

Comparison of Two Bipolar Systems in Laparoscopic Hysterectomy

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ABSTRACT

Objective: To compare the efficacy of 2 bipolar systems during total laparoscopic hysterectomy (TLH): the pulsed bipolar system (PlasmaKinetic; Olympus, Japan) vs. conventional bipolar electro-surgery (Kleppinger bipolar forceps; Richard Wolf Instruments, Vernon Hills, IL).

Methods: We retrospectively reviewed medical records of 80 women who underwent TLH for benign gynecologic disease between 2009 and 2010. Forty women received TLH using the conventional bipolar system and another 40 using the pulsed bipolar system. The clinical outcomes and complications were compared between the 2 groups.

Results: No significant differences between the 2 groups were observed in terms of age, body mass index, and hospital stay. However, the blood loss was greater ($515.3 \pm 41.2\text{mL}$ vs. $467.9 \pm 33.4\text{mL}$, $P < .05$) and the operation time was longer ($173.4 \pm 33.4\text{min}$ vs. $157.3 \pm 21.3\text{min}$, $P < .05$) in the conventional group. Additionally, the uterine weight was lighter in the conventional group ($218.5 \pm 23.4\text{g}$ vs. $299.4 \pm 41.1\text{g}$, $P < .05$). None of the surgeries were required to be converted to laparotomy. No significant differences were found in intraoperative or postoperative complications between the groups.

Conclusion: The pulsed bipolar system has some advantages over the conventional system, and therefore, may offer an alternative option for patients undergoing TLH.

Key Words: Total laparoscopic hysterectomy, Pulsed bipolar system, Conventional bipolar electro-surgery.

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DOI: 10.4293/108680812X13462882736259

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INTRODUCTION

Laparoscopic hysterectomy has been associated with reduced postoperative pain, shorter recovery time, reduced adhesion formation, and improved short-term quality of life compared with traditional abdominal hysterectomy.¹

Conventional electro-surgery comprises unipolar and bipolar diathermy methods. Unipolar electro-surgery uses low voltage for cutting ($<600\text{ W}$) and high voltage for fulguration ($>2000\text{ W}$); bipolar electro-surgery uses low-voltage cutting current for desiccation. Bipolar electro-surgery is the most popular energy-based modality for tissue management in gynecologic laparoscopic procedures. The benefits of bipolar electro-surgery include its focus on the tissue between the jaws of the instrument, a lower rate of stray current with undesired tissue effects, and low-capacitive coupling.²

However, bipolar instruments can possibly cause lateral thermal damage, and the jaws can potentially stick to the tissue, which is then difficult to remove after coagulation. These problems originate from the traditional bipolar generator's continuous energy delivery.³ The plasma kinetic tissue management system (Olympus, Japan) uses pulsed bipolar energy for coagulation. This system delivers intermittent pulses of energy through the instruments to the tissue, as opposed to conventional continuous bipolar energy. The tissue between the jaws of the forceps is therefore able to cool between pulses, thus limiting the lateral thermal injury and tissue sticking. The pulsed bipolar system has 2 different modes (vapor pulse coagulation, and PlasmaKinetic tissue cutting) delivering predetermined levels of energy matched to special surgical instruments. It has been reported that vessel sealing with the pulsed bipolar system is more effective than with clips, suture, or staples.⁴ The purpose of this study was to determine whether the pulsed bipolar system can safely and effectively replace conventional bipolar electro-surgery in total laparoscopic hysterectomy (TLH).

MATERIALS AND METHODS

This study was a retrospective, nonrandomized case-control study. We recruited consecutively 40 patients with benign gynecologic disease for TLH with the pulsed bi-

polar system. For a comparison group, we recruited consecutively the latest 40 patients with benign gynecologic disease for TLH with conventional bipolar electrosurgery in the same period. From 2009 to 2010, data from a total of 80 patients with benign gynecologic disease for TLH were included for statistical analysis. The selection of bipolar system was determined by the surgeons' preference. Patient characteristics, including age, parity, body mass index (BMI), and history of previous pelvic surgery, and operative outcomes were retrieved from medical records. The operative outcomes included operation time (from incision to repair of skin), estimated blood loss (recorded by anesthesiologist), hospital stay (postoperative stay), uterine weight (recorded by the surgeon), and intra- and postoperative complications (visceral injury and conversion to laparotomy). All procedures were performed by 1 of 3 senior surgeons, defined as surgeons who have performed over 60 TLH procedures. The indications for TLH in this study were benign gynecologic diseases including myoma and adenomyosis (**Table 1**).

Patients were excluded from this study if they had malignant disease, pelvic inflammatory disease, uterine prolapse, or severe endometriosis. Previous pelvic surgery including cesarean delivery was not considered a contraindication of TLH. The mean follow-up periods were 4 wk after surgery.

Surgical Technique

The procedure was performed with the patient under general anesthesia. The patient was placed in the Trendelenburg position. An intrauterine manipulator (RUMI system; Coopersurgical, Trumbull, CT), in conjunction with a Koh cup (KohColpotomizer system; CooperSurgical) was inserted. The surgical approach was performed through 4 laparoscopic ports: a 10-mm umbilical port for the camera, two 5-mm lateral ports, and one 5-mm supra-

pubic port for the laparoscopic instruments. To control bleeding and cutting, Kleppinger bipolar forceps/monopolar scissors (conventional bipolar electrosurgery) or the PlasmaKinetic tissue management system (pulsed bipolar system) were used. We reduced tissue sticking by manual pulsation of the Kleppinger bipolar forceps. And for large vessel hemostasis, multiple applications were required. The pulsed bipolar system is composed of a PK generator, which delivers intermittent pulses of bipolar energy and automatically monitors tissue impedance to the current to adjust power levels; 5-mm disposable plasmakinetic laparoscopic cutting forceps (45cm) designed with serrated jaws to grasp, coagulate, and cut vascular pedicles; and a reusable plasma kinetic compatible connector cable.

Following routine abdominal and pelvic inspection, the operation began with the coagulation and dissection of the bilateral round ligaments using conventional electrosurgery or plasmakinetic cutting forceps. Therefore, the anterior leaves of the broad ligaments were opened and incised completely using laparoscopic scissors. The cephalic part of the vesicouterine ligament was then desiccated and divided halfway between the bladder and the uterus, and the bladder was also pushed down below the level of the cervix. Afterward, the uterine arteries, the cardinal ligaments, and the uterosacral ligaments were coagulated and transected by conventional electrosurgery or plasma kinetic cutting forceps. Hysterectomy was completed with the performance of a circular colpotomy with a monopolar hook. The uterus was then extracted from the vagina with the intrauterine manipulator still in place. Vaginal cuff closure, including uterosacral ligaments, was performed in a single layer with No.1 synthetic resorbable suture.^{5,6} At 1-y follow-up, no cases of vault prolapse had occurred.

Statistical Analysis

All the data were registered using SPSS 13.0. Intraoperative data such as duration of operation, blood loss, uterine weight, and intraoperative complications were recorded. Descriptive statistics, such as means and standard deviations, were used to summarize the data. χ^2 tests and independent *t* tests were used to compare differences between the 2 groups. All P-values were 2-sided. *P* < .05 was considered statistically significant.

RESULTS

The characteristics of Group A (TLH with conventional bipolar electrosurgery) and Group B (TLH with pulsed bipolar system) are described in **Table 2**. The 2 groups of

Table 1.

Indications for Total Laparoscopic Hysterectomy

	Group A ^a (n=40)	Group B ^a (n=40)
Myoma uteri	23	25
Myoma uteri + adenomyosis	10	10
Adenomyosis	5	4
Dysfunctional uterine bleeding	2	1

^aGroup A: Conventional bipolar surgery. Group B: Pulsed bipolar system.

Table 2.
Patient Characteristics

	Group A ^a	Group B ^a
Age (y)	44.3 ± 4.8	44.9 ± 5.1
BMI (kg/m ²)	24.1 ± 3.3	24.8 ± 3.4
Parity ^b	1.7 ± 0.9	1.3 ± 1.0
Previous pelvic operation ^c	0.4 ± 0.7	0.7 ± 0.9

^aGroup A: Conventional bipolar surgery. Group B: Pulsed bipolar system. Independent ^b*t* test analysis: *P* < .05.

^c*t* test analysis: *P* < .05.

Table 3.

Intraoperative and Postoperative Comparisons of the 2 Groups

	Group A ^a	Group B ^a
Operation time, min ^b	173.4 ± 33.4	157.3 ± 21.3
Blood loss, mL ^c	515.3 ± 41.2	467.9 ± 33.4
Hospital stay, d	6.5 ± 1.3	6.2 ± 1.2
Uterine weight, g ^d	218.5 ± 23.4	299.4 ± 41.1
Intraoperative bladder injury	1	0
Postoperative complications	0	0

^aGroup A: Conventional bipolar surgery. Group B: Pulsed bipolar system.

^bIndependent *t* test analysis: *P* < .05.

^cIndependent *t* test analysis: *P* < .05.

^dIndependent *t* test analysis: *P* < .05.

patients were comparable in terms of age and BMI. However, parity of Group A was significantly higher than that of Group B (*P* < .05). The history of previous pelvic surgery including cesarean delivery, was significantly higher in Group B than in Group A (*P* < .05). **Table 3** shows intraoperative and postoperative outcomes of the 2 groups. Blood loss and operative time were significantly different.

The operation time for Group A was longer than that for Group B (173.4 ± 33.4 min vs. 157.3 ± 21.3 min; *P* < .001). The blood loss was lower in Group B than in Group A (467.9 ± 33.4 mL vs. 515.3 ± 41.2 mL; *P* < .05). The weight of the removed uterus was heavier in Group B than in Group A (299.4 ± 41.1 g vs. 218.5 ± 23.4 g; *P* < .05).

None of the laparoscopic procedures required conversion to laparotomy. One intraoperative complication occurred in Group A. Bladder injury occurred during the bladder dissection from the cervical isthmic portion in a patient with dense adhesion. The bladder injury was successfully repaired by laparoscopic suture. No postoperative com-

plications were observed, and the length of hospital stay was similar in both groups.

DISCUSSION

The first report on laparoscopic hysterectomy (LH) was published in 1989.⁷ Many studies have shown that laparoscopic hysterectomy is associated with shorter hospital stay, quicker recovery, better cosmetic results, and better short-term quality of life, compared with traditional hysterectomy.^{1,8,9}

Patient safety during hysterectomy has always been a major concern. The low complication rate encountered in this study compares favorably relative to the 4% to 9% major complication rate during laparoscopic hysterectomy reported in the literature.^{1,10} The risk of major complications during laparoscopic hysterectomy recently has been shown to be closely related to the technique used to secure the ovarian and uterine blood vessels.¹ Therefore, advanced laparoscopic procedures and the inherent tedium of laparoscopic suturing have necessitated the development of new energy-based reliable alternatives for vascular control. During the past 10 decades, several advances and improvements, including the revolution of laparoscopy, electrosurgical devices, and insufflators, have been made; these have resulted in better operability and lower rates of complication. Traditional electrosurgery for open and laparoscopic procedures provide good cutting and coagulation, but relatively extensive thermal damage.^{11,12}

An ideal energy form for surgery should produce minimal tissue injury and little or no smoke to obscure the visual field. In addition, it should provide a cutting ability equal or superior to that of a conventional scalpel, as well as satisfactory coagulation. The plasmakinetic pulsed bipolar system is a new feedback-controlled method of delivering pulsed bipolar energy to tissue and has the ability to seal vessels up to 7mm in diameter.¹³ The system is based on bipolar technology, offering vapor pulse coagulation.

The intermittent and automatically adjustable pulses of bipolar energy produced by the plasma kinetic generator cause minimal lateral thermal spread and sticking of tissue to the plasma kinetic forceps blades after coagulation.¹⁴ Therefore, during the process of coagulation, the use of pulsed energy can diminish thermal damage and almost avoid all sticking.¹⁵ Moreover, the plasma kinetic forceps should allow for a secure grasp and accurate transaction of tissue. By virtue of the serrated jaw design and sharp steel blade traveling between the jaws, and the elimina-

tion of the need for laparoscopic scissors or changing instruments makes the pulsed bipolar system highly effective.

The purpose of this study was to determine whether the pulsed bipolar system might be able to safely and effectively replace conventional bipolar electro-surgery in TLH. According to our results, the operation time and hospital stay were longer in the conventional group, despite the heavier uterine weight in the pulsed bipolar group. Moreover, parity was lower and history of pelvic surgery was more frequent in the pulsed bipolar group, which could be associated with a longer operation time and higher complication rate. However, the clinical outcomes were opposite of what we expected. As a result, patient characteristics do not seem to affect the surgical outcomes.

The operation time of the pulsed bipolar system group was shorter than that of the conventional bipolar electro-surgery group ($P < .005$). This may result from the plasmakinetic cutting forceps having a cutting ability equal to that of conventional electro-surgery with less thermal tissue damage. Moreover, the instrument does not stick to coagulated tissue, and fewer instrument changes are needed.

In our study, operation time was reduced by only 20 min with the pulsed bipolar system. This is because we included the subjects during the initial learning curve period. Therefore, it may be a strength of the new pulsed bipolar system to reduce operating time further than we observed overall, and possibly cost savings, despite the expenses of the disposable instruments. The blood loss was lower in the plasma kinetic pulsed bipolar system group compared with the conventional bipolar electro-surgery group ($P < .05$). This may result from the plasmakinetic pulsed bipolar system providing cutting ability equal or superior to that of a conventional scalpel, as well as satisfactory coagulation. In addition, the plasma kinetic pulsed bipolar system does not stick to coagulated tissue and the relatively less extensive thermal injury makes meticulous hemostasis possible. The mean operating time in our study was longer than previously reported times,¹⁶ because subjects treated during the initial learning curve period were included in the study group. According to more recent data, the mean operating time of TLH was not different from those previously reported.

The weight of the removed uterus was heavier in the plasma kinetic group than in the conventional bipolar electro-surgery group with less blood loss and shorter operation time ($P < .05$). This may result from the plasma kinetic pulsed bipolar system providing cutting and coag-

ulation ability equal or superior to that of the conventional bipolar system.

One intraoperative complication occurred in the conventional bipolar electro-surgery group. This 39-y-old patient was diagnosed with myoma and had a history of 3 cesarean deliveries. Dense adhesions were present between the isthmus of the cervix and bladder. During the bladder dissection from the cervical isthmus portion, a bladder laceration occurred. We repaired this laceration through laparoscopy without conversion to laparotomy. This patient recovered well without complications.

As for the hospital stay, there was no difference between the 2 groups. The mean hospital stay was about 2 d to 3 d longer than those previously reported,¹⁷ which might be due to a cultural difference between Eastern and Western countries. In Korea, most patients want to be discharged only after complete recovery. Additionally, patients are not concerned about the long duration of the hospital stay, because medical insurance companies fully reimburse medical costs in Korea.¹⁸

In this study, all laparoscopic procedures were performed without conversion to laparotomy, and overall intraoperative complication rates and length of hospital stay were comparable in both groups. However, the plasmakinetic pulsed bipolar group showed a better result than that of the conventional bipolar electro-surgery group in terms of operative blood loss and operation time. Both devices can be considered safe in TLH. However, the plasmakinetic cutting forceps have the benefit of allowing simultaneous performance of hemostasis and division, so the procedure



Figure 1. The plasma kinetic generator (pulsed bipolar system generator).

can progress without changing instruments between hemostatic and cutting devices. This can diminish the workload for the surgeon and other operating room personnel.¹⁹

CONCLUSION

In the hands of experienced surgeons, both the plasma kinetic pulsed bipolar system and conventional bipolar electro-surgery can be used safely in TLH. The plasma kinetic pulsed bipolar system eliminates the risk of electrical damage and minimizes thermal injury to tissues. In our study, the pulsed bipolar system is more effective in TLH compared with conventional bipolar electro-surgery. The pulsed bipolar system has the advantages over conventional bipolar electro-surgery of reduced blood loss and shorter operative time and therefore may offer an alternative option for patients undergoing TLH. However, the limitations of our study were the small number of patients studied and the fact that it was a retrospective study without a matching group. Moreover, there could be several biases, such as different surgeons, the selection of patients, and different indications, affecting the clinical outcomes. In the future, more large-scale, prospective, randomized studies will be required.

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