Yeditepe Medical Journal 2012;6(24): 559-566

ANESTHESIA FOR ROBOT-ASSISTED LAPAROSCOPIC RADICAL PROSTATECTOMY: OUR 4-YEAR EXPERIENCE

Orıgınal Artıcle

ROBOT YARDIMLI LAPAROSKOPİK RADİKAL PROSTATEKTOMİ ANESTEZİSİ: 4 YILLIK DENEYİMLERİMİZ

Murat Haliloglu

Yeditepe University Hospital, Department of Anesthesiology and Reanimation.

Mehtap Ozdemir

Umraniye Education and Research Hospital, Department of Anesthesiology and Reanimation.

Nurten Bakan

Umraniye Education and Research Hospital, Department of Anesthesiology and Reanimation.

Corresponding author:

Murat Haliloglu, M.D.

Devlet Yolu Ankara CD. No:102/104

34752 kozyatagi /Istanbul/ turkey

e.mail: mrt.haliloglu@gmail.com

ABSTRACT

Purpose: To assess the feasibility and postoperative outcomes in patients undergoing robot-assisted laparoscopic radical prostatectomy (RALP) with pressure-controlled ventilation mode.

Methods: 200 ASA physical status I, II, and III men underwent RALP was searched retrospectively. Demographic data, intraoperative hemodynamic and respiratory parameters and fluid and blood products, intraoperative and postoperative analgesic consumption were all recorded. Additional data included postoperative transfusion need; pre and postoperative hematocrit, platelet count, creatinine levels and length of hospital stay.

Results: Mean age of the patients undergoing RALP was 62 years; mean body mass index was 28.2 kg m-2. The mean anesthesia time was 3.42 hours and mean blood loss was 222 ml. Postoperative anemia (hemoglobin <10 g/dL) requiring blood transfusions was seen in 4.1% of the patients. One patient required postoperative mechanical ventilation because of laryngeal edema secondary to multiple intubation attempts.

Conclusions: RALP was associated with low estimated blood loss (EBL), few blood transfusions, PACU and short hospital stays.

Key Words: *Robotic surgery; Steep Trendelenburg;Pressure-controlled-ventilation; Prostate cancer*.

ÖZET

Amaç: Robot yardımlı laparoskopik radikal prostatektomi operasyonları sırasında uygulanan basınç kontrollü modun uygunluğunun ve postoperatif sonuçlarının değerlendirilmesi.

Method: Robot yardımlı laparoskopik radikal prostatektomi operasyonu geçiren ASA I-III grubu 200 hasta retrospektif olarak değerlendirildi. Hastaların demografik verileri, intraoperatifhemodinamik ve respiratuvar-parametreleri, peroperatif analjezik tüketimi incelendi. Ayrıca hastaların peroperatif hematokrit düzeyleri, platelet sayıları, kreatinin seviyesi ve transfüzyon ihtiyacına bakıldı.

Bulgular: Ortalama hasta yaşı 62 yıl, vücut kitle indeksi 28.2 kg m^{-2}, anestezi süresi 3.42 saat, kan kaybı 222 ml bulundu. Hastaların % 4.1'inde kan transfüzyonu gerektiren postoperatif anemi (hemoglobin< 10 g/dl) görüldü. Çok sayıda entübasyon girişimi sonucu gelişen larenks ödemi nedeniyle bir hastada postoperatif mekanik ventilasyon ihtiyacı oluştu.

Sonuç: Robot yardımlı laparoskopik radikal prostatektomi daha az kan kaybı, transfüzyon ihtiyacı, anestezi sonrası bakım ünitesi ve hastanede kalış süresi ile ilişkilidir.

Anahtar kelimeler: *Robotik cerrahi; Aşırı Trendelenburg; Basınç-kontrollü ventilasyon; Prostate kanseri.*

INTRODUCTION

Prostate cancer is the sixth most common cancer in the world, and a frequent cause of deaths related to cancer (1). Widespread screening with prostate spesific antigen (PSA) has led to detection of prostate cancer when the tumor is localized and therefore potentially curable (2). Radical prostatectomy (RP) is an effective option for localized prostate cancer and robotic-assisted radical prostatectomy is the newest and most technically advanced method. RALP, which increased from 1% in 2001 to almost 70% is the most frequently performed robotic surgical procedure world wide (3,4). RALP has the advantages of decreased blood loss, transfusion rates, shorter hospital stay and improved functional status have been reported (5). However, RALP presents many problems associated with pneumoperitoneum in combination with steep Trendelenburg position. Although much has been written about the surgical outcomes of RALP, little data exist regarding the perioperative anesthetic management of these cases.

In this study, we performed a retrospective database review of patients who presented at our hospital for RALP, beginning from December 2008 to February 2012. The goal of the study was to present perioperative anesthetic management and outcomes of patients undergoing RALP.

METHODS

Following the hospital instutional review board approval (Date: 21.03.2012; chairperson: Ahmet Göçmen, MD.), the perioperative database of patients who underwent RALP from 11/2008 until 2/2012 was searched retrospectively. We collected information about patient demographics, intraoperative fluid management, hemodynamic parameters, respiratory parameters, pain scores and rescue anti-emetic need in the postanesthesia care unit (PACU), intraoperative and postoperative analgesic consumption, and intraoperative use of vasopressors and antihypertensives. Postoperative transfusion need were reported. Urologic data on the pre and postoperative clinical status of each patient's were retrieved from the Division of Urology database. The laboratory parameters (hematocrit (Hct), platelet count, and serum creatinine) and the length of hospital stay of each patient were noted. Prostate-specific antigen (PSA) levels and Gleason sums were retrived along with the pathologic Gleason sum and pathologic extracapsular and seminal vesicle invasion percentages, and prostate weight.

The diet was restricted to clear liquids one day before the surgery, and a fleet enema, oral ranitidine, and low molecular weight heparin was administered the evening before surgery. A standardized protocol was used for anesthesia. Members of a team of two anesthetists and two surgeons provided care to all the patients. No premedication was given. In the operating room, standart monitoring devices (EEG, non-invasive arterial pressure, pulse oximetry, BIS, anesthetic gas, and CO_2 analyser) were applied and anesthesia was induced intravenously with remifentanil 0,5 µg kg^{-1}, propofol 2-2,5 mg kg^{-1}, and rocuronium 0,6 mg kg^{-1}. After intubation, anesthesia was maintained with desflurane 4-6% (end-tidal concentration), remifentanil 0.1-0.3 µg kg^{-1} min^{-1}, and adjusted to keep BIS value between 45 and 55. Rocuronium administration was repeated as needed for muscle relaxation. Ventilation was performed using pressure-controlled mode (Primus, Draeger™, Luebeck, Germany). During anesthesia, pressure control was adjusted to achieve tidal volume at 8 ml kg^{-1} of ideal body weight [i.e. 50+0,91×(height in cm-152,4)] and a positive end-expiratory pressure of 5 cmH_2O (6). The inspiratory:expiratory ratio was 1:1.7. Respiratory rate was adjusted to maintain the end-tidal CO_2 30-35 mm Hg and plateu pressure was kept as low as possible with upper limit of 35 cm H_2O. No recruitment manoeuvers were performed after tracheal intubation.

A 20-gauge radial artery catheter was inserted to left radial artery for blood sampling and pressure monitoring. RALP may be associated with hypothermia due to prolonged pneumoperitoneum with dry, cold gases. To maintain normothermia, a heating blanket (Bair Hugger 505, Augustine Medical, Eden Prairie, MN) was used. For reducing the risk of deep vein thrombosis, our pratice was to apply sequential compression stockings to the calves.

All patients received a continuous infusion application of colloid infusion (Voluven 130/0.46 %; Fresenius Kabi AG, Bad Homburg, Germany) with rate of 2-3 ml kg^{-1} h^{-1} intraoperatively. Additionally, a bolus of 500-1000 ml crystalloid was given in PACU.

In this procedure the patients were placed on an egg crate mattress that was attached to the bed with lower extremities in padded lithotomy stirrups. Shoulder braces covered with gel foam pads are used as additional safety devices for preventing injury to the brachial plexus and ulnar nerve. The patient's legs were placed in urological leg-holders and the thighs abduced sufficiently. Carbondioxide pneumoperitoneum was induced with 15±5 mmHg of intraabdominal pressure using the da Vinci Robot Surgical System (Intuitive Surgical, Sunnyvale, CA, USA), and then 40° Trendelenburg position was established. Intraperitoneal pressure was adjusted by the surgeon as needed.

Postoperative analgesia was initiated intravenously with 1 g paracetamol (Perfalgan®; Bristol-Myers Squibb, Istanbul, Turkey), 0.05 mg kg^{-1} morphine (morphine ampoule, Osel, Istanbul, Turkey) and 1 mg kg^{-1} tramadol (100mg/mL; Contramal ampoule, Abdi Ibrahim, Istanbul, Turkey) 30 min before the end of surgery. The PCA device (continuous infusion was given at 10 mg/hr, the bolus dose 20 mg and the lockout time was 20 min) was inserted immediately after the patients were transferred to the postanesthesia recovery room and extubation. 1 g of paracetamol was administered intravenously over 15 minutes every 6 hours. Rescue analgesia with 75mg diclofenac sodium intramuscularly was allowed if the patient could not obtain adequate pain relief from the PCA regimen.

STATISTICAL ANALYSIS

The data are expressed as mean (standart deviation), median with range, or numbers with percentage unless otherwise indicated. Student's t test was used for comprasion of the parameters. All results with $p < 0.05$ were considered statistically significant.

RESULTS

Data from 200 patients who underwent RALP was obtained from the perioperative database. After exclusion of data from patients who underwent additional procedures other than pelvic lymphadenectomies (n=5), who recived an epidural (n=5), or who ventilated by volume controlled ventilation (n=20), 170 patients remained and were included in the study. Patient demographics and tumor characteristics are summarized in **Table-1**.

Table-1: *Patient demographics and tumor characteristics.*

		RALP (N=200)
Demographics	Age (years)	62±6.5
	BMI (kg m^{-2})	28±3.3
	ASA I II III (n)	17/124/29
PSA (ng/ml)	Diagnostic	8.4±8.4
	Recurrence after surgery (n)	16 (9.4)
	Years before recurrence	1.2±0.7
Preoperative IEEF-5		17±10
Gleason Sum	Diagnostic	6.5±0.6
	Pathologic	6.8±0.8
Prostate Weight (g)		47±28
Invasion	Extracapsular (n)	31(18.2)
	Seminal vesicle (n)	3 (1.7)

Data are means ± Standard deviation or numbers (%).

ASA= American Society of Anesthesiologists phisical status score, BMI =Body mass index.

RALP=robot-assisted laparoscopic prostatectomy, PSA=prostate-spesific antigen.

The mean age was 62±6.5 years and mean BMI was 28±3.3 kg m^{-2}.

Intraoperative data are summarized in **Table-2.**

Table-2: *Operative data.*

	RALP
Anesthesia time (hours)	3.4±0.2
Insufflation time (hours)	2.7±0.3
Colloid (ml)	874±186
Urine output (ml)	175±32
EBL (ml)	222±198
RBC transfusion (unit)	0
Total remifentanil consumpton (µg)	1403±294
Mean temperature (°C)	36.2±0.6
Vasopressor use (n)	24
Anti-hypertensive use (n)	27

Data are means ± Standard deviation or numbers (%).

EBL=estimated blood loss, RBC=red blood cell.

No RALP patients received red blood cell, fresh frozen plasma or platelet transfusion intraoperatively. No ECG abnormalities or severe arrhythmias were recorded during the operation period. Total operative blood loss was less than 300 ml in all the patients.

Respiratory and hemodynamic variables at each time point are shown in **Table-3**.

Table-3: *Changes in respiratory and hemodynamic variables.*

	T1	T2	T3	P
HR (bpm)	75±12	72±10	74±10	0,6
MAP (mmHg)	87±18	84±11	82±8	0,2
SpO_2 (%)	99,8±0,4	99,6±0,6	99,7±0,4	0,7
$EtCO_2$ (mmHg)	30±2,3	33±2,9*	33±2,3*	0,001*
RR (breaths/min)	8±0	9,8±1,5*	10,7±1,7*	0,001*
Peak airway pressure (cmH_2O)	14±4	31±4*	32±3,6*	0,001*
Plateau pressure (cmH_2O)	12±4	29±4*	29±4*	0,001*
Minute volüme (L)	4,5±0,4	5,4±0,9*	6±1*	0,001*

Data are means ± Standard deviation.

P-values < 0.05 were considered significant.

HR=heart rate, MAP=mean arterial pressure, SpO2=oxgen saturation as recorded by pulse oximetry, EtCO2=ent-tidal carbon dioxide as recorded by capnography, RR=respiratory rate,

AaDo2 = the alveolar-arterial difference in oxygen tension.

T1= before insufflation, T2=60 min after insufflation, T3=120 min after insufflation

Hemodynamic data monitored continuously was recorded measured 5 minutes after intubation; and 60 and 120 minutes after abdominal insufflation in all the patients. The arterial oxygen saturation was found to be stable throughout the procedure with a mean SpO_2 of 99 %. Heart rate and mean arterial pressure (MAP) values of all the patient were within the physiological range. $EtCO_2$, respiratory rate, peak airway pressure, plateu pressure, minute volume showed a stastistically significant increase at 60 min and 120 min after steep Trendelenburg position and capnoperitoneum compared to supine position.

In our case series, 22 patients was given ephedrine due to lowered systemic vascular resistance induced by balanced general anesthesia. Moreover, norepinefrine infusion was necessary in two patients. 27 patients was needed nitroglycerine infusion for severe hypertension.

Postoperative patient data are summarized in **Table-4**.

Table-4:*Postoperative patient data.*

		n (%)
PACU	Diclofenac given	14 (8.2)
	Antiemetic given	27 (15.8)
	Minimum pain score (NRS)	1.1±1.6
	Maksimum pain score (NRS)	2.8±1.8
	Temperature (Celcius)	36±0.73
	Length of stay (mins)	120±51
	Crystalloid (ml)	837±282
Postoperative	Tramadol consumption (mg)	389,3±59,4
	Diclofenac given	35 (20.5)
	RBC transfusion	7 (4.1)
	FFP transfusion	4 (2.3)
	Platelet transfusion	0
	Hospital stay (hrs)	65±26
Laboratories	Creatinine (mg/dl)	
	Preoperative	0.9±0.1
	Postoperative	1.3±0.5
	%change-preop to postop	35.5±35.4
	Hemoglobin (gr dl^{-1})	
	Preoperative	14.2±1.3
	Postoperative	12.3±1.1
	%change-preop to postop	-13.4±6.5
	Hematocrit (%volume)	
	Preoperative	42.8±3.4
	Postoperative	36.5±3.4
	%chance-preop to postop	-14.2±6.8
	Platelets ($\times 10^9$ platelets/L)	
	Preoperative	254.7±64.8
	Postoperative	219.7±56.4
	%change-preop to postop	-13.5±9.9

Data are means ± Standard deviation or numbers (%).

PACU=Postanesthesia Care Unit, RBC=red blood cells, FFP=fresh frozen plasma.

The mean tramadol consumption was 389,31±59,36 mg and diclofenac sodium was given to 14 patients in the PACU and 35 patients in the ward as a rescue analgesic. RBC transfusion was required in 7 patients during the immediate postoperative period as hemoglobin level were less than 9 g dl^{-1}. Mean creatinine levels of the patients increased postoperatively compared to baseline, but these changes were within the normal range. The mean hospital stay was 65±26 hours, except for 3 patients. Two of them had an anastomotic leak (25 days) an one of them had abdominal abcess (24 days).

All the patients were extubated in the operation room except for one patient who had laryngeal edema due to multiple intubation attempts.

DISCUSSION

RALP is a frequently performed robotic surgical procedure world wide and offers advantages over conventional surgery such as sparing nerves, shorter hospital stay, reduced blood loss, and less postoperative pain (7,8,9). Compared to retropubic RP, minimally invasive RP was significantly associated with shorter hospital stays (2.0 versus 3.0 days), less blood transfusions (2.7 versus 20.8 percent), fewer respiratory complications (4.3 versus 6.6 percent), and fewer anastomotic strictures (5.8 versus 14.0) (10).

RALP is performed with a pneumoperitoneum and prolonged maximum Trendelenburg position which may have adverse physiologic effects. Both the steep Trendelenburg position and pneumoperitoneum influence the respiratory system, increasing arterial CO_2 and increasing peak inspiratory pressures during mechanical ventilation (11). Pulmonary compliance and functional residual capacity are reduced and the lungs are predisposed to compression atelectasis and ventilation/perfusion mismatch, which can lead to hypoxia (12). Our analyses revealed only 9 patients having one transient (less than 5 minutes) documented episode of hypoxemia.

Pressure-controlled ventilation (PCV) has been proposed as an alternative to volume-controlled ventilation (VCV) in ICU patients with adult respiratory distress syndrome, and in obese patients to achieve adequate oxygenation and normocapnia (13,14,15). The characteristics of PCV, which are faster volume delivery, different gas distribution, high and decelerating inspiratory flow, may compansate for any potential reduction in ventilation caused by pressure limitation (16). Also, the limitation of pressure levels has positive effects on patient's hemodynamic and might even reduce the risk of barotrauma (13). In patients undergoing general anesthesia, the use of PEEP prevents alveolar atelectasis and cyclical recruitment, improving lung compliance and correcting ventilation perfusion abnormalities (17). However, there is no concensus for the ideal level of PEEP during laparoscopic surgery (18). Due to these theoretical advantages, and our clinical experience, we prefered pressure-controlled ventilation and routinely used PEEP (5 cmH_2O) in RALP operations.

The steep trendelenburg position can stress the right ventricle and increase myocardial work and cardiac output, although the hemodynamic changes are often not significant or are transient (19,20).

The blood loss and lower transfusion requirements in the RALP patients in our cases were similar to earlier data (12). This might be due to more accurate hemostatic control as a result of the magnified three-dimensional view with the robot (21).

In RALP blood loss is minimal, but fluid requirements are large. There is a certain amount of third space formation, because of the peritoneal cavity invaded and insufflated with dry gas. Moreover intraoperative fluid should be given sparingly to reduce facial and airway edema and urine production, which obscures the operation field during bladder neck and urethrovesical anastomoses (22). For this reason, we gave a continuous infusion application of HES at a rate of 2-4 ml kg^{-1} h^{-1} intraoperatively; additionally a bolus of 500-1000 ml Lactated Ringer's was given in PACU. Fluid management was guided using the hemodynamic parameters.

Furthermore, swelling of the face, eyelids, conjunctiva, and tongue are common. Significant facial and laryngeal edema was seen in only one patient, which was self-limiting,in our case series without an evidence of brain edema.

Swelling of the soft tissues around the airway is a concern, and it has been recommended that removal of the endotracheal tube to be delayed in patients who have substantial swelling (23). Only one patient was not extubated immediately at the end of the surgery, due to laryngeal edema resulting from multiple laryngoscopic attempts and required transient post-operative mechanical ventilation. Subcutaneous emphysema occurs frequently, especially in the perineal area in and related to the total amount of CO_2 insufflation (24).

With insufflation pressures higher than 15 mmHg, urine output and glomerular filtration rate may be impaired, but it does not affect postoperative renal function and frequently recovers without any histologic changes (25,26,27,28). In our cases an increase in creatinine levels compared to bas eline was seen postoperatively, but it was in the normal limits.

Brachial plexus injuries due to use of shoulder braces, and also injuries to the sciatic nerve, obturator nerve, peroneal nerve and lateral cutaneous nerve have all been founded to be associated with robot assisted procedures (29,30). No peripheral nerve injuries were recorded.

One of the benefits of laparoscopic techniques is the reduction of postoperative pain, but the patients undergoing RALP still require opioid analgesia (31). The postoperative care plan for RALP at our clinic included a multimodal pain regimen with paracetamol, tramadol and diclofenac.

Some limitations of this study are inherent to its retrospective nature, because the accuracy of the data entries made by the health care providers. Moreover, the overall results become less influenced by occasional errors, because of the study’s size. Another limitation is that we did not have record of postoperative oxygenation and respiratory function.

In conculusion, we have presented our anesthesia experience of RALP in our clinic. RALP is the the most frequent adaptation of robotic-assisted surgery and offers promising initial results. Although having some anesthetic challenges during the surgical period such as high airway pressures, and increased fluid and vasopressor requirement, in our study the patients had low EBL, and blood transfusions. In the PACU, RALP patients also had relatively low opioid consumption and rescue antiemetics. Notably, they had short length of hospital stay.

REFERENCES

1)Jemal A, Siegel R, Xu J, Ward E. Cancer statistics, 2010. CA Cancer J Clin 2010; 60:277.

2)Kantoff P, Taplin M (2005) Overview of the clinical presentation, diagnosis, and staging of prostate cancer.

3)Guru KA, Hussain A, Chandrasekhar R, et al. Current status of robot-assisted surgery in urology: a multi-national survey of 297 urologic surgeons. Can J Urol 2009; 16:4736-4741.a

4)Murphy DG, Bjartell A, Ficarra V, et al. Downsides of robot-assisted laparoscopic radical prostatectomy; limitations and complications. Eur Urol 2009;57:737-746.

5)Menon T, Tewari A, Baize B, et al. Prospective comparison of radical radical retropubic prostatectomy and robot-assisted anatomic prostatectomy: the Vattikuti Urology Institute experience. J Urol 2003; 170:318-319.

6)The ARDS Network. Ventilation with lower tidal volumes as compared with tradional tidal volumes for acute lung injury and the acute respiratory distress syndrome. The Acute Respiratory Distress Syndrome Network. N Engl J Med 2000;342:1301-8

7)Murphy DG, Bjartell A, Ficarra V, et al. Downsides of robot-assisted laparoscopic radical prostatectomy;

limitations and complications. Eur Urol 2009;57:737-746.

8)Zorn KC, Gofrit ON, Orvieto MA, Mikhail AA, Zagaja GP, Shalhav AL. Robotic-assisted laparoscopic prostatectomy: functional and pathologic outcomes with interfascial nerve preservation. Eur Urol 2007;51:755-62.

9)Menon M, Tewari A, Peabody JO, et al. Vattikuti Institute prostatectomy, a technique of robotic radical prostatectomy for management of localized carcinoma of the prostate: experience of over 1100 cases. Urol Clin North Am 2004;31:701-17.

10)Hu JC, Gu X, Lipsitz SR, et al. Comparative effectiveness of minimally invasive vs open radical prostatectomy. JAMA 2009; 302:1557. www.uptodate.com.

11)Stolzenburg JU, Aedtner B, Olthoff D, et al. Anaesthetic considerations for endoscopic extraperitoneal and laparoscopic transperitoneal radical prostatectomy. BJU Int 2006;98:508-13.

12)Tokics L, Hedenstierna G, Strandberg A, Brismar B, Lundquist H. Lung collapse and gas exchange during general anesthesia: effects of spontaneous breathing, muscle paralysis, and positive end-expiratory pressure. Anesthesiology 1987;66:157-67.

13)Mercat A, Graini L, Teboul JL, Lenique F, Richard C. Cardiorespiratory effects of pressure-controlled ventilation with and without inverse ratio in adult respiratory distress syndrome. Chest 1993; 104:871-5.

14)Prella M, Feihl F, Domenighetti G. Effects of short-term pressure-controlled ventilation on gas exchange, airway pressures, and gas distribution in patients with volume-controlled ventilation. Chesth 2002; 122:1382-8.

15)Ogunnaike BO, Jones SB, Jones DB, Provost D, Whitten CW. Anesthetic considerations for bariatric surgery. Anesth Analg 2002; 95:1793-805.

16)Davis K Jr, Branson RD, Campbell RS, Porembka DT. Comparision of volume control and pressure control ventilation: is flow waveform the difference? J Trauma 1996;41:808-14.

17)Meininger D, Byhahn C, Mierdl S, Westphal K, Zwissler B. Positive end-expiratory pressure improves arterial oxygenation during prolonged pneumoperitoneum. Acta Anaesthesiol Scand 2005; 49: 778–83.

18)Sandbu R, Birgisdottir B, Arvidsson D, Sjostrand U, Rubertsson S. Optimal positive end-expiratory pressure (PEEP) settings in differential lung ventilation during simultaneous unilateral pneumothorax and laparoscopy: an experimental study in pigs. Surg Endosc 2001; 15: 1478–83.

19)Reich DL, Konstadt SN, Raissi S, Hubbard M, Thys DM. Trendelenburg position and passive leg raising do not significantly improve cardiopulmonary performance in the anesthetized patient with coronary artery disease. Crit Care Med 1989;17: 313-7.

20)Wilcox S, Vandam LD. Alas, poor Trendelenburg and his position! A critique of its uses and effectiveness. Anesth Analg 1988;67:574-8.

21)Joseph JV, Vicente I, Madeb R, Erturk E, Patel HR. Robot-assisted vs pure laparoscopic radical prostatectomy: are there any differences? BJU Int 2005;96:39-42.

22)Danic MJ, Chow C, Alexander G, et al. Anesthesia considerations for robotic-assisted laparoscopic prostatectomy: a review of 1,500 cases. J Robotic Surg. 2007;1 (2):119-123.

23)Winter R, Munro M. Lingual and buccal nerve neuropathy in a patient in the prone position: a case report. Anesthesiology 1989;71:452-4.

24)White P, Recart Freire A (2005) Ambulatory (outpatient) anesthesia. In: Miller RD (ed) Miller's anesthesia, 6th edn. Churchill Livingstone, Philadephia, pp 2288-2290.

25)Dunn MD, McDougall EM. Renal physiolgy. Laparoscopic considerations. Urol Clin North Am 2000;27:609-14.

26)Razvi HA, Fields D, Vargas JC et al (1996) Oliguria during laparoscopic surgery—evidence for direct renal parenchymal compression as an etiologic factor. J Endourol 10:1–4.

27)Nguyen NT, Perez RV, Fleming N et al (2002) Effect of prolonged pneumoperitoneum on intraoperative urine output during laparoscopic gastric bypass. J Am Coll Surg 195:476–483.

28)McDougall EM, Monk TG, Wolf JS et al (1996) The effect of prolonged pneumoperitoneum on renal function in an animal model. J Am Coll Surg 182:317–328.

29)Phong SV, Koh LK (2007) Anesthesia for robotic –assisted radical prostatectomy: considerations for laparoscopy in the Trendelenburg position. Ananest Intensive Care 35(2):281-285.

30)Appledorn SV, Costello AJ (2007) Complications of robotic sugery and how to prevent them. In: Patel VR (ed) Robotic Surgery: an introduction and vision for future. Springger, London, pp 169-178.

31)Trabulsi EJ, Patel J, Viscusi ER, Gomella LG, Lallas CD. Preemptive multimodal pain regimen reduces opioid analgesia for patients undergoing robotic-assisted laparoscopic radical prostatectomy. Urology 2010 76: 1122-1124.