Effects of Three Different Methods of General Anesthesia on Postoperative Renal and Hepatic Functions in Robot-Assisted Laparoscopic Radical Prostatectomy Patients

Robot Destekli Laparoskopik Radikal Prostatektomi Hastalarında Üç Farklı Genel Anestezi Yönteminin Postoperatif Böbrek ve Hepatik Fonksiyonlar Üzerine Etkileri

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ABSTRACT

Objective: We administered sevoflurane, desflurane and total intravenous anesthesia methods in robotic assisted laparoscopic radical prostatectomy (RLRP) patients and compared their effects on renal and liver functions. The effects of 3 different anesthesia methods on renal and liver functions in robotic assisted laparoscopic radical prostatectomy patients have not been studied.

Material and Methods: A total of 193 patients underwent Total Intravenous Anesthesia (TIVA) for Sevoflurane, Desflurane or TIVA groups. Patient data was generated by scanning the electronic patient data system (SARUS). Preoperative and postoperative laboratory findings of 3 groups were evaluated, and multivariate analysis was performed to isolate the effect of anesthesia types.

Results: One hundred and ninety-three patients who underwent RLRP with a mean age of 63.96±6.17 were evaluated retrospectively. Data were collected from 48 patients in seroflurane group, 131 patients in desflurane group and 14 patients in TIVA group. In the TIVA group, compared to the Sevoflurane and Desflurane groups, there were advantages associated with the preservation of postoperative renal and liver functions and less intraoperative respiratory acidosis.

Conclusion: TIVA was found to be well tolerated and a safe anesthesia technique for RLRP surgery. There is no other study comparing sevoflurane, desflurane, and TIVA one by one in RLRP surgery, and future studies are needed especially for revealing postoperative renal and hepatic values.

Key Words: Total intravenous anesthesia, Inhalation anesthesia, Robotic surgery

ÖZ

Amaç: Robotik yardımlı laparoskopik radikal prostatektomi (RLRP) hastalarına sevofluran, desfluran ve total intravenöz anestezi yöntemlerini uyguladık ve böbrek ve karaciğer fonksiyonları üzerindeki etkilerini karşılaştırdık. Robotik yardımlı laparoskopik radikal prostatektomi hastalarında 3 farklı anestezi yönteminin böbrek ve karaciğer fonksiyonları üzerine etkileri araştırılmamıştır.

Gereç ve Yöntemler: Toplam 193 hastaya Sevoflurane, Desflurane veya TIVA grupları için Total İntravenöz Anestezi (TIVA) uygulandı. Hasta verileri elektronik hasta veri sistemi (SARUS) taranarak üretildi. Üç grubun preoperatif ve postoperatif laboratuvar bulguları değerlendirildi ve anestezi tiplerinin etkisini izole etmek için çok değişkenli analiz yapıldı.

Bulgular: Yaş ortalaması 63.96±6.17 olan RLRP yapılan 193 hasta retrospektif olarak değerlendirildi. Serofluran grubu 48, Desfluran grubu 131 ve TIVA grubu 14 hastadan veriler toplandı. TIVA grubunda, Sevofluran ve Desfluran gruplarına kıyasla, postoperatif böbrek ve karaciğer fonksiyonlarının korunması ve daha az intraoperatif solunum asidozu ile ilişkili avantajlar vardı.

Sonuç: Bu bulgular doğrultusunda TIVA iyi tolere edilir ve RLRP ameliyatı için güvenli bir anestezi tekniğidir. RLRP cerrahisinde sevofluran, desfluran ve TIVA'yı tek tek karşılaştıran başka bir çalışma yoktur ve özellikle postoperatif böbrek ve karaciğer değerlerini ortaya çıkarmak için gelecekteki çalışmalara ihtiyaç vardır.

Anahtar Sözcükler: Total intravenöz anestezi, İnhalasyon anestezisi, Robotik cerrahi

BACKGROUND and OBJECTIVES

Radical prostatectomy (RP) is the standard treatment for patients with localized prostate cancer (cT1-T2) (1). The incidence of prostate cancer is known to be currently increasing in many countries (2,3). RP has been performed with several different techniques as open radical prostatectomy (ORP), retropubic radical prostatectomy (RRP), laparoscopic radical prostatectomy (LRP), and robot-assisted laparoscopic radical prostatectomy (RLRP). It is reported in some studies that RLRP surgery provides several advantages compared with standard laparoscopy such as better visualization, the ability to perform more precise dissection of the anatomic structures, better preservation of functional structures, and better perioperative and postoperative outcomes (4,5). In several studies, it has been shown that TIVA (Total Intravenous Anesthesia) via a target-controlled infusion system with propofol provides more rapid emergence compared to other anesthetic techniques in several kinds of surgeries (6,7). It is known that TIVA has many advantages including reduced postoperative pain, less postoperative nausea and vomiting, and less potential risk of organ toxicity such as hepatic and renal toxicity implicated to arise from volatile agents (8). In our study, we compared the postoperative renal and hepatic functions between anesthesia types with sevoflurane, desflurane, and TIVA in robot-assisted laparoscopic radical prostatectomy.

MATERIAL and METHODS

This retrospective study was conducted at the Department of Antalya Education and Research Hospital, between 2017 and 2018. The Local Ethics Committee of Antalya Education and Research Hospital approved the study (2018-081). After obtaining permission from the local board, this retrospective study retrieved information from the electronic database and the patient file records of the Antalya-Training and Research Hospital's Anesthesia Clinic. A total of 193 patients with localized prostate cancer (c T1-T2), with a mean age of 63.96 years, who had undergone RLRP were included. All of the patients were separated into three groups according to the types of anesthetic agents as Sevoflurane (48 patients), Desflurane (131 patients) and TIVA (14 patients). ASA (American Society of Anesthesiologists) physical status of the patients was identified as between 1 and 2 according to their comorbidity factors. After obtaining anesthesia, monitoring was ensured with an electrocardiogram, intra-arterial and central jugular catheter pressure reading, pulse oximetry, capnography, neuromuscular blockade, and urine output. Thiopental sodium (5 mg/kg) and medical air in oxygen with desflurane or sevoflurane were used for induction of anesthesia in the Desflurane and Sevoflurane groups. Otherwise, propofol (2 mg/kg) and remifentanil (1µg/kg) were used for induction of anesthesia and maintained with propofol (75 µg/kg/min), remifentanil (0.5 µg/kg/min) and 50% oxygen/air ventilation in the TIVA group. The bispectral index value was kept between 40-50 to ensure sufficient depth of anesthesia. Vecuronium(0.15 mg/kg) was used for muscle relaxation in all three groups. The liquid requirement of patients was provided with Isolyte-s input, and urine output was observed with the urethral catheter during the operation (Table I). BUN, creatinine, ALT, AST values were evaluated postoperatively and compared with preoperative values in all three groups. Additionally, arterial blood PH values were evaluated during the operation for assessment of intraoperative respiratory acidosis. At the end of the operation, all patients received tramadol 100 mg intravenously for postoperative analgesia.

Statistical Analysis

Statistical analysis was conducted with IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY). Pearson chi-square analysis was performed for categorical variables. The normality assumptions were controlled by the Shapiro-Wilk test. For the comparison of postoperative and preoperative parameters, the Wilcoxon Signed Rank test was used. The Kruskal-Wallis test was used for comparison of non-parametric variables between groups and the Bonferroni-Dunn test was used as a post-hoc test for significant cases while One-Way ANOVA with the post-hoc Tukey HSD test was used for parametric variables. Data are expressed as n (%), mean ±standard deviation (SD) or median (min-max), as appropriate. P values <0.05 were considered statistically significant.

RESULTS

We assessed 193 patients who underwent RLRP with a mean age of 63.96±6.1 years and included data from 48 (24.8%) patients receiving Sevoflurane, 131 (67.8%) patients receiving Desflurane and 14 (7.2%) receiving TIVA. All ASA physical status was between 1 and 2 and patients with additional comorbidity factors such as diabetes mellitus, hypertension or respiratory problems were excluded from the study.

There was no statistically significant difference between the age, anesthesia duration, operation time, bleeding values and urine output according to the type of anesthesia (p> 0.05) (Table I).

There was no statistically significant difference between the BUN, ALT and AST values of the patients according to the type of anesthesia (p>0.05). While there was no difference in creatinine levels between the groups (p=0.387), postoperative creatinine values of TIVA group were found to be statistically lower than the other two groups (p<0.001). When the alterations of the parameters before and after the operation was examined in all patients and anesthesia groups, it was observed that BUN, creatinine and AST values increased significantly in all patients and ALT values decreased significantly (p<0.001). BUN and creatinine values increased significantly in patients receiving sevoflurane while ALT values decreased significantly (p<0.05). In the desflurane group, BUN, creatinine, and AST values were significantly increased in all patients, while ALT values decreased significantly (p<0.05). In the TIVA group, BUN, ALT, and AST values were found to be increased, and the creatinine values decreased while the change was not significant (p>0.05) (Table II).

When the pH values of the patients were compared to the anesthesia group, no statistically significant difference was found (p=0.117). Patients were grouped as low, normal and high according to pH values and their relationship with the type of anesthesia was investigated. Accordingly, for patients in the TIVA group, the percentage of being in the low pH (pH≤7.35) and normal pH (pH≈7.35-45) group was higher than those of the other two groups, but this difference was not statistically significant (p=0.584) (Table III).

Table I: Comparison of patients demographics and clinical characteristics.

	Anesthesia Type			p
	Sevoflurane (n=48)	**Desflurane (n=131)**	**TIVA (n=14)**	
Age	64.08±5.6	64.24±5.93	61±9.32	0.174
Anesthesia time (min)	201.35±17.71	197.21±16.95	200.36±17.92	0.333
Operation time (min)	161.25±18.75	157.14±18.63	157.14±18.47	0.418
Bleeding (ml)	227.4±42	238.21±33.65	223.57±29.64	0.101
Isolyte-S (ml)	1850 (1500-2500)[a,b]	1750 (1500-2350)[a]	1925 (1650-2500)[b]	***0.025***
Urine output (ml)	380 (250-550)	380 (250-560)	350 (250-520)	0.325

Data are presented as mean±SD and median(min- max). **ASA**, American Society of Anesthesiologist; **TIVA**, patients receiving total intravenous anesthesia; **SD**, standard deviation. ANOVA and Kruskal-Wallis test with Bonferroni-Dunn correction. Different lowercase letters in a row indicate statistically significant difference between groups.

Table II: Comparison of study parameters between anesthesia groups.

	Anesthesia Type			p
	Sevoflurane (n=48)	**Desflurane (n=131)**	**TIVA (n=14)**	
Preop BUN	15 (7-29)	16 (8-31)	14.5 (9-25)	0.385
Postop BUN	16 (8-35)	17 (10-49)	15.5 (10-19)	0.077
p	***0.041***	***<0.001***	0.999	
Preop creatinine	1.02 (0.79-2.03)	1.04 (0.77-5.47)	1.01 (0.8-1.27)	0.387
Postop creatinine	1.09 (0.72-2.31)[a]	1.17 (0.78-7.91)[a]	0.96 (0.83-1.14)[b]	***<0.001***
p	***0.008***	***<0.001***	0.300	
Preop ALT	20 (7-50)	18 (7-74)	17 (11-125)	0.075
Postop ALT	18 (7-120)	16 (4-227)	18.5 (9-85)	0.362
p	***0.002***	***<0.001***	0.833	
Preop AST	21 (13-47)	21 (12-69)	17.5 (14-62)	0.229
Postop AST	23.5 (14-67)	22 (11-188)	23 (16-52)	0.768
p	0.325	***0.002***	0.053	

Data are presented as median(min- max). Kruskal-Wallis test with Bonferroni-Dunn correction and Wilcoxon Signed Rank test. Different lowercase letters in a row indicate statistically significant difference between groups. **Preop:** Preoperative, **Postop:** Postoperative

Table III: Comparison of pH values between anesthesia groups.

	Total (n=193)	Anesthesia Type			p
		Sevoflurane (n=48)	Desflurane (n=131)	TIVA (n=14)	
pH	7.36 (7.11-7.73)	7.35 (7.17-7.54)	7.36 (7.11-7.73)	7.41 (7.27-7.46)	0.117
Low (<7.35)	77 (39.9)	21 (43.8)	53 (40.5)	3 (21.4)	0.584
Normal (7.35-7.45)	98 (50.8)	23 (47.9)	65 (49.6)	10 (71.4)	
High (>7.45)	18 (9.3)	4 (8.3)	13 (9.9)	1 (7.1)	

Data are presented as n(%) and median(min- max). Pearson chi-square test and Kruskal-Wallis test.

DISCUSSION

RP is the standard treatment for patients with clinically localized prostate cancer (c T1-T2) (1). Besides open surgery, the LRP technique was standardized, and then the minimally invasive techniques have been improved (9). Recently, because of many advantages such as intraoperative less bleeding, volume and clear visualization, and a better appreciation of the dorsal venous complex and neurovascular bundles, the RLRP technique has been used more frequently in many centers (10,11).

Volatile anesthetics have been used in various surgeries including RLRP. In the most recent studies, TIVA was used during various types of surgical procedures such as living donor hepatectomy and endoscopic sinus surgery, and the postoperative conditions were compared with surgery using volatile anesthetics (12,13). It is well known that the metabolized products of volatile anesthetics are eliminated exclusively by the kidneys (14). In long-term laparoscopic operations, we considered it appropriate to evaluate blood Ph levels due to pneumoperitonium as well as liver and kidney functions. Although several studies reported the safety of desflurane in patients with renal failure with no significant negative influence on renal and hepatic functions, no other study has compared the postoperative effects of Sevoflurane, Desflurane and TIVA procedures one by one in RLRP patients so far (12). In our study, we compared the postoperative renal and hepatic effects of these 3 anesthesia procedures one by one and also the intraoperative respiratory acidosis rates in RLRP surgery. When we compared the preoperative and postoperative BUN values, there was no significant difference between the Sevoflurane, Desflurane and TIVA groups but postoperative creatinine was substantially higher in the Sevoflurane and Desflurane groups compared to the TIVA group.

In contrast, studies comparing the renal function between inhalation anesthesia and TIVA revealed no significant differences in postoperative creatinine levels (12,15). Isolyte-s infusion administered to the TIVA group was higher than in the other groups. The lower creatinine levels in the TIVA group found in our study might be due to dilution from the fluid given perioperatively. Besides, creatinine levels did not exceed the upper limits of the normal range in any group. Thus, it is clear that TIVA can lead to more rapid onset and shorter recovery profiles and it can be used safely in patients who have damaged preoperative renal functions who are undergoing RLRP. One limitation of this study is that we only used BUN and creatinine levels to assess kidney function.

Further studies using more sensitive tests are required for a reliable assessment of kidney functions. Although some other studies indicate no significant postoperative difference in ALT and AST between volatile anesthetics and TIVA, postoperative ALT values were mostly better in the TIVA group compared to the Sevoflurane and Desflurane groups in this study (16). Additionally, postoperative AST values were meaningfully elevated in the Desflurane group, but no significant difference was detected in the TIVA and Sevoflurane groups. Propofol is certainly used in TIVA during surgery and is a short-acting drug with a large volume of distribution and high total body clearance. It is metabolized rapidly in the liver and kidneys with no negative impact on hepatic and renal functions (17). Remifentanil is also an ultra-short-acting opioid and undergoes rapid hydrolysis by blood and tissue esterase with rapid elimination and recovery. This may explain why TIVA is a protective and safe procedure regarding renal and hepatic functions and is compatible with the results of our study.

On the other hand, the TIVA group had generally normal intraoperative arterial blood Ph values compared to the other groups, indicating a lower risk of respiratory acidosis. Additionally, it is well known that long anesthesia time can also cause hypercarbia that may lead to intraoperative acidosis. In our cases, the operation time and anesthesia time were clearly long in the 3 groups. Despite the long anesthesia time, there was no significant change in intraoperative arterial blood pH values in the TIVA group.

CONCLUSION

The increasingly popular RLRP interventions may cause some metabolic changes within the perioperative period. As a result of our study that compared three different anesthesia methods, we determined that the creatinine level was lower in the TIVA group in the postoperative period. Based on these findings, we believe that future studies are required with the TIVA anesthesia technique primarily for revealing postoperative renal and hepatic values in RLRP operations.

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