

# Comparison of analgesic requirements in robot-assisted versus conventional laparoscopic abdominal surgeries

Athira Suresh Mangalath, Lakshmi Kumar, Ambreen Basheer Sawant, Rajesh Kesavan, Greeshma Ravindran<sup>1</sup>, Rajan Sunil

Departments of Anaesthesiology and Critical Care and <sup>1</sup>Biostatistics, Amrita Institute of Medical Sciences, Amrita Vishwa Vidyapeetham, Kochi, Kerala, India

## Abstract

**Background and Aims:** Robot-assisted surgery is advantageous in the precision of tissue handling and shorter postoperative recovery. We compared postoperative analgesic requirements in laparoscopic versus robot-assisted surgery in the first 24 h as our primary objective. The secondary outcomes were extubation on table, time to ambulation, and length of ICU stay.

**Material and Methods:** After approval from the ethics committee 48 patients undergoing either laparoscopic (group L [ $n = 24$ ]) or robotic abdominal surgery (group R [ $n = 24$ ]) were evaluated for analgesic requirements postoperative targeting a numerical rating scale  $\leq 3$  in a prospective comparative study. Postoperative patients were allotted to a three-tier pain management, level 1 comprising paracetamol 1 g intravenously every 8 h, level 2, 1.5 mg/kg tramadol every 8 h, and level 3 fentanyl 0.5  $\mu\text{g}/\text{kg}$ . The total analgesic consumption in the first 24 h was calculated for each group. Statistical analysis was performed using the Chi-square test and Mann-Whitney U test.

**Results:** Age, weight, and types of surgery were comparable between the groups. The intraoperative opioid use was comparable between both groups but the duration of surgery was longer in group R. Postoperative analgesic requirements were significantly less in group R ( $P = 0.024$ ) and the length of ICU stay was shorter ( $P < 0.05$ ). The time to ambulation was significantly shorter in group R patients ( $P < 0.001$ ).

**Conclusion:** Analgesic requirements were significantly less in robot-assisted laparoscopic surgery in the first 24 h. The time to ambulation and length of ICU stay were shorter in the robot-assisted group in comparison to the laparoscopic group.

**Keywords:** Abdominal surgery, analgesia, laparoscopy, robot-assisted

## Introduction

Open abdominal surgery is gradually being replaced by minimally invasive surgery with advancements in video imaging, endoscope technology, and instrumentation. The popularity is due to quicker postoperative recovery and lower costs due to reduced hospital stay thereby increasing patient satisfaction.<sup>[1]</sup>

The postsurgical pain and the morbidity patients undergo is more frequently due to the traumatic injury while gaining access to the intended site of surgery rather than the surgery itself.<sup>[2]</sup>

Robots improve field visibility with greater depth perception, fine movement control, and enable more ergonomic anatomic movements of instruments closely mimicking human wrist

**Address for correspondence:** Dr. Lakshmi Kumar, Department of Anaesthesiology and Critical Care, Amrita Institute of Medical Sciences, Amrita Vidya Vishwapeetham, Kochi 682 021, Kerala, India.  
E-mail: lakshmi.k.238@gmail.com

### Access this article online

Quick Response Code:



**Website:**  
www.joacp.org

**DOI:**  
10.4103/joacp.JOACP\_354\_18

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

**For reprints contact:** WKHLRPMedknow\_reprints@wolterskluwer.com

**How to cite this article:** Mangalath AS, Kumar L, Sawant AB, Kesavan R, Ravindran G, Sunil R. Comparison of analgesic requirements in robot-assisted versus conventional laparoscopic abdominal surgeries. *J Anaesthesiol Clin Pharmacol* 2021;37:79-84.

**Submitted:** 26-Nov-2018 **Revised:** 28-Oct-2019

**Accepted:** 29-Oct-2019 **Published:** 10-Apr-2021

movements.<sup>[3]</sup> While the technical ease of resection and the surgeon's instrumentation freedom are discussed in detail in many studies, the anesthetic implications, analgesic needs, and patient outcomes are less studied.<sup>[4-9]</sup> There is a limitation in literature on the superiority of robot-assisted laparoscopy over conventional laparoscopy in postoperative pain in abdominal surgery.

The primary objective of our study was the comparison of postoperative analgesic requirements between robotic and conventional laparoscopic abdominal surgeries in the first 24 h after surgery.

The secondary outcomes were extubation on table, mean duration of ICU stay, time to ambulation, and postoperative outcomes.

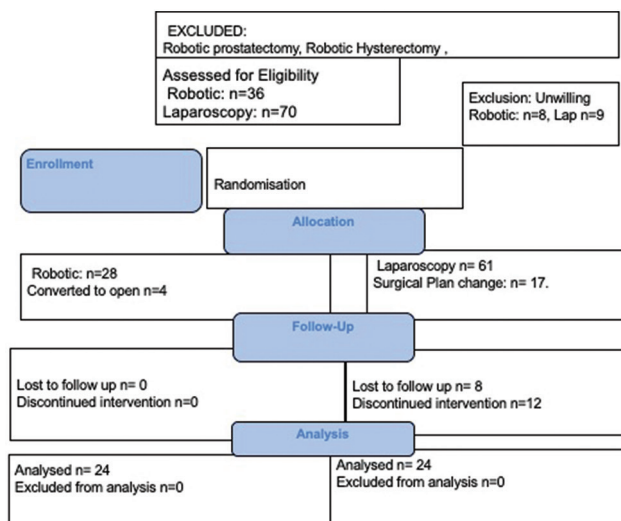
## Material and Methods

This was a prospective observational study following Ethics Committee approval conducted amongst 48 patients of the American Society of Anesthesiologist (ASA) with physical status 1–3, aged 18–75 years, undergoing elective robotic or conventional laparoscopic abdominal surgeries between September 2016 and September 2017. The allocation of patients into either type of minimally invasive surgery was at the discretion of the surgeon. All the surgeries of each specialty were performed by a single consultant and an equal number of cases were represented in either group [Table 2].

We did not find previous similar studies comparing immediate postoperative pain in robotic versus laparoscopic major abdominal surgery.

We conducted a pilot study on patients undergoing laparoscopic or robotic abdominal surgeries with the institutional protocol for pain management in minimally invasive surgery. This was identical to pain management in the study group. Nine patients in the laparoscopic group versus only five patients in the robotic group needed level 2 pain management within 24 h after surgery. With 90% power and 95% confidence interval, the sample size was calculated as 23 patients in each group. We included 24 patients in each group during the period of our study [Figure 1: Consort diagram].

Following the approval from the institutional ethics committee, patients of ASA physical status I–III undergoing elective laparoscopic or robotic abdominal surgery were included in the study. Informed consent for the proposed management of pain, which was the standard of care at the institution, was obtained. Patients with body mass index (BMI)  $\geq 40$ , with severe coronary artery disease (ejection fraction  $< 35\%$ ),



**Figure 1:** Consort diagram

renal dysfunction (class 3 chronic kidney disease [CKD] and higher), chronic obstructive airway disease (Gold class 3 or higher), and severe valvular heart disease were excluded from the study. Patients who presented with a history of paracetamol allergy were also excluded from the study.

All patients were induced as per a standardized anesthesia protocol with midazolam (0.03–0.04 mg/kg), propofol (titrated to a maximum of 2 mg/kg), fentanyl (2  $\mu\text{g}/\text{kg}$ ), and intubation following rocuronium (0.9 mg/kg) or atracurium (0.5 mg/kg). Maintenance of anesthesia was accomplished by volatile anesthetics (isoflurane or sevoflurane, minimum alveolar concentration 0.7–1.0),  $\text{O}_2$  with air ( $\text{FiO}_2 = 0.5$ ), in a closed circuit. An infusion of fentanyl at 0.5  $\mu\text{g}/\text{kg}$  body weight/hour was administered at the start and discontinued at skin/port closure for all patients.

The mean arterial pressure prior to the start surgery was recorded as the baseline and interventions were performed when the pressures rose above 20% of the baseline value. Fentanyl as a bolus of 0.5 mcg/kg was administered as an initial response, and beyond 2 boluses per hour in addition to the baseline infusion, propofol or inhalational agents were increased. The total intraoperative fentanyl, propofol, and inhalational agents used were calculated and noted as dose/min of surgery. Intermittent doses of atracurium were given for relaxation during surgery. At the end of the procedure, patients in both groups received port site and wound infiltration with 0.25% bupivacaine. Patients were extubated when they fulfilled the standard extubation criteria.

Postoperative pain scores were charted at extubation, 6 h, 12 h, 18 h, and 24 h or until being transferred out from ICU using the numerical rating scale (NRS). The

postoperative analgesic schedule was prepared according to the following format to allow comparisons between the two groups.

The first dose of paracetamol was administered when the patient complained of pain in the ICU and subsequent doses timed at 8 h intervals after pain assessment.

Level 1: 1 g Inj. paracetamol IV q. 8.h for all patients weighing >50 kg ( $\leq 50$  kg, dose adjusted to 15 mg/kg).

Level 2: Inj. tramadol 1.5 mg/kg s.o.s./q. 8.h, maximum 100 mg per dose.

Level 3: Inj. fentanyl (0.5  $\mu$ g/kg) for breakthrough pain.

All patients were scheduled to receive paracetamol as the first-line treatment for pain. The subsequent paracetamol dose was administered only 8 h after the first dose. All patients were shifted to the postoperative ICU with a 1:1 nurse bed ratio. Recording of pain was done at 6 h intervals. If the patient complained of pain (NRS > 3) before the next dose of paracetamol, they were escalated to the next level of pain management. Level 2 treatment included tramadol at a dose of 1.5 mg/kg to a maximum dose of 100 mg and the subsequent dose only administered after 8 h if needed. Inj. ondansetron 4 mg was administered along with tramadol to prevent any nausea or vomiting. If the patient developed pain prior to 8 h, they were given fentanyl as level 3 treatment at 0.5  $\mu$ g/kg).

Total doses of paracetamol, tramadol, and fentanyl used during the ICU stay were noted. Pain on ambulation and intervention for the same was noted. The patients were followed for their duration of stay in the ICU and observed for postoperative complications in the first 24 h after surgery.

Statistical analysis was performed using IBM SPSS 20. (SPSS Inc., Chicago, USA). An independent two-sample *t*-test was applied for parametric data and Mann-Whitney U test for nonparametric data of numerical variables. Chi-square test, Fisher's exact test were applied for categorical variables. A *P* value <0.05 was considered as statistically significant.

## Results

The demographic variables between both groups (group R—robotic and group L—laparoscopic) namely age and body mass index between both groups were comparable. A preponderance of males was seen in the robotic

**Table 1: Demographic variables and duration of surgery**

Variables	Group R (robotic)	Group L (laparoscopy)	<i>P</i>
Age (years)	52.4 $\pm$ 14	60.1 $\pm$ 21	0.1
Gender			0.0
Male	15 (62.5)	8 (33.3)	
Female	9 (37.5)	16 (66.7)	
BMI (kg/m <sup>2</sup> )	25.3 $\pm$ 4.8	25.5 $\pm$ 4.0	0.5
Mean duration hours	6.7 $\pm$ 2.0	4.9 $\pm$ 1.5	0.0*

group (*P* = 0.04). The mean duration of surgery was significantly longer in the robotic group than the laparoscopic group (*P* = 0.002) [Table 1].

The distribution of surgeries between both groups was comparable. The port sites were similar and incision and numbers of patients with a stoma were comparable [Table 2].

The intraoperative use of analgesics measured as  $\mu$ g/min in groups R and L was similar and the use of volatile anesthetic was comparable. Propofol consumption was higher in group L (*P* < 0.05) [Table 3].

In group R, 58.2% of patients needed only paracetamol for their pain management in the first 24 h and did not need interventions at levels 2 or 3, while only 20.8% in group L settled with paracetamol.

Seven patients in group R needed level 2 management and only three needed fentanyl for pain relief in comparison to 11 and 8 patients in Group L [Table 3].

Patients were monitored for pain and NRS  $\leq 3$  were satisfactory [Table 4]. Interventions were performed as per protocol when the scores were 4 and above and the number and levels interventions were used as surrogate evidence of pain.

The time to ambulation was shorter in group R and the length of ICU stay was less in group R in comparison to group L [Table 4].

All patients in this study were extubated on the table and none of them had postoperative complications in the first 24 h after surgery.

## Discussion

Laparoscopic colorectal surgery is associated with shorter lengths of hospital stay and superior quality of life at 3 years after surgery in comparison with open surgery at experienced centers.<sup>[10]</sup> Robotic surgery offers additional advantages of

**Table 2: Types of surgery and port distribution**

Laparoscopy cases	No of ports	Incision	Stoma	Robotic cases	No of ports	Incision	Stoma
Donor nephrectomy	4	++		Right hemicolectomy	5	+	
Right lap partial nephrectomy	5	+		Anterior resection and hysterectomy	5	+	Y
Lap left nephrectomy	4	+		Partial nephrectomy	5	+	
Lap splenectomy	4	+		Right partial nephrectomy	6	+	
Lap APR	5	++*	Y	Distal pancreatectomy with splenectomy	5	++	
Lap anterior resection	5	+	y	Robotic LAR	5	+	y
Lap APR and end colostomy	5	++*	Y	Anterior resection	5	+	y
Lap donor nephrectomy	4	++		Left radical nephrectomy	4	++	
Lap anterior resection	5	+	Y	total colectomy	5	++	
Lap radical nephrectomy	4	++		Right partial nephrectomy	6	+	
Lap splenectomy	4	+		Choledochal cyst	5	+	
Lap hemicolectomy	5	+		L partial nephrectomy	5	+	
Lap right hemicolectomy	4	+		Choledochal cyst excision	4	+	
Lap adrenalectomy	3	+		L radical nephrectomy	5	++	
Lap distal gastrectomy	5	+		L partial nephrectomy	5	+	
Right lap radical nephrectomy	4	+		Anterior resection	5	+	y
Diagnostic lap and sigmoid colectomy	5	+		R hemicolectomy	5	+	
Lap sigmoid colectomy	5	+		Robotic AR	5	+	y
Lap anterior resection	5	+		Robotic sigmoid colectomy	5	+	
Lap right extended hemicolectomy	5	+		Robotic APR and hysterectomy	5	++*	
Lap splenectomy	4	+		Robotic AR	5	+	y
Lap APR	5	++*	y	Robotic AR	5	+	
Lap anterior resection	5	+		Robotic AR	5	+	
Lap gastrectomy	5	+		Robotic AR	5	+	y

+ small incision ++ larger incision

\*perineal incision

APR: Abdominoperineal resection, LAR: Low anterior resection, AR: Anterior resection

**Table 3: Intraoperative anesthetic usage**

	Group R (n=24)	Group L (n=24)	P
Fentanyl ( $\mu\text{g}/\text{min}$ )	1.0 $\pm$ 0.4	0.1 $\pm$ 0.3	0.7
Propofol (mg/min)	0.4 $\pm$ 0.2	0.4 $\pm$ 0.2	0.0
Inhalational agent (ml/min)	0.1 $\pm$ 0.1	0.1 $\pm$ 0.1	0.5
Analgesia level 1 n (%)	14 (58.3%)	5 (20.8%)	0.0
Level 1 and 2 n (%)	7 (29.2%)	11 (45.8%)	
Levels 1, 2, and 3 n (%)	3 (12.5%)	8 (33.4%)	

**Table 4: Postoperative parameters**

	Postoperative pain and recovery profile		
	Group R (n=24)	Group L (n=24)	P
NRS 0 h	1.2 $\pm$ 1.7	1.7 $\pm$ 1.5	0.1
NRS 6 h	2.4 $\pm$ 1.0	2.6 $\pm$ 0.7	0.5
NRS 12 h	1.1 $\pm$ 1.2	2.2 $\pm$ 0.1	0.5
NRS 18 h	1.3 $\pm$ 1.0	1.4 $\pm$ 0.5	0.6
NRS 24 h	0.4 $\pm$ 0.5	0.8 $\pm$ 0.5	0.0*
Time to ambulation (h)	19.5 $\pm$ 2.8	23 $\pm$ 3.5	0.0*
NRS at ambulation	1.6 $\pm$ 0.8	1.7 $\pm$ 0.5	0.9
LOICU stay (days)	1.3 $\pm$ 0.7	1.8 $\pm$ 0.9	0.0

NRS: Numerical rating scale for pain, LOICU: Length of ICU stay

three-dimensional vision, superior freedom in movement, reduced impact of physiological tremor, better ergonomics, and reduced fulcrum effect.<sup>[11]</sup>

We postulated that the precision in movements in robotics could be associated with lesser pain even in comparison to laparoscopy after surgery. Betcher *et al.*<sup>[12]</sup> had shown a reduction in pain while evaluating patients undergoing robotic versus conventional laparoscopic gynecological surgery. The decrease in pain was evident despite increased numbers of ports and longer operating time for robotic surgery.

There is limited published literature from India on the analgesic requirement in robotic surgery. As robotic surgery is an evolving specialty, we included comparable cases between laparoscopy and robotic groups. Laparoscopic radical prostatectomy or hysterectomy is no longer being performed at our institution thus we did not include these in our study. The distribution of cases between both groups was comparable and portholes were similar.

The pain in minimally invasive surgery is multifactorial including port site pain, pain due to distention of the peritoneum following insufflation, visceral pain and shoulder tip pain following residual gas in the peritoneum.<sup>[13]</sup> Carbon dioxide insufflation could shear the blood vessels, exert traction on the nerve endings, and cause the release of inflammatory mediators.

Paracetamol is effective in minimally invasive surgery but only as a part of multimodal analgesia. We did not include nonsteroidal anti-inflammatory drugs (NSAIDs) in our management as our patients were in the age groups 50–75 years with multiple comorbid illnesses on account of concerns relating to renal dysfunction and gastrointestinal bleed.

Tramadol was introduced as a second-line drug (Level 2) in our patients. Parenteral tramadol is useful in the reduction of postoperative pain following abdominal, orthopedic, and cardiac surgery and produced equivalent analgesia in comparison to epidural ropivacaine in labor analgesia.<sup>[14]</sup>

All patients in our study received a standard intraoperative analgesia protocol and local wound infiltration after surgery. Patients undergoing robotic surgery needed fewer interventions with tramadol and fentanyl compared to group L. In group R, only seven patients needed tramadol and only four patients needed fentanyl as an incremental intervention for their pain. This requirement was significantly lesser than that for the laparoscopic group. This is similar to the results of Martino *et al.*<sup>[15]</sup> who noted a reduction in the numbers of drug interventions for pain with a 50% reduction toward the costs of pain medications in gynecological patients undergoing surgery for endometrial malignancies. Chui *et al.* showed similar results in patients undergoing hysterectomy for large tumors.<sup>[16]</sup> They documented improved pain scores and lesser analgesic requirements in group R. The duration of surgery in group R was significantly more 6½ h against 5 h for laparoscopic surgery. Infusions of perioperative fentanyl could have a prolonged postoperative effect due to the context-sensitive half-life of fentanyl, and this could have contributed to improved analgesia in group R. However, we had noted decreased requirements until 24 h when the effects of fentanyl may not have been present.

Kang *et al.* used a three-arm comparison of robotic versus open and robotic versus laparoscopic surgery for rectal cancer. The time to resumption of soft diet, postoperative stay, and visual analog scores from days 1 to 5 was superior in group R.<sup>[17]</sup> This study, however, looked at an extended pain beyond the first day while our profile of patients appeared to have little or no pain beyond 24 h.

Jin *et al.*<sup>[18]</sup> in a propensity-matched analysis score of pain in robotic versus laparoscopic partial nephrectomy inferred that the pain between both is not different. The contradictory result could be explained by the fact that partial nephrectomy, although technically challenging, is

truly minimally invasive and may not usually result in much pain after surgery.

A pooled analysis of patients undergoing surgery for colonic cancer included 14 meta-analysis, 4924 robotic surgeries, and 121,055 laparoscopic surgeries that was conducted showed that robotic surgeries had an advantage in a shorter hospital stay and faster time to recovery of bowel function.<sup>[19]</sup> In our study, we noted that group R had a shorter ICU stay in comparison with group L for the same surgical profile. Although the duration of surgery was longer, the patients were ambulated earlier on account of better pain scores similar to other studies.<sup>[19,20]</sup> The lesser use of both tramadol and fentanyl as levels 2 and 3 analgesics may have resulted in lesser sedation and more alert patients.

Our study had some limitations. The allocation of patients to either laparoscopy or robotic was at the discretion of the operating surgeon. As robotic surgery was an evolving specialty it is possible that technically less challenging surgeries were allocated to the robotic group.

We standardized the analgesic infusion to 0.5 µg/kg in both groups. The longer duration of robotic surgery may have contributed to residual analgesic effects of fentanyl in the postoperative period.

The interventions to hemodynamic changes were standardized, however, the interpretation of the response was left to the discretion of the anesthesiologist. The analgesic usage between both groups was similar for the duration of surgery.

Postoperative pain was assessed only for the first 24 h following the surgery as we believed that maximum pain intensity occurs within this time. Subsequently, the patients were either shifted and those in the ICU were managed as per standard protocols. The impact of pain beyond 24 h was not assessed in our study.

We also noted the lengths of ICU stay following surgery but did not include subsequent admissions during the same hospitalization.

Robot-assisted laparoscopic surgery is associated with lesser analgesic requirements than conventional laparoscopic surgery in the first 24 h. Patients operated robotically had an earlier time to ambulation and shorter length of ICU stay in comparison to conventional laparoscopic patients.

### **Financial support and sponsorship**

Nil.



## Conflicts of interest

There are no conflicts of interest.

## References

- Satava RM. Surgical robotics: The early chronicles: A personal historical perspective. *Surg Laparosc Endosc Percutan Tech* 2002;12:6-16.
- Mack MJ. Minimally invasive and robotic surgery. *JAMA* 2001;285:568-72.
- Sullivan MJ, Frost EA, Lew MW. Anesthetic care of the patient for robotic surgery. *Middle East J Anesthesiol* 2008;19:967.
- Lanfranco AR, Castellanos AE, Desai JP, Meyers WC. Robotic surgery: A current perspective. *Ann Surg* 2004;239:14.
- Weiser MR. Masters Program Colon Pathway: Robotic Right Hemicolectomy. In: Patel A., Oleynikov D.(eds) *SAGES Manual of Robotic Surgery*. Springer; 2018. p. 141-150.
- Einarsson JI, Wattiez A. Minimally invasive gynecologic surgery: Evidence-based laparoscopic, hysteroscopic and robotic surgeries. *Contemporary OB/GYN* 2017;62:30-1.
- Pavan N, Derweesh I, Rassweiler J, Challacombe B, Zargar H, Porter J, *et al.* Contemporary minimally invasive surgery for adrenal masses: It's not all about (pure) laparoscopy. *BJU Int* 2017;119:201-3.
- Choi K, Hill S, Hale N, Phillips S, Deem S. Intraoperative mannitol during robotic-assisted-laparoscopic partial nephrectomy. *J Robot Surg* 2018. doi: 10.1007/s11701-018-0868-4. [Epub ahead of print].
- Minig L, Achilarré MT, Garbi A, Zanagnolo V. Minimally invasive surgery to treat gynecological cancer: Conventional laparoscopy and/or robot-assisted surgery. *Int J Gynecol Cancer* 2017;27:562-74.
- Jeong SY, Park JW, Nam BH, Kim S, Kang SB, Lim SB, *et al.* Open versus laparoscopic surgery for mid-rectal or low-rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): Survival outcomes of an open-label, non-inferiority, randomised controlled trial. *Lancet Oncol* 2014;15:767-74.
- Rodriguez-Sanjuan JC, Gomez-Ruiz M, Trugeda-Carrera S, Manuel-Palazuelos C, Lopez-Useros A, Gomez-Fleitas M. Laparoscopic and Robot assisted laparoscopic digestive surgery: Present and future directions. *World J Gastroenterol* 2016;22:1975-2004.
- Betcher RE, Chaney JP, Lacy PR. Analysis of postoperative pain in robotic versus traditional laparoscopic hysterectomy. *J Robot Surg* 2014;8:35-41.
- Batley SE, Prasad V, Vasdev N, Gowrie Mohan S. Post-operative pain management in patients undergoing robotic urological surgery. *Curr Urol* 2016;9:5-11.
- Lamba A, Sardana P, Kaur R. Comparison of parenteral tramadol and epidural ropivacaine for labour analgesia: A prospective clinical study. *Int J Reprod Contracept Obstet Gynecol* 2016;5:1722-7.
- Martino MA, Shubella J, Thomas MB. A cost analysis of postoperative management in endometrial cancer patients treated by robotics versus laparoscopic approach. *Gynecologic Oncol* 2011;123:528-31.
- Chiu LH, Chen CH, Tu PC. Comparison of robotic surgery and laparoscopy to perform total hysterectomy with pelvic adhesions or large uterus. *J Minim Access Surg* 2015;11:87-93.
- Kang J, Yoon KJ, Min BS, Hur H, Baik SH, Kim NK, Lee KY. The impact of robotic surgery for mid and low rectal cancer: A case-matched analysis of a 3-arm comparison--open, laparoscopic, and robotic surgery. *Ann Surg* 2013;257:95-101.
- Jin SJ, Park JY, Kim DH, Yoon SH, Kim E, Song C, *et al.* Comparison of postoperative pain between laparoscopic and robot assisted partial nephrectomy for renal tumors. A propensity score matching analysis. *Medicine* 2017;96:e7581.
- Duan BS, Zhao GH, Yang H, Wang Y. A pooled analysis of robotic versus laparoscopic surgery for colon cancer. *Surg Laparosc Endosc Percutaneous Tech* 2016;26:523-30.
- Staderini F, Foppa C, Minuzzo A, Badii B, Qirici E, Trallori G, *et al.* Robotic rectal surgery: State of the art. *World J Gastrointest Oncol* 2016;8:757-71.