end-tidal CO2 (ETCO2) of 35 – 45 mmHg. In epidural group, the block was done before the induction of general anesthesia. Patients were positioned in sitting position, after the intravertebral space of Th11-12 identified, an 18-gauge Tuohy needle were inserted into the epidural space using loss of resistance (LOR) technique. Epidural catheter was inserted 6 cm into the epidural space. A vacuum aspiration test and test dose of bupivacaine 0.25% and epinephrine 1: 200.000 total volume 3 mL was given via epidural. Escalation of heart rate and mean arterial pressure ± 20% and changes in motoric sensation on extremities were indicators of catheter displacement. A bolus of bupivacaine 0.25% 3 mL followed by continuous infusion of bupivacaine 0.25% 6 mL/hour was administered via epidural before incision.

In QL group, after induction of general anesthesia, we performed anterior QL block in both sides of the abdomen. A low-frequency Ultrasonography (USG) was attached in inferior lumbar region which consisted of inferior iliac crest bordered by latissimus dorsi in the posterior and abdominal external oblique in the anterior, known as Petit’s triangle. QL muscle was identified via the Shamrock sign. The QL muscle (QL) is seen as a darker triangular shape attaching to the apex of the transverse process of L4. The three leaves of the Shamrock are composed of the QL, the psoas major and erector spinae muscles while the transverse process constitutes the stem. After the QL muscle identified, the Contiplex® needle was directed until the tip of needle was confirmed in the border of QL and PM muscle. The aspiration test was performed and then a total of 20 mL bupivacaine 0.25% was administered in each side. A catheter was placed in both sides while maintaining the USG to ensure the placement.

Intraoperative hemodynamic changes were observed through HR and MAP, measured with non-invasive intermittent blood pressure monitoring. Fentanyl 50 µg was given if there were 20% escalation from baseline in HR and MAP. HR and MAP were measured in all groups pre-induction (baseline), post induction, during CO2 insufflation, Pfannenstiel incision, and at the end of operation. Total fentanyl consumption intraoperative was also recorded.

3. Results
Between May to July 2018 we randomly allocated the first 26 patients into the ongoing study. None of patient was excluded from this study. We randomized the patients into 13 subjects each group of
epidural and QL block. Table 1 shows demographics and perioperative characteristics between two groups.

Table 1. Demographic data.

| Variable                  | Epidural group (n=13) | QL group (n=13) |
|---------------------------|-----------------------|-----------------|
| Male (%)                  | 7 (53.8)              | 8 (61.5)        |
| Female (%)                | 6 (46.2)              | 5 (38.5)        |
| Age (years)               | 38.54±10.66           | 43.3±15.91      |
| Weight (kg)               | 61.55±10.28           | 62.74±10.25     |
| Height (cm)               | 160.54±7.71           | 163.08±7.99     |
| BMI (kg/m²)               | 23.90±3.95            | 23.61±3.58      |
| ASA I (%)                 | 10 (76.9)             | 5 (38.5)        |
| ASA II (%)                | 3 (23.1)              | 8 (61.5)        |
| Ephedrine Intra-op (mg)   | 5 (0-30)              | 0 (0-5)         |
| Duration of surgery (hours)| 5 (4.5-6)            | 5 (4.5-6)       |
| Duration of anesthesia (hours)| 5.5 (5-6.5)     | 5.5 (5-6.5)     |

QL, quadratus lumborum; BMI, body mass index; ASA, american society of anesthesiologist. Categorical data are presented as percentage, numerical data are presented as mean ± SD.

We recorded MAP and HR in five measurements for both group (figure 1 and figure 2). As seen in Figure 1, patients in QL group had relatively steadier MAP than patients in epidural group. Thus, multivariate analysis through general linear model showed statistical difference of MAP on both groups during five measurements (p = 0.001). This however was not shown in individual factor analysis (table 2).

Both groups showed minor changes in heart rate on both group as seen in figure 2. However, general linear model analysis for HR in the two groups were not statistically different (p = 0.114). Moreover, there was also no difference in intraoperative consumption of fentanyl in both groups (table 3).

4. Discussions
Laparoscopy surgery induces alteration in the peritoneal spaces. Pneumoperitoneum caused by CO₂ insufflation will increase intraabdominal pressure (IAP) and affect hemodynamic secondary to mechanical and neurohormonal responses. Positive changes of IAP will increase MAP and systemic vascular resistance (SVR) and may decrease cardiac output (CO). Elevations in plasma norepinephrine, epinephrine, cortisol, vasopressin, renin and aldosterone levels were also demonstrated during pneumoperitoneum. Reduction in renal blood flow, secondary to mechanical compression of renal arteries also stimulates renin release. Elevation in renin and aldosterone temporarily correlates with an increase in MAP. CO₂ insufflation stretches the peritoneum, which increases vagal tone and can lead to bradycardia and asystole [8,9].

Combination of regional block with general anesthesia for laparoscopy surgery can reduce surgical stress responses intraoperative thus reduces release of catecholamine. Regional blockade prevents the nociceptive signals from surgical area reaching central nervous system thus inhibits endocrine and metabolic response to surgery [4,7,10]. Both groups provided a relatively stable hemodynamic intraoperative condition. However statistically, QL group showed a relatively steadier MAP than the epidural group (p = 0.001).

QL block provided widespread and long-lasting analgesia effect as its block could provide analgesia from T7-L1. The key to the analgesia lies in the thoracolumbar fascia (TLF). TLF is a
complex, connective tissue tubular structure formed by binding aponeuroses and fascia layers, which enveloping the back muscles, connects the anterolateral abdominal wall with the lumbar paravertebral region. It is believed that the local anesthetics spread along the TLF and the endothoracic fascia into the paravertebral space [11].

![Figure 1. Intraoperative mean arterial pressure in both QL and epidural groups.](image)

**Table 2.** Mean difference of mean arterial pressure between QL and epidural groups.

| Variable       | Mean difference | \(p^a\) value | 95% CI           | \(p^b\) value |
|----------------|-----------------|---------------|------------------|---------------|
| **Epidural Group** | **QL Group**    |               |                  |               |
| Pre induction   | 86.75±1.04      | 87.49±1.04    | 0.891            | -0.692(-11.001 to 9.616) | 0.001\(\) |
| Post induction  | 77.16±1.04      | 82.41±1.03    | 0.315            | -4.846(-14.594 to 4.901) |
| Insufflation    | 94.88±1.03      | 91.39±1.04    | 0.563            | 3.077(-7.744 to 13.898)  |
| Pfannenstiel    | 80.72±1.5       | 79.65±1.04    | 0.055            | 0.923(-9.389 to 11.235)  |
| Postoperative   | 70.63±1.02      | 83.17±1.03    | 0.001\(\)        | -12.723(-19.585 to -5.886) |

Data presented as mean ± SD

\(a\)Independent t-test, \(p<0.05\) is significant

\(b\)General Linear Model test, \(p<0.05\) is significant

**Table 3.** Intraoperative fentanyl consumption between QL and epidural groups.

| Variable | Median (min-max) | \(p\) value\(a\) |
|----------|------------------|------------------|
| Epidural | 50 (0-150)       | 0.579            |
| QL       | 50 (0-150)       |                  |

Data presented as median (minimum-maximum)

\(a\)Mann-Whitney test, \(p<0.05\) is significant

Studies shown that QL block is an effective analgesic method for abdominal surgery, particularly effective for lower abdominal surgery, also there were no studies reporting complications after the QL
A good regional blockade and adequate analgesia could prevent surgical stress response induced catecholamine release, thus provide steadier blood pressure during laparoscopy surgery.

Both QL and epidural block had no significant differences in maintaining intraoperative HR (p = 0.114). Total consumption of fentanyl in both groups also showed no significant differences. Fentanyl is given almost regularly during CO$_2$ insufflation as there was an abrupt rise of MAP and SVR in the first 5 minutes after insufflation.

**Figure 2.** Intraoperative heart rate in both QL and epidural groups.

5. Conclusions
QL block could be considered as an alternative technique performed in combination with general anesthesia for living donor nephrectomy for renal transplantation using laparoscopic surgery. The intraoperative MAP in QL group showed better stability in comparison with epidural groups which may be caused by reduction of surgical stress responses in QL group. Further studies with much greater sample and additional parameter were recommended to evaluate the effectiveness of QL block in reducing intraoperative hemodynamic stress responses.

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