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Tissue damage in abdominal hysterectomy performed with a vessel sealing system

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Aim: To compare the tissue damage, operation times, blood loss, short-term postoperative complication rates, and hospitalization durations of abdominal hysterectomies performed due to benign gynecological conditions using the LigaSure vessel sealing system (LVSS) and conventional suture ligation.

Materials and methods: Patients were prospectively enrolled in LVSS (TAH-L group, 22 cases) and suture ligation (TAH-S group, 31 cases) groups. Anesthesia time, operation time, intraoperative blood loss, intraoperative and short-term postoperative complications, and hospitalization durations were compared between the groups. Tissue damage was assessed by comparing changes in C-reactive protein, creatine phosphokinase levels, and white blood cell counts on preoperative and postoperative days 1 and 2. Blood loss was further evaluated by comparing changes in hemoglobin (Hg) levels on preoperative and postoperative days 1 and 2.

Results: Operation time, blood loss, postoperative short-term complications, and hospitalization durations were similar in the TAH-L and TAH-S groups. Changes in the biochemical markers of tissue damage and Hg levels were also similar in the groups.

Conclusion: The LVSS is safe and leads to similar tissue damage as the conventional suture ligation technique in abdominal hysterectomies performed due to benign gynecologic conditions.

Key words: LigaSure, abdominal hysterectomy, tissue damage

Damar mühürleme sistemi ile gerçekleştirilen abdominal histerektomide doku hasarı

Amaç: Benign jinekolojik nedenlerle gerçekleştirilen abdominal histerektomi olgularında LigaSure damar mühürleme sistemi (LVSS) kullanımı ile konvansiyonel sütür bağlama tekniği arasında doku hasarını, ameliyat süresini, kan kaybını, kısa dönem postoperatif komplikasyon hızını ve hastenede yatış süresini karşılaştırmaktır.

Yöntem ve gereç: Olgular prospektif olarak LVSS (TAH-L grubu, 22 olgu) ve konvansiyonel sütur bağlama tekniği (TAH-S grubu, 31 olgu) gruplarına dahil edildi. Anestezi ve operasyon süreleri, intraoperatif kanama miktarı, intraoperatif ve postoperative kısa dönem komplikasyonlar ve hastanede kalış süresi gruplar arasında karşılaştırıldı. Doku hasarı, preoperatif ve postoperatif 1. ve 2. gündeki C-reaktif protein ve keratin fosfokinaz seviyeleri ve beyaz küre sayısındaki değişim ile değerlendirildi. Kan kaybı ayrıca preoperatif ve postoperatif 1. ve 2. gündeki hemoglobin düzeylerindeki değişim ile değerlendirildi.

Bulgular: Operasyon süresi, kanama miktarı, postoperatif kısa dönem komplikasyonlar ve hastanede yatış süresi TAH-L ve TAH-S gruplarında benzerdi. Doku hasarının biyokimyasal belirteçlerindeki ve hemoglobin düzeylerindeki değişiklikler de her iki grupta benzerdi.

Sonuç: Benign jinekolojik nedenlerle gerçekleştirilen abdominal histerektomilerde LigaSure damar mühürleme sistemi güvenlidir ve konvansiyonel sütür bağlama tekniği ile benzer doku hasarına neden olmaktadır.

Anahtar sözcükler: Ligasure, abdominal histerektomi, doku hasarı

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Introduction

Hysterectomy is one of the most common surgical procedures in gynecological practice (1), and the abdominal removal of the uterus is the most commonly preferred method by surgeons worldwide (2,3). Although the earliest attempts at hysterectomy happened in the 19th century, it became safer in the early 20th century with the advent of surgical techniques. Historically, one of the major drawbacks of abdominal hysterectomy (AH) was the high intra- and postoperative bleeding rates, leading to high mortality. After AH became safer, surgeons tried to improve the surgical technique to decrease intraoperative complication rates and to improve patient comfort and healing by decreasing postoperative pain and infection. Recently, several hemostatic devices have been introduced to the market to increase safety and decrease the costs of the operation.

The LigaSure® vessel sealing system (LVSS) (Covidien, Boulder, CO, USA) has been introduced as a hemostatic device alternative to sutures. It seals the vessels by denaturing the collagen and elastin in the tissue. It can sense a change in tissue impedance and deliver an appropriate amount of energy. The LVSS has been used safely in various surgical procedures like splenectomy, thyroidectomy, and gastric surgery (4-6), as well as laparoscopic and vaginal hysterectomy (7,8). However, studies evaluating the contributions of the LVSS to AH are still scanty.

Surgery is a major trauma leading to tissue damage (9). A minimally invasive and tissue-respectful technique with minimal tissue damage is the aim of all surgical techniques. However, energy-based surgical devices used for securing vascular pedicles instead of sutures produce collateral thermal damage in neighboring tissue (10). C-reactive protein (CRP) and creatine phosphokinase (CPK) levels increase postoperatively in response to injury and inflammation, and white blood cell (WBC) counts increase to defend the body against foreign materials (11,12). In the current study, we primarily aimed to compare tissue damage with the biochemical markers CRP, CPK, and WBC in AHs performed for benign gynecologic conditions with the LVSS and a conventional suture ligation technique. Our secondary aim was to compare the operation times, blood loss, short-term complications, and hospitalization durations in these two techniques.

Materials and methods

Between July and October 2010, we enrolled the consecutive cases that underwent AH for benign gynecologic conditions with or without bilateral salpingo-oophorectomy (BSO) with the aid of a LigaSure device (TAH-L group) or conventional suture ligation (TAH-S group) in our prospective case control study. A power analysis was performed using the data reported in the publications, and the minimum necessary sample size in each group was found to be 22 cases when the desired significance level was set to 0.05 (α) and the power was set to 0.8 (1-β). Therefore, 31 cases and 22 cases were enrolled in the TAH-S and TAH-L groups, respectively. Our study was approved by the local ethics committee and all participants signed a written informed consent form before enrollment. All participants were required to meet the inclusion criterion of having a benign gynecologic disease that required AH with or without BSO (leiomyoma, benign ovarian cyst, cervical intraepithelial neoplasia, or dysfunctional uterine bleeding). Excluded were patients who underwent hysterectomy due to malignant conditions, patients who underwent hysterectomy due to tubo-ovarian abscess, patients who had surgical interventions in addition to AH with or without BSO, and patients with conditions that could lead to a rise in the levels of biochemical markers (inflammatory conditions like pelvic inflammatory disease or rheumatoid arthritis, cardiovascular disease, or diabetes mellitus).

Surgical procedure and postoperative care

All patients underwent a standard surgical procedure with a Richardson-type hysterectomy (13) with or without BSO via a Pfannenstiel incision. For securing the vascular pedicles, hemostasis with clamping, cutting, and suture ligation (TAH-S group) or the LVSS (TAH-L group) were used according to the preference of the surgeon. None of the patients in the TAH-L group received suture hemostasis. The operations were performed by final-year residents under the supervision of a consultant or consultants who were experienced in LVSS use. The start and end times of anesthesia and surgery were recorded. The amount of blood loss was estimated and the uterine weight was measured. All patients received antibiotic prophylaxis with 1 g of cefazolin sodium (Eqizolin®, Tüm Ekip, İstanbul, Turkey) during anesthesia

induction, which was continued postoperatively with 1 g twice daily starting 12 h after the end of surgery. Postoperative analgesia was provided to all patients by giving 50 mg of pethidine hydrochloride (Aldolan®, Liba, İstanbul, Turkey) 4 times daily in the first 24 h after the surgery and 75 mg of diclofenac sodium (Dikloron®, Deva, İstanbul, Turkey) twice daily after 24 h. The other medications received postoperatively were 10 mg of metoclopramide (Primperan®, Biofarma, İstanbul, Turkey) 3 times daily and 50 mg of ranitidine hydrochloride (Ranitab®, Deva, İstanbul, Turkey) as the patient needed. The time that passed from the end of anesthesia to the first bowel movement and first flatulence was documented. The total duration of hospitalization and any short-term complications, such as postoperative hemorrhage, hematoma, fever, wound dehiscence, intraabdominal infection, reoperation, and reapplication to hospital after discharge, were recorded.

Assays for biochemical markers of tissue damage and blood loss

WBC count and CPK, CRP, and hemoglobin (Hg) levels were evaluated 1 day before and 24 and 48 h after each surgery.

CRP levels were measured using the nephelometric method (BN II, Dade-Behring, Marburg, Germany) with intra- and interassay coefficients of variance of 2% and 3.6%, respectively. CPK levels were measured spectrophotometrically (Architect C8000, Abbott Diagnostics, Abbott Park, IL, USA) with intra- and interassay coefficients of variance of 1.3% and 1.5%, respectively. An automated hematology instrument was used to measure Hg levels (linearity range of 0-25.0 g/dL) and WBC counts (linearity range of (0-400.00) $\times$ 10^3 cells/μL) using volume, conductivity, and scatter technology (Coulter LH780, Beckman Coulter, Fullerton, CA, USA).

Statistical analysis

The data were analyzed using SPSS 15.0 for Windows (SPSS Inc., Chicago, IL, USA). The normality of distribution of variables was tested using the Kolmogorov-Smirnov test. The data are given as mean ± standard deviation or percentage. The data were compared using a Mann-Whitney U test, and the categorical data were compared using a Pearson chi-square test. The changes in Hg, WBC, CRP, and CPK levels were compared using a general linear model for repeated measures. $P < 0.05$ was considered significant.

Results

The surgery was performed due to uterine myoma in 16 (51.6%) and 11 (50%) cases, ovarian cyst in 5 (16.1%) and 4 (18.2%) cases, uterine myoma and ovarian cyst in 2 (6.5%) and 1 (4.6%) cases, menometrorrhagia and dysfunctional uterine bleeding in 6 (19.4%) and 5 (22.7%) cases, and cervical intraepithelial neoplasia in 2 (6.5%) and 1 (4.6%) cases in the TAH-S and TAH-L groups, respectively. Out of the 31 women in the TAH-S group, 27 (87.1%) underwent AH and BSO, while 18 out of 22 women (81.8%) in the TAH-L group did so ($P = 0.597$). The mean age was 50.4 ± 7.3 and 54.3 ± 12.7 years in the TAH-S and TAH-L groups, respectively ($P = 0.581$). The mean gravidity was significantly higher in the TAH-L group (6.7 ± 2.9 compared to 5 ± 2.3 in the TAH-S group, $P = 0.04$); however, mean parity ($P = 0.236$) was similar in the groups (Table 1). The mean BMI ($P = 0.830$), the mean anesthesia ($P = 0.459$) and operation ($P = 0.962$) times, the mean weight of the uterus removed ($P = 0.175$), and the mean amount of intraoperative blood loss ($P = 0.749$) were also similar in the groups (Table 1). Intraoperative complications did not occur in any of the patients.

Postoperatively, time to resumption of first bowel movement ($P = 0.688$) and first flatulence ($P = 0.490$) were similar in the groups. In each group, there was only 1 case of a mild fever over 37.5 °C, and the rate of high body temperature was similar in the groups ($P = 0.804$). The mean duration of hospitalization was similar in the groups ($P = 0.527$) and other short-term complications were not recorded in any of the patients (Table 1).

The mean plasma Hg levels ($P = 0.932$), WBC counts ($P = 0.980$), CRP levels ($P = 0.251$), and CPK levels ($P = 0.529$) on the days before and days 1 and 2 after the surgery were similar in the groups (Table 2). The change in WBC counts and CRP, CPK, and Hg levels on the days before and after the hysterectomy were not significantly statistically different in the TAH-S and TAH-L groups using the general linear model analysis for repeated measures.

Table 1. Patient and operative characteristics.

	TAH-S (n = 31)	TAH-L (n = 22)	P
Age (years)	50.4 ± 7.3	54.3 ± 12.7	0.581
Gravidity	5 ± 2.3	6.7 ± 2.9	0.04**
Parity	4.4 ± 2.3	5.6 ± 3.2	0.236
BMI (kg/m²)	27.9 ± 3.1	27.6 ± 2.9	0.830
Anesthesia time (min)	122.7 ± 23.1	114.6 ± 25.2	0.459
Operation time (min)	92.1 ± 21.1	90.2 ± 20.6	0.962
Uterine weight (g)	301.9 ± 256.6	209.1 ± 110.6	0.175
Blood loss (mL)	142.3 ± 40.5	157.1 ± 89.1	0.749
Bowel movement (h)	7.8 ± 1.2	7.8 ± 1.5	0.688
Flatulence (h)	12.1 ± 5.9	12.2 ± 4.2	0.490
Fever (%)	3.2	4.6	0.804
Hospitalization (days)	3.2 ± 1	3.6 ± 2.4	0.527

*Data are given as mean ± standard deviation or percentage.
**Statistically significant.

Table 2. Levels of hemoglobin and tissue damage markers before and after hysterectomy.

	TAH-S (n = 31)	TAH-L (n = 22)	P
Hg (g/dL)			
Pre-op	12.3 ± 1.5	12.3 ± 1.3	
Post-op 1	11.4 ± 1.7	11.4 ± 1.4	0.932
Post-op 2	10.9 ± 1.7	11 ± 1.4	
WBC (count/μL)			
Pre-op	8.4 ± 2.1	7.7 ± 1.9	
Post-op 1	12.2 ± 2.9	12.7 ± 3.1	0.980
Post-op 2	10.2 ± 3.1	10.4 ± 3	
CRP (mg/L)			
Pre-op	15.6 ± 18.2	7.8 ± 6.5	
Post-op 1	49.9 ± 37.5	41.8 ± 26.5	0.251
Post-op 2	143.2 ± 149.3	115.95 ± 79.1	
CPK (IU/L)			
Pre-op	59.6 ± 33.4	72.8 ± 38.5	
Post-op 1	310.4 ± 189.3	342.3 ± 350.5.7	0.529
Post-op 2	659.2 ± 494.4	768.6 ± 782.4	

*Data are given as mean ± standard deviation.
**Abbreviations: Pre-op: preoperative,
Post-op 1: postoperative day 1, Post-op 2: postoperative day 2.

Discussion

We found the LVSS to be as safe as conventional suture ligation in AHs performed for benign gynecologic conditions. None of the patients experienced ureter, bowel, or major blood vessel injuries intraoperatively or needed reoperation due to a hemorrhage postoperatively. The short-term complication rate of the LVSS was also similar to that of conventional suture ligation, which was in accordance with other studies (7,8,14). Although we did not have any major short-term complications except postoperative fever in 1 case in each group, the short-term complications reported by Hagen et al. (15) after AH were wound infection and wound rupture in 3 out of 15 cases with the LVSS and wound infection and vault bleeding in 2 out of 15 cases with suture ligation.

Although case control studies showed similar complication rates with LVSS use compared to conventional suture ligation, a metaanalysis evaluating 29 prospective randomized trials showed fewer complications with the LVSS compared to conventional mechanical hemostatic methods (odds ratio 0.66, 95% CI: 0.47-0.92, P = 0.02) (16).

The LVSS was found to be effective and fast, resulting in less blood loss and shorter operation times in vaginal hysterectomy (17) and in radical AH performed for gynecologic malignancies (18,19). However, we found the operation times and blood loss with the LVSS to be similar to those of suture ligation in AHs performed for benign gynecologic conditions. There are 2 published studies evaluating the contribution of the LVSS in AH (14,15). Similar to our findings, they did not find a decrease in the operation times and blood loss with the LVSS compared to conventional suture ligation. Hagen et al. converted to suture ligation in 7 out of 15 cases, with a high LVSS failure rate (15). Therefore, they linked the similar operation durations with the conventional suture ligation to the prolonging effect of the LVSS failure. In our study, there were no LVSS failures and the surgeons were experienced in LVSS use. Therefore, there were no dilatory factors leading to the prolongation of operation time in our cases with LVSS use.

Another advantage of the LVSS was shorter hospitalization for vaginal hysterectomy (20,21). It was linked to less postoperative pain (20) and presumably less foreign body reaction and inflammation due to nonuse of suture material. However, our study and that of Lakeman et al. found the hospitalization periods to be similar for the LVSS and conventional suture ligation groups for AH (14). Our unit's policy is to discharge patients after at least 2 days of hospitalization postoperatively. Therefore, this may obscure the substantial effect of LVSS use on the duration of hospitalization. However, we believe there are no clinics discharging their patients 1 day after an AH. Therefore, the comparison of hospitalization durations can still be valid.

The LVSS causes thermal tissue damage, which was attributed to several factors including blade temperature, transaction time, and tissue properties (10). It delivers a high-powered current at a low voltage to the tissue and automatically shuts down when the tissue impedance reaches a critical level to minimize thermal damage. Therefore, it causes less thermal damage to the tissue compared to existing bipolar electrocoagulation devices (22). The extent of collateral tissue damage was found to be up to 1-3 mm with the LVSS but up to 1-6 mm with bipolar forceps. The least collateral tissue damage, which was up to 0-1 mm, was found with the harmonic scalpel (23). However, there is no published data about tissue damage from the LVSS in contrast to conventional suture ligation. The extent of tissue damage due to surgical trauma may affect postoperative pain, healing, and adhesion formation. Lakeman et al. found less postoperative pain and faster healing after AH performed with the LVSS (14). However, there are no data about postoperative adhesion with the LVSS. In contrast to the indirect indicators of tissue damage, like postoperative pain and healing, we found the markers of tissue damage to be similar between the LVSS and conventional clamping and suture ligation. The similarity in tissue damage may be due to the crushing effect of clamping and the foreign material left behind, which may increase the inflammatory reaction in suture ligation.

The cost of a LigaSure device is also an important issue in choosing it over the conventional suture ligation. We and others did not compare the costs of the LVSS and suture use in hysterectomies; however, the decreased operation time and hospitalization duration rendered LVSS use cost-effective in vaginal and radical hysterectomies (17-19). On the other hand, we did not find such an advantage of LVSS use in AHs.

The weakness of the current study was the heterogeneity of the groups, consisting only of cases that underwent AH with or without BSO. Removal of both ovaries and fallopian tubes could add tissue trauma and further increase the markers. However, the TAH-S and TAH-L groups were similar in terms of the rate of AH with BSO. Therefore, we suggest that the heterogeneity of the groups had no confounding effect. We also introduced diclofenac sodium intramuscularly as an analgesic starting from day 1 after surgery. Diclofenac sodium may influence CRP levels due to its suppressive effect on inflammation (24). However, the CRP levels obtained on day 1 of surgery were determined before the introduction of diclofenac sodium, and the mean CRP levels on day 1 of surgery were still similar in the groups.

In conclusion, although the LVSS was safe for securing vascular pedicles, it had no benefit in respect to decreasing the operation time, blood loss, and hospitalization period in AH. Our data showed that LVSS had no advantage or disadvantage on tissue damage. Further studies with greater numbers of participants are needed to strengthen our conclusion.

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