10.5005/jp-journals-10033-1241

LITERATURE REVIEW

Comparison between Robotic Radical Hysterectomy with Laparoscopic and Open Abdominal Radical Hysterectomy in the Treatment of Early Stage Cervical Cancer

Boy Busmar

ABSTRACT

Robot-assisted procedures are being increasingly incorporated in gynecologic oncology. Several studies have confirmed the feasibility and safety of robotic radical hysterectomy for selected patients with early-stage cervical cancer. It has been demonstrated that robotic radical hysterectomy offers an advantage over laparoscopic and open abdominal radical hysterectomy approaches with regard to operative time, blood loss and hospital stay.

Also, initial evidences concerning oncological outcomes seem to confirm the equivalence to traditional open technique. Despite the fact that costs of robotic system are still high, they could be compensated by several health-related and social benefits: less pain, faster dismissal, and return to full activity than other surgical approaches.

Keywords: Abdominal radical hysterectomy, Blood loss, Conversion rate, Early cervical cancer, Hospital stay, Laparoscopic radical hysterectomy, Number of lymph node, Operative time, Postoperative infection, Recurrence, Robot-assisted radical hysterectomy, Urinary tract complication.

How to cite this article: Busmar B. Comparison between Robotic Radical Hysterectomy with Laparoscopic and Open Abdominal Radical Hysterectomy in the Treatment of Early Stage Cervical Cancer. World J Lap Surg 2015;8(1):26-31.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

Cervical cancer is the third most common cancer in women, and the seventh overall, with an estimated 5,30,000 new cases in 2008. More than 85% of the global burden occurs in developing countries, where it accounts for 13% of the female cancers. High risk regions are Eastern and Western Africa (Age Standardized incidence Rate (ASR) greater than 30 per 100,000), South Central Asia (ASRs 24.6 per 100,000), South America and Middle Africa (ASRs 23.9 and 23.0 per 100,000 respectively). Rates are lowest in Western Asia, Northern America and Australia/New Zealend (ASRs less than 6 per 100,000).

Cervical cancer remains the most common cancer only in Eastern Africa, South Central Asia and Melanesia. Overall, the mortality incidence ratio is 52%, and cervical cancer is responsible for 2,75,000 deaths in 2008, about 88% of which occur in developing countries.[1]

The gold standard for over 100 years for early stage cervical cancer was open radical hysterectomy with pelvic lymph node dissection, resulting in 5-year survival rates of 75 to 90%. Intermediate risk factors for recurrence after radical hysterectomy include tumor size, lymphovascular space invasion (LVSI), and high risk factors include parametrial involvement, lymph node metastasis, and resection margin involvement.[2]

In 1984, Kurt Semm was the first to describe laparoscopic assistance at the time of vaginal hysterectomy. In 1989 Reich et al, performed the first laparoscopic hysterectomy. Soon after, enthusiastic pioneers claimed laparoscopic hysterectomy to be a better alternative to abdominal hysterectomy because of its lower postoperative morbidity, cosmetic result and reduced costs with no increase in complication rates. Now, it became the new technique to replace abdominal hysterectomy.[3,4]

In the past two decades, the gynecologic oncologic surgeons performed minimally invasive techniques in order to decrease morbidity while maintaining surgical and oncological outcomes.

The laparoscopic approach provides comparable long-term outcomes to open radical hysterectomy by adding benefits of minimally invasive surgery in terms of blood loss, analgesic requirement and hospital stay. Despite all these clear advantages, laparoscopic radical hysterectomy was not widely adopted in surgical practice, probably due to some drawbacks of this technique: long learning curve, two-dimensional (2D) view, poor ergonomics surgeon position, and limited instruments movements. These conditions negatively influenced the surgical performance, resulting in more tremor, fatigue, and subsequent less accuracy.

Robot-assisted technique through the da Vinci surgical system (Intuitive Surgical Inc, Sunnyvale, Calif, USA)

Consultant

Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, Persahabatan Hospital, Rawamangun East Jakarta, Indonesia

Corresponding Author: Boy Busmar, Consultant, Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, Persahabatan Hospital, Rawamangun, East Jakarta-13220, Indonesia, e-mail: boybusmar@gmail.com

emerged in the context of minimally invasive surgery to overcome shortcomings of conventional laparoscopy. Robotic system provides three-dimensional (3D) view, more ergonomic surgeon position and articulated wrist-like instruments, increasing surgical precision, and dexterity. Robotic also decrease the fatique that the doctors experience during surgeries that can last several hours. Exhausted surgeon can experience hand tremors as a result. The da Vinci has been programmed to compensate for tremors, so if the surgeons hands shakes, the computer ignores it and keep the mechanical arm steady.

The robotic application grew rapidly in gynecological oncology field, especially for technically challenging procedures by laparoscopy, such as radical hysterectomy.

The use of a robotic system in preset laboratory drills has been associated with faster performance times, increased accuracy, enhanced dexterity, faster suturing, and reduced number of errors when compared to conventional laparoscopic procedure.

Complex operations, such as radical hysterectomy, can be addressed in a more efficient fashion and the skills to perform this procedure are acquired not only in a shorter time but by a larger number of laparotomy surgeons who encountered difficulties with conventional laparoscopy.[4,5]

OBJECTIVE

In the present paper, we sought to review the available descriptive evidences and to compare intraoperative, pathologic finding, and postoperative, oncological outcomes of robot-assisted, laparoscopic and open abdominal radical hysterectomy, in the treatment of early cervical cancer.

MATERIALS AND METHODS

We searched the articles about robotic-assisted radical hysterectomy, laparoscopic radical hysterectomy and abdominal radical hysterectomy of early cervical cancer by google search engine and PubMed. We tried to elaborate the most recent publications.

REVIEW ARTICLES

Mean Operating Time

Longer operative time and learning curve are among the reasons why the minimally invasive staging has not yet been adopted worldwide in gynecological oncology practice. For robotic system, total operative time consists of docking time and console time. The first is the time needed to assemble instruments and attach patient to the robot, advancing the column to the operating table, fastening the robotic arms to the inserted trocars, and introducing the laparoscope. Console time is defined as the surgical time needed to perform the entire operation at the console.[5]

Salicrú and Gil-Moreno et al found the operative time for laparoscopic radical hysterectomy longer than open abdominal radical hysterectomy.[6]

Sert and Abeler describe 35 patients with early cervical cancer who underwent robot assisted radical hysterectomy,[7] laparoscopic radical hysterectomy and 26 abdominal radical hysterectomy, showing mean operating times 263 minutes for robot-assisted radical hysterectomy, 364 minutes for laparoscopic radical hysterectomy and 163 minutes for open abdominal radical hysterectomy.[7]

Kruijdenberg and van den Eiden et al among 342 cases of robotic assisted radical hystetrectomy and 914 cases of total laparoscopic radical hysterectomy, found that there was no statistical difference of mean operative time between the robotic and laparoscopic radical hysterectomy.[8]

A similar operative time was reported by Tinelli et al 323 minutes for robotic assisted radical hysterectomy and 255 minutes for laparoscopic radical hysterectomy ($p < 0.005$).[9]

Retrospective study by Lee and Kang et al also found no statistically significant difference existed between the laparoscopic radical hysterectomy and radical abdominal hysterectomy with respect to operative time.[10]

From a multi-institutional experience Lowe and Chamberlain et al found median operative time for robotic-assisted radical hysterectomy 215 minutes.[11]

From prospective studies of 7 patient who underwent robot-assisted radical hysterectomy and 7 patients who underwent traditional radical hysterectomy, Lowe and Hoekstra et al found the diference of operative time statitically not significant, 260 minutes in robot-assisted radical hysterectomy and 264 minutes in traditional radical hysterectomy.[12]

Estape et al compared 32 patiens who underwent robotic radical hysterectomy with 17 patients laparoscopic radical hysterectomy and 14 patients abdominal radical hysterectomy. Operative time for the robotic group was 2.4 h ± 0.8 and not significantly different from the laparoscopic group at 2.2 ± 0.7 hours nor the laparotomy group (1.9 ± 0.6 hours $p = 0.05$).[13]

Nezhat et al in their prospective analyzed cases of robotic radical hysterectomy and laparoscopic radical hysterectomy found no statistical difference were observed regarding operative time, (323 *vs* 318 minutes.[14]

Table 1 summarizes the means operating time of robotic, laparoscopic and open radical hysterectomy.

Blood Loss and Blood Transfusion

There is general agreement about the significant decrease of intraoperative bleeding in minimally invasive surgery. This benefit is confirmed also for robotic-assisted

Table 1: Operating time (in minute) robotic radical hysterectomy (RRH), laparoscopic radical hysterectomy (LRH) and open radical hysterectomy (ORH)

No. Authors	RRH	LRH	ORH	p
1. Salicrú et al[6]		> ORH		
2. Sert, Abeler[7]	263	364	163	
3. Kruijdenberg et al[8]	NS	NS		
4. Tinelli et al[9]	323	255		< 0.005
5. Lee et al[10]		NS	NS	
6. Lowe et al[11]	215			
7. Lowe et al[12]	260		264	NS
8. Estape et al[13]	2.4 ± 0.8	2.2 ± 0.7	1.9 ± 0.6	NS, 0.05
9. Nezhat et al[14]	323	318		NS

technique. The literature reported similar values of blood loss comparing robotic with laparoscopic radical hysterectomy, with important differences with respect to open surgery.

Among their 68 cases of robotic, laparoscopic and laparotomy radical hysterectomy, Sert and Abeler reported mean blood loss was 82 ± 74 ml, 164 ± 131 ml, and 595 ± 28 ml, respectively ($p < 0.0001$, $p = 0.023$).[7]

In comparison between robotic *vs* total laparoscopic radical hysterectomy, Kruijdenberg et al reported that among their 342 cases of robotic radical hysterectomy and 914 total laparoscopic radical hysterectomy, only 5.4% cases should get transfusion in robotic group and 9.7% cases in laparoscopic group, $p < 0.05$.[8]

Tinelli et al in their multicenter study found that mean blood loss was more in robot assisted radical hysterectomy in comparison to laparoscopic radical hysterectomy, 157 ml (CI 95%, 50–400) *vs* 95 ml (CI 95%, 30–500).[9]

Lee, Kang and Kim, found less blood loss in radical laparoscopy in comparison to radical abdominal hysterectomy, 414.3 ml in laparoscopic radical hysterectomy *vs* 836.0 in abdominal radical hysterectomy, $p < 0.001$. Blood tansfusion only 20% in laparoscopic radical hysterectomy in comparrison to 47.9% in abdominal radical hysterectomy, $p < 003$.[10]

Lowe and Chamberlain et al reported a mean blood loss of 50 ml and no transfusion among 42 patients who underwent robotic radical hysterectomy.[11]

Lowe and Hoekstra et al in their prospective study found significant difference of blood loss between robotic radical hysterectomy and abdominal radical hysterectomy, 75 and 700 ml, respectively.[12]

The estimated blood loss for patients undergoing robotic hysterectomy was 130 cm ± 119.4. This was significantly less than the laparotomy group (621.4 ml ± 294.0, $p < 0.0001$), but not the laparoscopic group (209.4 ml ± 169.9, $p = 0.09$). This data came from 32, 17 and 14 patients who underwent robotic, laparoscopic and abdominal radical hysterectomy as reported by Estape et al.[13]

In their prospective analyzed cases who underwent robotic radical hysterectomy and laparoscopic radical hysterectomy, Nezhat et al reported that there is no statistical difference regarding estimated blood loss between the two group (157 *vs* 200 ml).[14]

Nam and Kim, in 32 cases of robotis and 32 cases of abdomonal radical hysterectomy, found mean blood loss 220 ml in robotic radical hysterectomy and 531 ml in abdominal radical hysterectomy, $p < 0.001$.[15]

Table 2 summarizes the means intraoperative blood loss of robotic, laparoscopic and open radical hysterectomy.

Intraoperative Complications

An intraoperative complications rate was found lower in robot assisted and laparoscopic paroscopic technique, than open approach, due to a more accurate tissue manipulation and a better anatomic visualization. Robotic surgery may further reduce intraoperative morbidity and improve surgical precision as a consequence of several technical advantages over conventional laparoscopy. Urinary injuries, which may happen during ureterolysis and bladder isolation steps, are frequent reported complications for radical hysterectomy.

The multi-institutional experience by Lowe and Chamberlain et al reported one bladder injury adjacent to the trigone and one ureteral injury (2.4%) and one conversion to laparotomy.[11]

On the contrary, Nezhat et al did not note significant differences between robotic and laparoscopic approach with respect to intraoperative complications: in both groups two incidental cystotomies were described.[14]

Sert and Eraker described, among 25 robotic radical hysterectomies, three cases of bladder perforation, which were successfully repaired robotically.[16]

Table 2: Intraoperative blood loss (in ml) of robot radical hysterectomy (RRH), laparoscopic radical hysterectomy (LRH) and open radical hysterectomy (ORH)

No. Authors	RRH	LRH	ORH	p
1. Sert, Abeler[7]	82 ± 74	64 ± 131	595 ± 28	< 0.0001, 0.023
2. Kruijdenberg et al[8]	NS	NS		
3. Tinelli et al[9]	157	95		
4. Lee et al[10]		414.3	836.0	< 0.001
5. Lowe et al[11]	50			
6. Lowe et al[12]	75		700	
7. Estape[13]	130 ± 119.4	209.4 ± 169.9	621 ± 294.4	< 0.0001, 0.09
8. Nezhat et al[14]	NS	NS		
9. Nam, Kim[15]	220		531	< 0.001

Postoperative Complications

Wound infection following laparoscopy is less but not rare. Many types of post laparoscopic surgery has been reported including bladder infection, pelvic cellulitis and pelvic abces.[4]

There are evidences of an increased relative risk of vaginal cuff complications for minimally invasive hysterectomy techniques when compared to vaginal or abdominal ones. It may be associated with an extensive use of monopolar and bipolar electrosurgery, which may increase thermal injury and devascularization of the cuff site. Other organs are also at risk of thermal injury. Thermal injury to bowel may be more difficult to diagnose intraoperatively.[4]

Kruijdenberg et al from 342 cases of robotic assisted radical hysterectomy and 914 laparoscopic radical hysterectomy reported 9.6 and 5.5% postoperative complication respectively ($p < 0.05$).[8]

Lowe and Chamberlain et al reported an experience from multi-institutional, 12% postoperative complications, including: one (2.4%) deep venous thrombosis (DVT), 7.2% infection, and 2.4% bladder/urinary tract complication.[11]

Estape et al reported that the incidence of postoperative complications was less in the robotic cohort (18.8%) as compared to the laparoscopic (23.5%), and laparotomy cohorts (28.6%), a.[13]

Ucella et al reported vaginal dehiscence in 2 of 665 (0.3%) patients after laparoscopic hysterectomies with transvaginal colporrhaphy. Their literature search identified postoperative vaginal separation 91 of 13.030 (0.66%) endoscopic hysterectomies. The incidence of vaginal dehiscence was lower for transvaginal cuff closure (0.18%) than for both laparoscopic [0.64%; odds ratio (OR), 0.28; 95% confidence interval (CI), 0.12–0.65] and robotic (1.64%; OR, 0.11; 95% CI, 0.04–0.26) colporraphy. Laparoscopic cuff closure was associated with a lower risk of dehiscence than robotic closure (OR, 0.38; 95% CI, 0.28 to 0.6).[17]

Vaginal cuff separation is a rare but a serious complication following hysterectomy. Nick et al reported among 36 laparoscopic radical hysterectomy and 19 robotic-assisted radical hysterectomy, 7 (1.7%) developed a cuff complication. Three (1.1%) patients in the laparoscopy group suffered a vaginal cuff evisceration (n = 2) or separation (n = 1). Four patients in the robotic group (3.0%) had a vaginal evisceration (n = 1) or separation (n = 3). Vaginal cuff complication were 9.46 fold higher among patients who had a radical hysterectomy ($p < 0.01$). Median time to presentation of vaginal cuff complication was 128 days (58–175) in the laparoscopy group and 37 days (32–44) in the robotic group.[18]

Kho and Akl et al reported 21 of 519 (4.1%) patients were identified with vaginal cuiff dehiscence after robotic cuff closure. Nine among 21 patients the robotic procedure was performed for a gynecologic malignancy.[19]

Older literature review by Magrina JF et al showed that there was no difference of intraoperative and postoperative complication among patiens who underwent robotic, laparoscopic and abdominal radical hysterectomy.[20]

Hospital Stay and Costs

Kruijdenberg et al reported a shorter median hospital stay for the robotic radical hysterectomy than laparoscopic radical hysterectomy, 3.3 days and 6.2 days ($p < 0.04$), respectively.[8]

Tinelli et al also reported a shorter median hospital stay for the robotic radical hysterectomy than laparoscopic radical hysterectomy, 3 and 4 days. The difference is not statistically significant.[9]

Lowe and Chamberlain et al reported median hospital stay of 1 day, among 42 cases of roboti-assisted radical hysterecrtomy.[11]

Estape et al reported a 2.6 days hospital stay in robotic group and 2.3 and 4.0 days in laparoscopic and abdominal radical hysterectomy groups, respectively.[13]

Comparison between robotic, laparoscopic and abdominal radical hysterectomy, Magrina et al reported a short hospital stay in robotic group than in laparoscopic and abdominal radical hysterectomy group, 1.7, 2.4 and 3.6 days, respectively.[20]

Table 3 summarizes the means hospital stay among patients of robotic, laparoscopic and open radical hysterectomy.

Oncological Outcomes

The primary endpoint to be considered when comparing minimally invasive techniques and conventional laparotomy for gynecological oncology is the equivalence in terms of surgical staging completeness and survival. Oncological outcomes after radical hysterectomy for early cervical cancer are the number of lymph node retrieved and the recurrence rate. There are controversial results concerning the number of lymph nodes collected by different surgical approaches.

Table 3: Hospital stay (in day) among patient after robotic radical hysterectomy (RRH), laparoscopic radical hysterectomy (LRH) and open radical hysterectomy (ORH)

No.	Authors	RRH	LRH	ORH	p
1.	Kruijdenberg et al[8]	3.3	6.2		< 0.04
2.	Tinelli et al[9]	3	4		NS
3.	Lowe et al[11]	1			
4.	Estape et al[13]	2.6	2.3	4.0	
5.	Magrina et al[20]	1.7	2.4	3.6	

Recent review of a large series by Kruijdenberg et al showed that there is no difference in the number of lymph node resected, between robotic-assisted radical hysterectomy and total laparoscopic hysterectomy.[8]

Regarding recurrent rate comparison between robotic radical hysterectomy and laparoscopic radical hysterectomy, Tinelli et al found no significant difference.[9]

Lee et al in the retrospective study reported that there was no significant difference of the number of lymph nodes resected between laparoscopic and radical abdomional hysterectomy.[10]

Lowe and Hoekstra et al reported the similar number of lymph nodes resected in robotic radical hysterectomy and abdominal radical hysterectomy, 19 and 14 nodes, respectively.[12]

Estape et al reported the number of lymph nodes resected by robotic and laparoscopic radical hysterectomy was significantly different, 32.4 and 18.6, $p < 0.0001$. The number of lymph nodes resected by laparotomy radical hysterectomy was 25.7, $p = 0.05$.[13]

Nehzat et al reported the the number of lymph nodes resected by robotic radical hysterectomy and laparoscopic radical hysterectomy almost the same, 25 and 31 nodes, respectively. And no recurrences in laparoscopic and robotic radical hysterectomy groups at 12 months and in laparoscopic group at 29 month.[14]

In the prospective study by Magrina et al all patients of the three groups are alive and free from disease at mean follow-up of 31.1 months.[20]

A comparative study by Kho and Muto et al showed a mean number of lymph nodes resected did not differ between robotic radical hysterectomy and open radical hysterectomy (15.6 *vs* 17.1, $p = 0.532$).[21]

Boggess et al reported number of lymph nodes resected during robotic assisted radical hysterectomy and open radical hysterectomy. There is a significant differences between the number of lymph nodes resected, in favor of robotic radical hysterectomy ($p = 0.0003$).[22]

Finally, Cantrell et al assessed the progression-free and overall survival for 71 women who attempted RRH for cervical cancer. Their experience demonstrated that RRH appears to have equivalent oncological outcomes compared with laparotomic surgery in the first 3 years of follow-up. They showed a 94% of progression-free and overall survival in the robotic cohort at 36 months.[23]

Table 4 summarizes the means number of lymph nodes resected among patients of robotic, laparoscopic and open radical hystetrectomy.

Table 4: Number of lymph nodes resected after robotic radical hysterectomy (RRH),), laparoscopic radical hysterectomy (LRH) and open radical hysterectomy (ORH)

No.	Authors	RRH	LRH	ORH	p
1.	Kruijdenberg et al[8]	NS	NS	NS	
2.	Lee et al[10]		NS	NS	
3.	Lowe et al[12]	19	14		
4.	Estape et al[13]	32.4	18.6	25.7	< 0.0001, p 0.05
5.	Nezhat et al[14]	25	31		
6.	Kho et al[21]	15.6	17.1		0.532
7.	Boggess et al[22]	RRH > ORH			0.0003

DISCUSSION

Robot-assisted radical hysterectomy is associated with a long operative time. The shorter length of hospital stay is one of the most important advantages of minimally invasive surgery. All comparative studies concerning robotic radical hysterectomy reported a mean length of hospital stay of 1 to 2 days, similar to the laparoscopic group, but significantly shorter than the open group.

Accordingly, robotic surgery provides other advantages, such as lower perioperative complications and reintervention rates, less postoperative pain, and analgesic consumption. All these issues positively influence hospital stay, quality of life, and time to return to full activities, providing a benefit from a medical and socioeconomic point of view.

However, longer operative time and a possible high cost due to sophisticated instrument, robotic radical hysterectomy has advantages over conventional surgery, including short hospital stay, lower perioperative complication, enhanced precision and reduced trauma to the patient, less bleeding, less postoperative pain and analgesic consumption. All these issues influence quality of life and time to return to full activities, providing a benefit from a medical and socioeconomic point of view.

An increased risk of vaginal cuff complications for minimally invasive hysterectomy techniques when compared to vaginal or abdominal ones, may be associated with an extensive use of monopolar and bipolar electrosurgery, which may increase thermal damage and devascularization of the cuff site. This thermal injury is difficult to estimate its extent of damage by visual inspection as the zone of desiccation may exceed the area of visual damage. An understanding of the differing impacts of the various types of electrical current is essential for estimation of the extent of injury. With patience, prudence, and meticuluos technique, thermal injury could be prevented.

The outcome of the robotic radical hysterectomy surgery according to oncological points of view is acceptable, in term of surgical completeness, number of nodes resected, recurrence and survival rate.

The reviewed data suggests that robotic-assisted radical hysterectomy may offer an alternative to traditional radical hysterectomy. The growing literature about

robotic-assisted radical hysterectomy and prospective comparisons with traditional radical hysterectomy will show a benefit of this minimal access surgery.

Prospective randomized controlled trials will give more definite results, especially concerning surgical outcomes comparing robotic and laparoscopic techniques.

CONCLUSION

Robotic-assisted radical hysterectomy, facilitates the better surgical approach in comparison to laparoscopy in the treatment of early cervical cancer. It is superior due to its steady 3-dimensional visualization, instrumentation with articulating tips, and an adaptive downscaling of the surgeons movements without tremor, allowing very selective dissection and good clinical end point result.

ACKNOWLEDGMENT

I would like to express my sincere thanks to Prof RK Mishra for having given me an opportunity to attend the Fellowship and Diploma In Minimal Access Surgery program, including a one day introduction and hand on training with real da Vinci robot, in laparoscopic training course at World Laparoscopy Hospital, Gurgaon, NCR Delhi, 122 002, India.

REFERENCES

1. GLOBOCAN 2008. Cancer fact sheet. Incidence, mortality. Internet. Acessed on Feb 18, 2012.
2. Nam J-H, Park J-H, Kim D-Y, Kim Y-H, Kim Y-M, Kim Y-T. Laparoscopic versus open radical hysterectomy in early-stage cervical cancer: long term survival outcomes in a match cohort study. Ann Oncol 2012 August 12.
3. Claerhout F, Deprest J. Laparoscopic hysterectomy for benign diseases. Clin Obstet Gynecol 2005;19(3):357-375.
4. Mishra RK. Textbook of practical laparoscopic surgery. 2nd ed. New Delhi: Jaypee Brothers Medical Publishers (P) LTD; 2009.
5. Renato S, Mohammed M, Serena S, Giulia M, Diego R, Riccardo S. Robot-assisted radical hysterectomy for cervical cancer: review of surgical and oncological outcomes. Obstet Gynecol 2011;2011:872434.
6. Salicrú S, Gil-Moreno A, Montero A, Roure M, Pérez-Benavente A, Xercavins J. Laparoscopic radical hysterectomy with pelvic lymphadenectomy in early invasive cervical cancer. J Minim Invasive Gynecol 2011 Sep-Oct;18(5):555-568.
7. Sert MB, Abeler V. Robot-assisted laparoscopic radical hysterectomy: comparison with total laparoscopic hysterectomy and abdominal radical hysterectomy; one surgeon's experience at the Norwegian Radium Hospital. Gynecol Oncol 2011 Jun 1;121(3):600-604.
8. Kruijdenberg CB, van den Einden LC, Hendriks JC, Zusterzeel PL, Bekkers RL. Robot-assisted versus total laparoscopic radical hysterectomy in early cervical cancer, a review. Gynecol Oncol 2011 Mar;120(3):334-339.
9. Tinelli R, Malzoni M, Cosentino F, Perone C, Fusco A, Cicinelli E, Nezhat F. Robotics versus laparoscopic radical hysterectomy with lymphadenectomy in patients with early cervical cancer: a multicenter study. Ann Surg Oncol 2011 Sep;18(9):2622-2628.
10. Lee EJ, Kang H, Kim DH. A comparative study of laparoscopic radical hysterectomy with radical abdominal hysterectomy for early-stage cervical cancer: a long-term follow-up study. Eur J Obstet Gynecol Reprod Biol 2011 May;156(1):83-86.
11. Lowe MP, Chamberlain DH, Kamelle SA, Johnson PR, Tillmans TD. A multiinstitutional experience with robotic-assisted radical hysterectomy for early stage cervical cancer. Gynecol Oncol 2009 May;113(2):191-194.
12. Lowe MP, Hoekstra AV, Jairam-Thodla A, Singh DK, Buttin BM, Lurain JR, Schink JC. A comparison of robot-assisted and traditional radical hysterectomy for early-stage cervical cancer. J Robotic Surg 2009;3:19-23.
13. Estape R, Lambrou N, Diaz R, Estape E, Dunkin N, Rivera A. A case matched analysis of robotic radical hysterectomy with lymphadenectomy compared with laparoscopy and laparotomy. Gynecol Oncol 2009 Jun;113(3):357-361.
14. Nezhat FR, Datta MS, Liu C, Chuang L, Zakashansky K. Robotic radical hysterectomy versus total laparoscopic radical hysterectomy with pelvic lymphadenectomy for treatment of early cervical cancer. JSLS 2008 Jul-Sep;12(3):227-237.
15. Nam EJ, Kim SW. A case control study of robotic radical hysterectomy and pelvic lymphadenectomy using 3 robotic arm compared with abdominal radical hysterectomy in cervical cancer. Int J Gynecol Cancer 2010 Oct 20;20(7):1284-1289.
16. Sert MB, Eraker R. Robot-assisted laparoscopic surgery in gynecological oncology; initial experience at Oslo Radium hospital and 16 months follow-up. Int J Medical Robotics and Computer Assisted Surg 2009;5(4):410-414.
17. Uccella S, Ghezzi F, Mariani A, Cromi A, Bogani G, Serati M, Bolis P. Vaginal cuff closure after minimally invasive hysterectomy: our experience and systematic review of the literature. Am J Obstet Gynecol 2011 Aug;205(2):119.e1-12.
18. Nick AM, Lange J, Frumovitz M, Soliman PT, Schmeler KM, Schlumbrecht MP, dos Reis R, Ramirez PT. Rate of vaginal cuff separation following laparoscopic or robotic hysterectomy. Gynecol Oncol 2011 Jan;120(1):47-51.
19. Kho RM, Akl MN, Cornella JL, Magtibay PM, Wechter ME, Magrina JF. Incidence and characteristics of patients with vaginal cuff dehiscence after robotic procedures. Obstet Gynecol 2009 Aug;114(2 Pt 1):231-235.
20. Magrina JF, Kho RM, Weaver AL, Montero AP, Magtibay PM. Robotic radical hysterectomy: comparison with laparoscopy and laparotomy. Gynecologic Oncology 2008;109(1):86-91.
21. Ko EM, Muto MG, Berkowitz RS, Feltmate CM. Robotic versus open radical hysterectomy: a comparative study at a single institution. Gynecol Oncol 2008 Dec;111(3):425-430.
22. Boggess JF, Gehrig PA, Cantrell L, Shafer A, Ridgway M, Skinner EN, Fowler WC. A case-control study of robot-assisted type III radical hysterectomy with pelvic lymph node dissection compared with open radical hysterectomy.Am J Obstet Gynecol 2008 Oct;199(4):357.e1-7.
23. Cantrell LA, Mendivil A, Gehrig PA, Boggess JF. Survival outcomes for women undergoing type III robotic radical hysterectomy for cervical cancer: a 3-year experience. Gynecologic Oncology 2010;117(2):260-265.