Bladder Function Following Nerve-sparing Radical Hysterectomy: a Retrospective Cohort Study in Hong Kong

L LEE MBBS, MMedSc, MRCOG, FHKCOG, FHKAM (O&G)
SK HUI MBBS, MRCOG, FHKCOG, FHKAM (O&G)
KM CHOW MBBS, MMedSc, MRCOG, FHKCOG, FHKAM (O&G), FRCOG)
Department of Obstetrics and Gynaaecology, Princess Margaret Hospital, Laichikok, Kowloon, Hong Kong

Objective: To compare radical hysterectomy with nerve-sparing radical hysterectomy in terms of bladder function and perioperative complications.
Methods: The records of 56 patients having radical hysterectomy (n=30) and nerve-sparing radical hysterectomy (n=26) were reviewed. Postoperative bladder function assessment consisted of the time to: (a) achieve voiding with a residual urine volume of <100 ml, (b) feel bladder fullness after voiding, and (c) obtain satisfaction after micturition.
Results: Those having nerve-sparing radical hysterectomy had a significantly shorter time to bladder function recovery in terms of voiding residual volume of <100 ml (median, 3; range, 1-51 days) than non–nerve-sparing group (median, 7; range, 2-138 days) [p=0.003]. There was significant difference between nerve-sparing radical hysterectomy and radical hysterectomy groups regarding the numbers of patients self-catheterizing (4 vs 12; p=0.042) and self-satisfactory micturition (median [range] days: 4 [1-51] vs 8 [3-138]; p=0.001). The groups did not differ significantly in terms of bladder sensation, operating time and other complications, but the nerve-sparing group had a less median blood loss (500 vs 800 ml; p=0.011).
Conclusion: The nerve-sparing radical hysterectomy appeared superior to non–nerve-sparing radical hysterectomy in terms of bladder dysfunction, without increasing in operating time and complication, whilst their hospital stays were shorter.
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Introduction

The classical surgical management of early-stage cervical cancer (stage IA1 with lymphovascular space involvement, and stages IA2, IB1, IB2 and IIA) is radical hysterectomy (RH) which includes removal of uterus together with parametrial tissue, the upper vagina, and complete bilateral pelvic lymphadenectomy. It was first described by Wertheim in 1912[1], then modified by Okabayashi in 1921[2] and re-introduced by Meigs in the 1940s[3]. In the 1970s, Piver et al[4] classified RH into five types. The Werthiem-Meigs operation, considered as type III, is usually utilised for stage IB-IIA cervical cancers. Despite similar therapeutic effects for early cervical cancer, radical surgery still gained in popularity for young women. However, surgery is also notoriously prone to postoperative complications, such as urinary tract fistula, thromboembolism, lymphocysts, lymphoedema, and bladder dysfunction[5,6]. The frequency of postoperative bladder dysfunction has been reported between 70 and 85%[7,8] and is the most common long-term complication post-RH, mainly manifesting as sensory loss, storing and voiding dysfunctions, and incontinence[8]. This results from the disruption of autonomic fibres of the bladder during the operation. Its negative impact on quality of life was also demonstrated in some questionnaire-based studies[9,10]. Recent anatomical studies on cadavers suggested that radical surgery often leads to damage to pelvic autonomic nerve[11-13]. The following autonomic nerves are prone to injury during RH: (1) hypogastric (sympathetic) nerves at resection of the uterosacral ligament, (2) pelvic splanchnic (parasympathetic) nerves during dissection of lymph nodes and medial internal iliac and deep uterine veins, (3) vesical branches of the pelvic plexus during resection of vesico-uterine ligament, (4) the inferior hypogastric plexus during resection of uterosacral and rectovaginal ligament. Hence, based on various studies, nerve-sparing radical hysterectomy (NSRH) has been proposed as a means of preserving bladder function[14-18]. This technique was first adopted in our hospital in December 2006 and became our standard treatment for early cervical cancer in 2008.

Correspondence to: Dr. Lee Lee
Email: cherrieyung@gmail.com

Methods

In all, 54 patients having RHs for carcinoma of cervix stage IA2 to IIA and carcinoma of corpus stage IIB during the period January 2004 to December 2010 were included in this study. However, one patient with carcinoma of the corpus IA and one with carcinoma of cervix IA1 who had RHs were also included. This was because one presented with a cervical polypoid growth in the endocervical canal, making preoperative diagnosis difficult, and in the other multi-focal microinvasive tumour was considered possible. Among these, twenty-six of them had NSRH performed between January 2008 and December 2010. Data were collected on: patient age, body mass index, operating time, hospital stay, blood loss, time to resume bladder function, need for intermittent postoperative self-catheterization, postoperative complications, pathological diagnosis, lymph node involvement, and adjuvant radiotherapy. All patients had RH and pelvic lymph node dissection. Para-aortic lymph node dissection was performed if there were palpable lymph nodes. The nerve-sparing technique was used for patients operated on after December 2007. Prophylactic antibiotics was given to all cases. All procedures were performed by or under the supervision of gynae-oncologists.

All the patients had urinary indwelling catheters (suprapubic or Foley's from February 2010) after the operation. The time of catheter removal was variable; the bladder training differed depending on the type of catheterization, and started on day 10 before 2008 and on day 7-8 from January 2008 onwards. When the residual urine after voiding was less than 100 ml, the catheter was removed. The period of bladder training to achieve less than 100 ml was counted from the start of training to the date of removal. For those with Foley's catheters, the catheter was removed on postoperative day 7, and bladder training time counted from that date to the date when residual urine did not exceed 100 ml.

The primary end-points for bladder function were the period to achieve residual urine of <100 ml (using ultrasound for measurement) and resorting to intermittent self-catheterization after removal of the catheter. Those who resorted to intermittent self-catheterization recorded their daily voiding volume and residual urine (measured by catheterization) after discharge and were followed up in the outpatient clinic. The need for catheterization was reviewed at follow-up (around 2-4 weeks) by continence nurse.

Secondary end-points for bladder function were self-reporting of (1) the time to acquire full bladder sensation, and (2) the time to achieve 'satisfactory' micturition. Both were obtained during ward rounds, and from patient recall at follow-up. The former was defined as the sensation of bladder fullness by the patient, and the latter as self-reported good voiding volume (>150 ml per void) and frequency in the output chart. During follow-up visit, patients were asked to recall these features, and before and after discharge findings were compared. The routine follow-up visits were 8 weeks after discharge, then every 3 months in the first year, every 4 months in the second year, and half-yearly thereafter till the fifth year. All information was retrieved from hospital inpatient and outpatient records up to the last follow-up before 31 December 2010.

Categorical variables were analysed using the Chi-square test. The mean values of the continuous variables were compared using the Mann-Whitney *U* test. The statistical significance was considered at $p<0.05$. The Statistical Package for the Social Sciences (Windows version 16.0; SPSS Inc, Chicago [IL], US) was used for statistical analyses.

The Autonomic Nerve-sparing Technique

The operation was performed under general anaesthesia in a Trendelenburg position. Systemic inspection of whole abdominal cavity to exclude distant metastasis included the peritoneum, liver, stomach, omentum, bowel, and appendix. Identification of the bilateral inferior hypogastric and the splanchnic nerves was always performed after pelvic lymphadenectomy. Frozen sections were obtained on palpable lymph nodes and the procedure abandoned if they showed evidence of metastasis. The identification of ureters below the level of common iliac vessels and along the peritoneum of mesorectum guided careful dissection of peritoneum and the ureter and hence facilitated identification of the inferior hypogastric nerve 1-2 cm below the ureter. The nerve was dissected towards the uterine artery with simultaneous dissection of the inferior hypogastric nerve away from the uterosacral ligament. The pelvic splanchnic nerves run from S2-S4 roots of the sacral plexus and join the inferior hypogastric nerves plexus (with the inferior hypogastric nerves) at the lateral part of cardinal ligament. RH was then continued in the usual way, carefully preserving the nerve during resection of the parametrium. At the end of procedure, either a suprapubic or Foley's catheter (starting from February 2010) was inserted.

Results

Patient Characteristics

In all, 56 patients were included in this study; 30 had traditional Wertheim hysterectomies during the period

of January 2004 to December 2007, while 26 had NSRH performed during the period of 2008 to 2010. The mean ages of the patients having standard RH and NSRH were 45 (range, 23-59) and 45 (range, 32-59) years, respectively. Their mean body mass index values were 23.3 (range, 17.0-31.1) and 23.7 (range 17.3-35.7) kg/m^2, respectively.

There was no statistically significant difference in stage of the disease, tumour size (final pathological measurement of the specimens), lymphovascular invasion, pelvic and para-aortic lymph node involvement, and metastasis between the groups (Table 1).

Two patients had recurrence of disease in the NSRH group. One had a local pelvic recurrence and the other had distant metastasis in the breast, lung, and bone. In the RH group, one patient had an intra-abdominal recurrence. No statistically significant differences in the type of pathology and receipt of adjuvant therapy were detected in the two groups (Table 2). Postoperative chemoradiation and radiotherapy were indicated for large tumours (>3 cm), deep stromal invasion, lymphovascular involvement, close margin, and high-grade lesions. Decisions about adjuvant therapy were usually made after weekly tumour board discussions.

Table 1. Patient's pathological characteristics*

Pathology	Radical hysterectomy (n = 30)	Nerve-sparing radical hysterectomy (n = 26)	p Value
CA corpus			0.327
IA	0	1	
IIB	1	2	
CA cervix			0.118
IA1	0	1	
IA2	0	2	
IB1	25	12	
IB2	3	5	
IIA	1	3	
Pathology			0.277
Squamous cell carcinoma	21	12	
Adenosquamous	0	3	
Endometrioid	2	3	
Adenocarcinoma	6	5	
Serous adenocarcinoma	0	1	
Small cell carcinoma	0	1	
Poorly differentiated carcinoma	1	1	
Tumour size (cm)	2.2 ± 1.4 (0.2-4.8)	2.1 ± 1.2 (0.6-5.5)	0.820
Lymphovascular infiltration	9 (30%)	7 (27%)	0.790
Pelvic LN involvement	3 (10%)	2 (8%)	0.760
Para-aortic LN involvement	0	0	0.830
Metastasis	1 (3%)	2 (8%)	0.910

Abbreviation: LN = lymph node

* Data are shown as No., or mean ± standard deviation (range)

Table 2. Adjuvant therapies received by patients

Adjuvant therapy	Radical hysterectomy	Nerve-sparing radical hysterectomy	p Value
No therapy	21	23	0.57
Chemoradiation	8	1	0.08
Radiation	1	2	0.63

The length of the vaginal cuff in patients having RH ranged from 1 to 3.5 cm (median, 2 cm) and from 1 to 3.5 cm (median, 1.5 cm) for those having NSRH; the difference was not statistically significant (p = 0.110). Also there were no significant differences in mean tumour size of the pathological specimens, respective values being 2.2 (standard deviation [SD], 1.4; range: 0.2-4.8) cm versus 2.1 (SD, 1.2; range, 0.6-5.5) cm. The operating time for RH and NSRH groups ranged from 140 to 290 (median, 200) minutes and 145 to 270 (median, 205) minutes, respectively; the difference was not statistically significant (p = 0.812). Blood loss in RH and NSRH ranged from 200 to 2500 (median, 800) ml and from 100 to 1200 (median, 500) ml, respectively; such difference was significant (p = 0.011), and may be related to the change of technique involving the use of bipolar diathermy scissors for dissection (Table 3). There was not much difference in the number of patients with postoperative complication, as shown in Table 4. In all, 11 patients had postoperative complications, which accounts for 20% of all the patients having RH. A high urinary tract infection rate was detected in both groups (13% in the RH group vs 19% in the NSRH group), despite the use of prophylactic antibiotics.

Postoperative assessment of urinary function was objectively measured using the time (1) to achieve residual urine volume of <100 ml, and (2) resorting to intermittent self-catheterization after discharge from hospital. Subjective measures, namely self-reported bladder fullness sensation and satisfactory micturition, were recorded after removal of the indwelling urinary catheter. The time to achieve residual urine volumes of <100 ml for the RH and NSRH group ranged from 2 to 138 (median, 7) days and 1 to 51 (median, 3) days, respectively. The differences in both of these measurements (40% and 15% respectively) were in favour of NSRH and statistically significant (p=0.003, p=0.042 respectively). One patient with non-NSRH still continued to use intermittent self-catheterization and has an excessive residual urine volume of >100 ml after 5 years of follow-up. Hospital stay (from admission to discharge) was affected by the recovery of voiding function. Thus, NSRH patients had statistically significant shorter hospital stays than RH patients (median, 14 vs 19 days; p<0.001).

Patients reported bladder fullness sensation sooner than achieving desired residual urine volumes in both groups. The time to bladder fullness sensation for the RH

Table 3. Patient's outcome of different radical hysterectomies

Operative outcome	Median (range)		p Value
	Radical hysterectomy	Nerve-sparing radical hysterectomy	
Length of vagina (cm)	2 (1-3.5)	1.5 (1-3.5)	0.110
Operating time (mins)	200 (140-290)	205 (145-270)	0.812
Blood loss (ml)	800 (200-2500)	500 (100-1200)	0.011
Days obtaining residual urine of <100 ml	7 (2-138)	3 (1-51)	0.003
Days reporting bladder sensation	3 (0-56)	3 (0-32)	0.094
Days reporting satisfactory micturition	8 (3-138)	4 (1-51)	0.001
Intermittent self-catheterization*	12 (40%)	4 (15%)	0.042
Hospital stay (days)	19 (10-31)	14 (10-20)	<0.001
Median follow-up (months)	52 (8-83)	18 (3-60)	<0.001

* No. (%) of patients are shown

Table 4. Postoperative complications

Postoperative complication	Radical hysterectomy	Nerve-sparing radical hysterectomy	No. of patients with complication
Urinary tract infection	4 (13%)	5 (19%)	9
Intestinal obstruction	1	0	1
Wound infection	0	1	1
Total	**5**	**6**	**11**

and NSRH patients ranged from 0 to 56 (median, 3) days and from 0 to 32 (median, 3 days) respectively, but this difference was not statistically significant. Furthermore, the median time to achieve satisfactory micturition for the respective patient groups (8 vs 4 days) and the time needed for bladder training (19 vs 14 days) also differed significantly (Table 3).

The traditional RH group has a longer median follow-up time than NSRH group (52 vs 18 months; Table 3), but it should be realised that the operations were performed during different periods of time.

Discussion

Incidence and mortality of cervical cancer have been greatly reduced in most developed countries, whether due to extensive screening programmes and / or other factors, and a similar trend has been reported in Hong Kong. In 2007, cervical cancer was the third common gynaecological cancer and the eighth commonest women's cancer in Hong Kong[19], where 25% of new patients were younger (<45 years). Surgical treatment has gained in popularity among young patients, despite surgery and chemoradiation produce similar survival benefits. Besides, surgery can preserve the ovarian function and maintain the vaginal integrity. Type III RH is considered the standard surgical treatment for FIGO stage IA2-IIA cervical cancer worldwide. Unlike radiotherapy, it appears to be not associated with the long-term outcomes such as proctitis, dermatitis, or radiation cystitis. However, it is well known to be accompanied by early and late postoperative morbidity, including lymphoedema, bladder dysfunction, fistula formation (between the urinary tract and vagina), anorectal dysfunction and sexual dysfunction[20-22]. Studies have also demonstrated a deterioration in patient's quality of life due to mental and physical stress[9,23-25].

Function disorders of the lower urinary tract (loss of sensation, storage problems, voiding dysfunction, and incontinence) are the most common complications of RH, and affect 5 to 76% of patients[26,27]. Long-term bladder dysfunction was explained by the radical nature of parametrial resection and the different methods of assessing bladder functions. Adequate RH during resection of uterosacral ligament and inferior hypogastric plexus during resection of vesico-uterine ligaments can damage autonomic sympathetic and parasympathetic innervation of the pelvis, especially the hypogastric nerve. Therefore, the gynaecological oncologists always strike a balance between cure of disease (good resection margin) and quality of life (normal bladder function). NSRH was developed to reduce bladder dysfunction. The concept was first introduced by Kobayashi in 1961 and based on preservation of the splanchnic nerve by separation of the vascular (containing the deep uterine vein) and neural parts during division of the parametrium[28]. Fujii et al[29] described the technique in detail with diagrammatic illustrations. In 1998, Höckel et al[16] reported the liposuction-assisted NSRH. Other studies also described techniques of nerve-sparing surgery and their outcomes[15,17,18,30-32]. In animal studies, normal urinary function could be maintained so long as sympathetic nerves were preserved unilaterally. Wu et al[10] also showed the improvement in postoperative bladder function recovery and quality of life after NSRH, when compared to classical RH.

In our study, patients with NSRH took shorter times to achieve desirable residual urine volume (median, 3 vs 7 days). Moreover, their rate of voiding by self-catheterization was 15% (4/26) after NSRH but was 40% (12/30) after standard RH. However, the rate of post-voiding residual volume after non–NSRH is high, being 40% in our cohort compared to 15-20% in other studies[14,18,33]. The rate of self-catheterization in NSRH reported by others ranged from 0 to 7%[29,34-36]. It is difficult to compare these other studies of nerve-sparing because the techniques, the extent of RHs (type II and type III[35]) and the method of bladder function evaluation differ. Some used bladder scans while others used self-catheterization and even urodynamic studies in the postoperative period[36]. As our study included a long period of time, there was a change in bladder training over the study period, thus making the method of assessment variable.

Furthermore, bladder fullness sensation was the first to return and followed by self-reported micturition. This suggests that the sympathetic function is better preserved than the parasympathetic function and that the pathophysiology still remains unclear. Nevertheless, there is no significant difference in bladder fullness sensation between the RH and NSRH groups. Parasympathetic function was better preserved in the nerve-sparing group. Furthermore, unexpectedly in the NSRH patients, blood loss was also less, though operation times did not differ. Patient characteristics and pathology cannot explain the reduction in operative blood loss. The use of bipolar scissors for dissection and coagulation, and the improved expertise by our teams performing the nerve-sparing technique might have contributed to the difference.

Our results demonstrated reduced bladder disturbance after NSRH, which was similar to that reported

in the literature. However, these papers reported small series and heterogeneous patient populations during different stages of disease, most lacked controls, and their methods for assessment of bladder function were diverse. The limitations of our study included lack of preoperative and postoperative objective urodynamic testing, dependence on subjective self-reported bladder sensation and satisfactory micturition, and no randomisation to treatments. Moreover, the two patient groups were operated on during different periods of time, thus the median follow-up time of NSRH patients was shorter (3-60 months) and provided incomplete information for comparison. Analysing survival benefits in the two groups therefore becomes difficult. Finally, in view of benefits for bladder morbidity with adequate radical dissection, nerve-sparing surgery seems very feasible without further increasing operative risk. Thus, it seems unjustified to undertake traditional RH procedures in the future. Further studies clarifying neuroanatomy and pathophysiology of autonomic nervous system, and prospective randomised controlled trial with preoperative and postoperative urodynamic assessment should be carried out before the treatment to improve morbidity and disease outcomes and eliminate other cause of underlying bladder dysfunction.

References

1. Wertheim E. The extended abdominal operation for carcinoma uteri (based on 500 operative cases). *Am J Obstet Dis Women Child* 1912; 66:169-232.
2. Fujii S. Original film of the Okabayashi's radical hysterectomy by Okabayashi himself in 1932, and two films of the precise anatomy necessary for nerve-sparing Okabayashi's radical hysterectomy clarified by Shingo Fujii. *Int J Gynecol Cancer* 2008; 18:383-5.
3. Meigs JV. The Wertheim operation for carcinoma of the cervix. *Am J Obstet Gynecol* 1945; 40:542-3.
4. Piver MS, Rutledge F, Smith JP. Five classes of extended hysterectomy for women with cervical cancer. *Obstet Gynecol* 1974; 44:265-72.
5. Forney JP. The effect of radical hysterectomy on bladder physiology. *Am J Obstet Gynecol* 1980; 138:374-82.
6. Ralph G, Winter R, Michelitsch L, Tamussino K. Radicality of parametrial resection dysfunction of the lower urinary tract after radical hysterectomy. *Eur J Gynaecol Oncol* 1991; 12:27-30.
7. Low JA. Mauger GM, Carmichael JA. The effect of Wertheim hysterectomy upon bladder and urethral function. *Am J Obstet Gynecol* 1981; 139:826-34.
8. Scotti RJ, Bergman A, Bhatia NN, Ostergard DR. Urodynamic changes in urethrovesical function after radical hysterectomy. *Obstet Gynecol* 1986; 68:111-20.
9. Ditto A, Martinelli F, Borreani C, et al. Quality of life and sexual, bladder, and intestinal dysfunctions after class III nerve-sparing and class II radical hysterectomies: a questionnaire-based study. *Int J Gynecol Cancer* 2009; 19:953-7.
10. Wu J, Liu X, Hua K, et al. Effect of nerve-sparing radical hysterectomy on bladder function recovery and quality of life in patients with cervical carcinoma. *Int J Gynecol Cancer* 2010; 20:905-9.
11. Maas CP, Kenter GG, Trimbos JB, et al. Anatomical basis for nerve-sparing radical hysterectomy: immunohistochemical study of the pelvic autonomic nerves. *Acta Obstet Gynecol Scand* 2005; 84:868-74.
12. Mauroy B, Demondion X, Bizet B, et al. The female inferior hypogastric (= pelvic) plexus: anatomical and radiological description of the plexus and its afferences — applications to pelvic surgery. *Surg Radiol Anat* 2007; 29:55-66.
13. Kato T, Murakami G, Yabuki G. A new perspective on nerve-sparing radical hysterectomy: nerve topography and over-preservation of the cardinal ligament. *Jpn J Clin Oncol* 2003; 33:589-91.
14. Yabuki Y, Asamoto A, Hoshiba T, et al. A new proposal for radical hysterectomy. *Gynecol Oncol* 1996; 62:370-8.
15. Trimbos JB, Maas CP, Deruiter MC, et al. A nerve-sparing radical hysterectomy: guidelines and feasibility in Western patients. *Int J Gynecol Cancer* 2001; 11:180-6.
16. Höckel M, Konerding MA, Heussel CP. Liposuction-assisted nerve-sparing extended radical hysterectomy: oncologic rationale, surgical anatomy, and feasibility study. *Am J Obstet Gynecol* 1998; 178:971-6.
17. Possover M, Stöber S, Plaul K, et al. Identification and preservation of the motoric innervation of the bladder in radical hysterectomy type III. *Gynecol Oncol* 2000; 79:154-7.
18. Ercoli A, Delmas V, Gadonneix P, et al. Classical and nerve-sparing radical hysterectomy: an evaluation of the risk of injury to the autonomous pelvic nerves. *Surg Radiol Anat* 2003; 25:200-6.
19. Cheung FY, Mang OW, Law SC. A population-based analysis of incidence, mortality, and stage-specific survival of cervical cancer patients in Hong Kong: 1997-2006. *Hong Kong Med J* 2011; 17:89-95.
20. Bergmark K, Avall-Lundqvist E, Dickman PW, et al. Vaginal changes and sexuality in women with a history of cervical cancer. *N Engl J Med* 1999; 340:1383-9.
21. Brown JS, Sawaya G, Thom DH, et al. Hysterectomy and urinary incontinence: a systematic review. *Lancet* 2000; 356:535-9.
22. Zullo MA, Manci N, Angioli R, et al. Vesical dysfunctions after radical hysterectomy for cervical cancer: a critical review. *Crit Rev Oncol Hematol* 2003; 48:287-93.
23. Plotti F, Sansone M, Di Donato V, et al. Quality of life and

sexual function after type C2/type III radical hysterectomy for locally advanced cervical cancer: a prospective study. *J Sex Med* 2011;8:894-904.

24. Manchana T. Long-term lower urinary tract dysfunction in gynecologic cancer survivors. *Asian Pac J Cancer Prev* 2011; 12:285-8.
25. Vrzackova P, Weiss P, Cibula D. Sexual morbidity following radical hysterectomy for cervical cancer. *Expert Rev Anticancer Ther* 2010; 10:1037-42.
26. Jackson KS, Naik R. Pelvic floor dysfunction and radical hysterectomy. *Int J Gynecol Cancer* 2006; 16:354-63.
27. Rob L, Halaska M, Robova H. Nerve-sparing and individually tailored surgery for cervical cancer. *Lancet Oncol* 2010; 11:292-301.
28. Kobayashi T. Abdominal radical hysterectomy with pelvic lymphadenectomy for cancer of the cervix [in Japanese]. *Tokyo: Nanzando*, 1961.
29. Fujii S, Takakura K, Matsumura N, et al. Anatomic identification and functional outcomes of the nerve sparing Okabayashi radical hysterectomy. *Gynecol Oncol* 2007; 107:4-13.
30. Sakuragi N, Todo Y, Kudo M, et al. A systematic nerve-sparing radical hysterectomy technique in invasive cervical cancer for preserving postsurgical bladder function. *Int J Gynecol Cancer* 2005; 15:389-97.
31. Maas K, Moriya Y, Kenter G, et al. A plea for preservation of the pelvic autonomic nerves. *Lancet* 1999; 354:772-3.
32. Mantzaris G, Rodolakis A, Vlachos G, et al. Magnifying lenses assisted nerve-sparing radical hysterectomy and prevention of nerve plexus trauma. *Int J Gynecol Cancer* 2008; 18:868-75.
33. Landoni F, Maneo A, Cormio G, et al. Class II versus class III radical hysterectomy in stage IB-IIA cervical cancer: a prospective randomized study. *Gynecol Oncol* 2001; 80:3-12.
34. Kavallaris A, Hornemann A, Chalvatzas N, et al. Laparoscopic nerve-sparing radical hysterectomy: description of the technique and patients' outcome. *Gynecol Oncol* 2010; 119:198-201.
35. Raspagliesi F, Ditto A, Fontanelli R, et al. Type II versus Type III nerve-sparing radical hysterectomy: comparison of lower urinary tract dysfunctions. *Gynecol Oncol* 2006; 102:256-62.
36. Puntambekar SP, Patil A, Joshi SN, et al. Preservation of autonomic nerves in laparoscopic total radical hysterectomy. *J Laparoendosc Adv Surg Tech A* 2010; 20:813-9.