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The effect of erector spinae plane block on cost of percutaneous nephrolithotomy surgery

Erektör spina plan bloğunun perkütan nefrolitotomi cerrahisi maliyetine etkisi

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ABSTRACT

Aim: The analgesic effect of ESPB for percutaneous nephrolithotomy have been reported in a few study. However there is not any study yet in terms of the effect of ESPB on the cost of anesthesia. The aim of the study is to evaluate the effect of ESPB on sevoflurane and opioid consumption and cost for percutaneous nephrolithotomy.

Material and Method: The patients who underwent percutaneous nephrolithotomy were divided into two groups as ESPB group (Group B; N, 30) and non-ESPB group (Group K; N, 31) whether ESPB was performed or not in this prospective observatioanl study. Total consumption of sevoflurane, remifentanyl and total consumption of tramadol was recorded. Total consumption of sevoflurane, remifentanil and tramadol was multiplied by the unit price of the drug (milliliter and milligram) for determining cost estimation.

Results: The total amount of remifentanil, sevoflurane and tramadol consumption were significantly lower in the Group B (respectively; p=0.009, p=0.001, p<0.001). The total remifentanil, sevoflurane and tramadol costs were found to be statistically significantly lower in the Group B (respectively: p=0.006, p=0.001, p<0.001).

Conclusion: The ESPB is a cost-effective procedure and contributes to the multimodal anesthesia.

Keywords: ESPB, cost estimation, percutaneous nephrolithotomy, anesthesia, analgesia

ÖZ

Amaç: ESPB'nun perkütan nefrolitotomi cerrahisinde analjezik etkileri çok az bir çalışma ile rapor edilmiştir. Ancak ESPB'nun anestezi maliyeti üzerine etkisi hakkında henüz bir çalışma yoktur. Bu çalışmanın amacı ESPB'nun perkütan nefrolitotomi cerrahisi için sevofluran ve opioid tüketimi ve maliyeti üzerine etkisini değerlendirmektir.

Gereç ve Yöntem: Bu prospektif gözlemsel çalışmada perkütan nefrolitotomi geçiren hastalar ESPB'u yapılan (Grup B; 30) ve blok yapılmayan (Grup K; 31) şeklinde iki gruba ayrılmıştır. Sevofluran, remifentanil ve tramadol toplam tüketim miktarları kaydedilmiştir. Maliyet tahmini için sevofluran, remifentanil ve tramadolün toplam tüketilen miktarları ilaçların birim fiyatları (mililitre ve miligram) ile çarpılmıştır.

Bulgular: Toplam tüketilen remifentanil miktarı, sevofluran miktarı ve tramadol miktarı Grup B'de anlamlı olarak düşüktü (sırasıyla; p=0.009, p=0.001, p<0.001). Toplam remifentanil, sevofluran maliyeti ve tramadol maliyeti Grup B'de istatistiksel olarak anlamlı derecede düşük idi (sırasıyla; p=0.006, p=0.001, p<0.001).

Sonuç: ESPB'u maliyet etkin bir uygulamadır ve multimodal anesteziye katkı sağlamaktadır.

Anahtar kelimeler: ESPB, maliyet tahmini, perkütan nefrolitotomi, anestezi, analjezi

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INTRODUCTION

Health expenditure is increasing day by day due to developing technology and increasing prices.1 Therefore, cost control becomes inevitable (1). Although anesthesia seems to be a part of the cost of the surgical procedure, the cost-increasing effect of many anesthesia applications can be observed in the long term (2). The surgical procedure, the drugs used in the anesthesia practice and the type of anesthesia are the factors affecting the total anesthesia cost (3). Reducing expensive drug use in anesthesia practice has been shown as an appropriate method for cost control (4).

In clinical practice, inhalation agents are more frequently used both in induction and maintaining of anesthesia. The efficacy and safety of inhalation agents are well established and clinical investigations have continued to define the different interactions between the drugs (5). Due to the higher cost of inhalation agents in total anesthesia-related expenditure, different management methods have been researched for decreasing the inhalation agents's requirements (3,6).

Intravenous (IV) opioids have been used to manage nociception in intraoperative and to treat pain in the early postoperative period (7). Several methods have suggested for anesthesiologists and surgeons to decrease unnecessary opioid use, opioid-related adverse events, and side effects in the perioperative period (8).

Erector spinae plane block (ESPB) is a new technique used for management of pain (9). Local anesthetics were injected interfascial plane of the structures (10). Göktaş et al. (11) reported that the local anesthetic infiltration via epidural catheter after anesthesia induction reduced the consumption of inhaled agent. It is well known that local anesthesics reduce the consumption of inhaled agent due to reducing the minimum alveolar concentration (MAC) of inhalation anesthetics because of their central action after being absorbed from the injection site (11,12).

The analgesic effect of ESPB have been reported (13). However there is not any study regarding the effect of ESPB on the cost. In addition, ultrasound-guided ESPB has been performed in very few studies in patients undergoing percutaneous nephrolithotomy (PCNL) (14,15). In this study, we aimed to evaluate the effect of ESPB on sevoflurane and opioid consumption and cost.

MATERIAL AND METHODS

This prospective observational study was approved by Local Ethics Committee (2019/11, Ref. No: 2019.06.08). Written informed consent form was taken from all patients. ASA (American Society of Anesthesiology) I-II-III, between 18-75 years old, 61 patients who underwent percutaneous nephrolithotomy between August 2019 and December 2019 were included in the present study according to the Declaration of Helsinki. Patients with central nervous system disease, severe cardiovascular system disease, liver failure, kidney failure, impaired coagulation parameters, allergy to any of the study drug, infection of the injection site, obesity (body mass index >35 kg m^{-2}) and open surgery procedures were not included in the study.

Erector spinae plane block is performed in our clinic for postoperative analgesia for patients (who request) who undergoing PCNL surgery. Patients who underwent PNCL between the dates specified in the previous paragraph and who had undergone block and not were included in the present study. The patients were divided into two groups as ESPB (Group B; N, 30) and non-ESPB (Group K; N, 31) whether ESPB was performed or not. In our clinic ESPB was performed as follows;

All patients underwent standard monitoring (heart rate, oxygen saturation, non-invasive blood pressure measurement). In Group B, ESPB (inplane approach) was performed with bilateral ultrasound at T10 level for patients with sitting position under midazolam (0.03 mg/kg) sedation. The ESPB was made using a 7-18 MHz linear ultrasound probe (Esaote My Lab 6 US Machine, Florance, Italy) and a 22 gauge 100 mm needle (B. Braun, Germany). It was performed by another experienced anesthetist who did not manage the perioperative anesthesia of the patients. The skin was sterilized with povidone iodine. The probe covered with aseptic sheath was placed parallel to the T10 vertebral axis and moved medial side to the lateral side. When the shadow of the eight rib and the transvers process was seen, the needle was inserted toward the trapesius and erector spinae mucsle and T10 transvers process. The needle contacted to the transvers process. Two milliliter (ml) of saline was injected and the interfascial plane between erector spinae muscle and the transvers process was confirmed. Thirty ml of 0.25% bupivacaine was applied to one side and local anesthetic spread was observed. After the block procedure, the patients were taken to the operating room. All patients were monitored (peripheral oxygen saturation, heart rate, noninvasive mean blood pressure) and standard general anesthesia was applied. Thiopental sodium 5-7 mg/kg (i.v.) and fentanyl 1.5-2 mg/kg (i.v.) were used in anesthesia induction and 0.6 mg/kg (i.v.) rocuronium was applied to facilitate tracheal intubation. The maintenance of anesthesia was carried out in 2% sevoflurane, 50% air and 50% oxygen, with controlled ventilation in 4 L fresh gas flow. Bispecteral index (BIS) (A-2000, Aspect Medical Systems, USA) was used to control the depth of anesthesia. BIS values were kept between 40-50 with increasing or decreasing sevoflurane

concentrations in both groups. Remifentanil (0.5-1 mcg/kg/min) infusion was administered to patients without sufficient depth who were hemodynamically unstable. Muscle relaxant was applied repeatedly according to the TOF rate (when reached 25%) throughout the operation. In addition to routine monitoring parameters, the MAC values of sevoflurane in the 5th, 10th, 15th, 20th, 25th, 30th, 35th, 40th, 45th, 60th, 90th, 110th, 130th, 150th minutes were recorded. The characteristics (age, gender, ASA) and anesthetic properties (duration of anesthesia, duration of surgery, total sevoflurane consumption, total remifentanil consumption) were also recorded. In addition, tramadol consumption according to postoperative pain follow-ups (24 hour) were recorded. The amount of sevoflurane was calculated according to how long the inhalation anesthesia (sevoflurane) was applied, the varying fresh gas (FG) flow and volatile anesthetic (VA) concentration settings. The total consumption amount of sevoflurane gas was determined by calculating the VA consumption of each time period using the formula reported by Biro (16):

Fluid sevoflurane (ml)=FG flow (ml/dk)1×VA conc (vol%)2×Anesthesia duration (min)/saturated gas volume (ml/ml)3×100 (vol %)

1. FG flow of sevoflurane
2. Sevoflurane concentration
3. Sevoflurane vapor volume

Postoperative analgesia was performed with 1000 milligram (mg) parasetamol and 50 mg dexketoprophene twenty minute before the end of the surgery. Neostigmine (0.05 mg/kg) and atropine (0.01 mg/kg) were applied to restore the patient's muscle strength after spontaneous ventilation was achieved. Patients were extubated and transferred to the post anesthesia care unit. Visual analog scale (VAS) scores (0-3; mild pain, 4-6; moderate pain, 7-10; severe pain) were recorded that indicate no to severe pain of patients at postoperative 0th, 1th, 2th, 6th, 12th and 24th hours (17). Resque analgesic (1 mg/kg intravenous tramadol) was administered when VAS scores were more than four. Total consumption of tramadol was recorded. The total consumption of sevoflurane, remifentanil and tramadol was multiplied by the unit price of the drug (milliliter and milligram) for determining cost estimation.

Sampla size calculation

The results of our preliminary study were used for sample size calculation. Accordingly, consumption of sevoflurane was 42.85±9.86 ml in the Group B and 53.15±14.89 ml in the Group K. According to these data, the minimum sample size required for this study was determined as 54 using G * Power 3.1.9.2 software with an error of 0.05 and a power of 0.90. Sixty one (61) patients were enrolled in the study considering dropout rate of 10%.

Statistical analysis

The statistical analysis was performed with SPSS program for Windows Version 20.0 statistical package (IBM Corporation, Armonk, NY, USA). Data were analyzed with Kolmogorov-Smirnov test for conformity to normal distribution. According to the distribution of the data, if the normal distribution does not fit, the Mann-Whitney-U test was performed. Independent T-test was used for comparison between groups in normally distributed data. Continuous variables were presented as mean±standard deviation or median (minimum-maximum) according to the distribution. For categorical variables, frequency counts and percentages were calculated. P values lower than 0.05 have been considered statistically significant.

RESULTS

Sixty one (61) patients were included in the present study. There was no significant difference between the demographic and anesthtetic characteristics (age, sex, ASA status, anesthesia time, surgery time) of the patients between the groups (p>0.05) (**Table 1**). There was no significant difference between the perioperative follow-up parameters (heart rate, mean blood pressure, BIS values, discharge time) of the patients between the groups (p>0.05) (**Table 2**). The time of the first analgesic was given to the patient was statistically significantly longer in Group B than Group K (p=0.008) (**Table 2**). Mean MAC values were statistically significantly higher in the Group K (p<0.001) (**Table 2**). The total amount of remifentanil consumption, the total amount of sevoflurane consumption and the total amount of tramadol consumption of the patients were significantly lower in the Group B in the perioperative period (respectively; p=0.009, p=0.001, p<0.001) (**Table 3**).

Table 1. Anesthesia and surgical features of patients

	Group B N, 30	Group K N, 31	P value
Age, mean±sd	48.07±14.61	47.23±14.02	0.79
Sex (F/M), n	7/23	7/24	0.75
ASA, n (%)			
I	8 (25.9%)	7 (22.6%)	
II	15 (51.9%)	22 (70.9%)	0.25
III	7 (22.2%)	2 (6.5%)	
Anesthesia duration, min, mean±sd	130.22±17.11	127.76±17.82	0.42
Surgery duration, min, mean±sd	122.59±17.23	120.11±18.55	0.39

Group B, patients with ESPB; group K, patients with non block; F, female; M, male; sd, standart deviation

The total remifentanil cost, sevoflurane cost and tramadol cost obtained by multiplying the unit prices of these drugs used in the perioperative period were found to be statistically significantly lower in the Group B (p=0.006, p=0.001, p<0.001) (**Table 3**).

Table 2. Perioperative follow-up results of patients

	Group B N, 30	Grup K N, 31	P value
HR, beat/min, mean±sd	69.87±2.76	70.09±3.00	0.81
MBP, mmHg, mean±sd	76.91±3.20	76.33±3.16	0.43
MAKmean mean±sd	0.80±0.01	1.10±0.01	<0.001*
BİS, mean±sd	45.77±1.88	45.91±1.84	0.77
First analgesia time, hour, mean±sd	3.78±2.37	2.37±1.00	0.008*
Discharge time, day mean±sd	3.93±1.41	4.38±1.55	0.24

Group B, patients with ESPB; group K, patients without block; N, number; HR, heart rate; MBP, mean blood pressure; MAK, minimum alveolar concentration; BİS, bispecteral index; sd, standart deviation
*, P values for independent t-test

Table 3. Perioperative total consumption and costs of anesthetic agents

	Group B N, 30	Group K N, 31	P value*
Intraop-remifentanyl consumption, µicrogram Median (min-max)	80 (15-375)	200 (80-500)	0.009
Intraop-sevoflurane consumption, milliliter, mean±sd	42.37±9.63	52.65±12.81	0.001
Postop-tramadol consumption, milligram, mean±sd	77.77±42.36	137.14±61.04	<0.001
Intraop-remifentanyl cost, TL, Median (min-max)	3.44 (0.64-16.13)	8.60 (3.44-21.50)	0.006
Intraop-sevoflurane cost, TL, mean±sd	66.52±15.12	82.67±20.11	0.001
Postop-tramadol cost, TL, mean±sd	13.2±7.2	23.31±10.37	<0.001

Group B, patients with ESPB group; group K, patients without block, N, number; intraop, intraoperative; postop, postoperative; TL, turkish liras; sd, standart deviation
*, P values for Independent T-test and Mann Whithey-U test

DISCUSSION

In the present study, preoperative ESPB was found to be cost-effective by reducing opioid and sevoflurane consumption in the patients who underwent percutaneous nephrolithotomy (PCNL) surgery. Recently, the effect of ESPB (which is frequently used for postoperative analgesia) on postoperative pain and opioid consumption is being investigated in different surgical procedures (18). However, in the literature, we find a few study investigating the effect of ESPB administration on perioperative consumption of analgesic agents for PCNL surgery (14,15). In addition, there was not any study that investigated the anesthesia cost effect of ESPB for PCNL surgery. With the present study, we observed that ESPB application reduces intraoperative and postoperative analgesic consumption and inhalation agent consumption and directly reduces the cost.

Balanced anesthesia applications are procedures using the lowest dose of drugs to minimize possible drug side effects (19). Regional analgesia methods are also preferred because of the lower cost and less medication is used (20). Therefore, regional anesthesia has taken its place in multimodal balanced anesthesia (19). In this study a kind of the regional anesthesia that commonly used in recent years for different type of surgeries was used. We observed that the consumption of sevoflurane was lower in patients for whom ESPB was performed who underwent balanced anesthesia. In balanced anesthesia, the inhalation agent contributes to antinociception and supports loss of consciousness in patients with unconsciousness (19). Local anesthetics that used in block procedures show their effects by preventing nerve end stimulation (21). They also act by preventing the potential for action in the peripheral nerves. Thus, they create antinociceptive effects too (21). This suggested that the amount of sevoflurane was low in patients with blockade and MAC values were low due to the antinociceptive additive effect of the local anesthetic agent. In a previous study, the transverse abdominis plane block was performed for post operative analgesia after general anesthesia (22). Kokulu et al. (22) used desflurane (a different inhalation agent) and found that its consumption and cost were lower in the group of patients with blockade. They suggested that, according to the results of their study, local anesthetics prevented the transmission of sensory messages to the central nervous system, thereby the MAC value of the inhalation agent (desflurane) was reduced. In our opinion, in our study, local anesthetic antinociceptive effect was shown by decreasing sevoflurane consumption and MAC values in the block group. Accordingly, performing the ESPB before general anesthesia reduced the cost by contributing to multimodal anesthesia.

Opioids are used in balanced anesthesia with inhalation agents as part of multimodal anesthesia (23). However, due to concerns about opioid overuse and undesirable side effects, additional multiple agents are used to reduce the amount of opioids and manage the nociceptive component of anesthesia (23). Regional anesthesia applications have an important role in maintaining the ERAS protocol after surgery and as a part of perioperative multimodal anesthesia and analgesia (24). Therefore, both central and peripheral nerve blocks can be used for opioid-free anesthesia. In the present study, we observed that opioid consumption (remifentanil consumed intraoperatively and tramadol consumed postoperatively) was lower in patients who had applied ESPB, which is used frequently in recent years, in the preoperative period.

Cost control has become an imperative in all areas of health care in the face of increasing health expenditure. When the cost of anesthesia is calculated annually, it only costs 5-6% of the surgical procedures (25). The cost of anesthesia per surgical procedure appears to be low. However, anesthesia is given for many surgical procedures throughout the year. Also anesthesia is a component of

not only surgical but also medical diagnostic procedures as well as in pain management (26). For this reason, cost studies are carried out by changing the anesthesia type, anesthesia method and combinations of drugs used in anesthesia applications (27). In a previous study, the cost of anesthesia was lower in balanced general anesthesia method compared to the total intravenous anesthesia method (28). In the present study, multimodal balanced general anesthesia was applied too and ESPB was found to be cost-effective in percutaneous nephrolithotomy surgery. In addition, the use of drugs in anesthesia creates a great cost. At this point, cost effectiveness can be achieved by reducing the doses of the drugs (29). In our study, the consumption of the inhalation agent-which attracts attention with its increasing price and the consumption of opioids-which have relatively side effects and which increased the cost due to the subsequent abuse, were found to be lower.

Some amount of local anesthetics that have some systemic effect can also pass into the blood when used in regional anesthesia (30). In our study, it was probably some amount of local anesthetic passed into the blood (we did not analyze the amount). This is the limitation of our study. Because it is not possible to know how much systemic analgesic effects of local anesthetics. The another limitation of the present study is the lack of the sensorial level of block application due to the general anesthesia. Furthermore, the third limitation is that the total drug costs used by the patients during their hospital stay and the cost estimation according to the duration of hospitalization in the intensive care unit were not calculated as they would complicate the estimation. In future studies, evaluations may be made with different surgical procedures, different blocks and different inhalation agents, taking into account the entire hospitalization process and treatment per patient.

CONCLUSION

The preoperative ESPB reduced the consumed inhalation agent and opioid and showed cost effectiveness in the perioperative period.

At the same time, ESPB has been observed as a method that contributes to the basic principles of multimodal anesthesia as well as multimodal analgesia.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was approved by the Local Ethics Committee (2019/11, Ref. No: 2019.06.08)

Informed Consent: All patients signed the informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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