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EDUCATION AND TRAINING

Learning curves for laparoscopic hysterectomy after implementation of minimally invasive surgery

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ABSTRACT

Objective: To evaluate the learning process for total laparoscopic hysterectomy (TLH) and laparoscopic supracervical hysterectomy (LSH) for benign uterine pathologies among surgeons inexperienced in laparoscopy. *Methods:* A retrospective comparative study was conducted of all hysterectomies performed by four attending surgeons and three resident surgeons at a tertiary university center in Homburg/Saar, Germany. Laparoscopic procedures were assessed between October 1, 2009, and October 31, 2010 (period A); November 1, 2010, and March 31, 2012 (period B); and April 1, 2012, and June 30, 2013 (period C). Data were obtained by medical chart review. *Results:* Overall, 269 patients underwent TLH and 165 underwent LSH. Duration of surgery for all surgeons decreased from 136 ± 60 minutes in period A to 118 ± 44 minutes in period B ($P=0.013$), but increased to 122 ± 56 minutes in period C (A vs C: $P=0.067$). Among attending surgeons, the duration of surgery seemed to decrease after 20 TLH procedures and after 10 LSH procedures. Among resident surgeons, duration decreased after 10 LSH procedures; no fall was apparent for TLH. *Conclusion:* Both TLH and LSH were readily adopted among a group of surgeons inexperienced in laparoscopy, although LSH might be easier to learn. Experienced surgeons have a steeper learning curve than do their inexperienced counterparts.

1. Introduction

Hysterectomy is the most frequently used non-obstetric gynecologic procedure, representing the standard treatment for benign uterine pathologies. Guidelines recommend a minimally invasive approach whenever feasible [1,2]. Compared with open surgery, laparoscopy reduces blood loss, pain, risk of infection, and duration of hospitalization; this technique also accelerates convalescence and resumption of usual activities [3–5]. The laparoscopic approach has been associated with good outcomes in terms of symptom relief, quality of life, and sexual function [6]. Nevertheless, worldwide, hysterectomies are still performed predominantly through an abdominal approach [7–9], owing to high equipment costs and prolonged duration of laparoscopic surgery versus open procedures [5,10]. Another important factor limiting adoption of laparoscopy is the need for advanced surgical skills.

As institutions start to adopt laparoscopic procedures, it becomes prudent to consider how many operations an individual surgeon must perform to achieve competence. The acquisition of technical competency is represented by a learning curve [11], which is defined as a progressive decrease in operating time and/or complications. The number of cases needed to achieve criterion-level performance ranges from 20 to 30 [7,12–16]; however, the criteria used to define competence can vary between studies [7,13,17,18].

This aim of the present study was compare the performance of surgeons experienced in vaginal and abdominal gynecologic surgery with that of inexperienced surgeons by assessing learning curves for total laparoscopic hysterectomy (TLH) and laparoscopic supracervical hysterectomy (LSH).

2. Materials and methods

A retrospective comparative study was conducted of surgeons who performed TLH or LSH between October 1, 2009, and June 30, 2013, in the Department of Gynecology and Obstetrics, Saarland University Medical Center, Homburg/Saar, Germany. Eligible surgeons had no previous experience of laparoscopy. Data were obtained for the patients who underwent TLH or LSH as treatment for benign uterine pathologies and had no pathologic findings of a cervical smear within the previous 6 months. Ethics committee approval was waived and informed patient consent was not required owing to the retrospective design of the present study. Patient data were anonymized before analysis.

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Participating surgeons provided their consent to be included in the analysis. Patient data were anonymized before analysis.

The present study center is a tertiary facility that transitioned from an open surgery center to a primarily laparoscopic center in October 2009. All patients received detailed preoperative counseling and their decision to undergo a particular procedure was taken as informed consent for surgery. The decision about whether to undertake TLH or LSH depended on the result of the cervical smear and individual patient preference.

Medical history was obtained preoperatively and all patients underwent gynecologic examination, transvaginal ultrasonography, and ultrasonography of the kidneys. Basic laboratory tests were performed at admission. Surgery was conducted under general anesthesia. All patients received perioperative antibiotics (1.5 g cefuroxime and 500 mg metronidazole administered intravenously) and postoperative thrombosis prophylaxis (40 mg enoxaparin administered daily by the subcutaneous route). All patients received a temporary (≤24-hour) bladder catheter. A HOHL uterine manipulator (Karl Storz, Tuttlingen, Germany) was placed before the operation commenced.

As described elsewhere [19,20], hysterectomies were performed in the dorsal lithotomy position via four ports: an umbilical port for insertion of a 10-mm optic trocar, two inferolateral abdominal ports (two fingers above the iliac crest) for insertion of 5-mm working trocars, and a suprapubic port (two fingers above the pubic symphysis) for a 15-mm working trocar. A pneumoperitoneum (15 mm Hg pressure) was established with a Veress needle via the umbilical port. The LSH procedure was performed with a monopolar loop (SupraLoop Modell Brucker/Messroghli; Karl Storz, Tuttlingen, Germany). Morcellation of the uterus was achieved using a Rotocut G1 electric morcellator (Karl Storz, Tuttlingen, Germany) via the 12-mm suprapubic port. The vaginal vault was closed laparoscopically by interrupted or continuous single-layer or two-layer Vicryl 1 sutures (Ethicon, Norderstedt, Germany). Additional procedures were defined as pathologies diagnosed intraoperatively that required expansion of the operation, such as extensive adhesiolysis, adnexectomy, sacropexy of the cervical stump, and excision of endometriosis (ENZIAN score: E1a–E2b) [21].

For the present analysis, patients' characteristics were obtained through medical chart review and included age, body mass index (BMI, calculated as weight in kilograms divided by the square of height in meters), history of abdominal surgery, indication for surgery, duration of surgery (from first incision to final closure), mass of the uterus, complications, and length of hospital stay (from first postoperative day to the day of discharge). Intraoperative complications included conversion to laparotomy and iatrogenic injury of the urinary tract, bowel, or any major vessel. Postoperative complications (morbidity within 30 days) were classified as low grade (Clavien–Dindo grade I–II) or high grade (Clavien–Dindo grade IIIa–IIIb) [22].

Data were collected in an Excel 2010 datasheet (Microsoft Corporation, Redmond, WA, USA) and analyzed using SPSS version 19 (IBM, Armonk, NY, USA). The study timeframe was divided into three periods to assess the surgeons' learning curve: period A was from October 1, 2009, to October 31, 2010; period B from November 1, 2010, to March 31, 2012; and period C from April 1, 2012, to June 30, 2013. Data normality was determined with the Kolmogorov–Smirnov test. Continuous variable datasets were subjected to one-way analyses of variance and the Student t test; categorical data were subjected to χ^2 or Fisher exact tests, as appropriate. Learning curves were produced for each laparoscopic method. Duration of surgery learning curves were plotted in chronological order; the fourth period moving average (i.e. mean duration of the four previous surgeries) was calculated to gauge the direction of the trend of operation duration. Univariate linear regression analysis was used to assess relationships between operating time and perioperative parameters. The data were reported as mean ± standard deviation, as well as absolute and relative frequencies. All P values were two-sided and not adjusted for the issue of multiple testing owing to the explorative nature of the present study. $P<0.05$ was considered statistically significant.

3. Results

Four attending surgeons with extensive experience in laparotomy and vaginal hysterectomy, and three residents with little such experience provided their consent to participate in the present study. None of these seven surgeons had previous laparoscopic experience before the center's transition to laparoscopy in October 2009. The attending surgeons performed TSH and LSH in all three study periods, whereas the residents performed these procedures in periods B and C only (in period A, they assisted the attending surgeons).

A total of 434 patients were included in the present study. The mean age of the cohort was 47 years (range 28–81), the mean BMI at the time of operation was 27 (range 16–55), and the mean total uterine mass resected was 228 g (range 20–2148). The main indications for surgery were uterine leiomyomas (307 [70.7%] patients), genital descensus (43 [9.9%]), cervical dysplasia (34 [7.8%]), endometriosis (4 [0.9%]), and other benign uterine pathologies (46 [10.6%]). Most patients (350 [80.6%]) had a history of at least one surgery; 211 (48.6%) had previously undergone laparotomy. Overall, 269 (62.0%) patients underwent TLH and 165 (38.0%) underwent LSH. No statistically significant differences in BMI, uterine mass, and previous laparotomy were observed between periods A (n = 81), B (n = 173), and C (n = 180) (Table 1).

Additional procedures were required during laparoscopic hysterectomy for 319 (73.5%) patients. No intraoperative complications occurred in period A; however, intraoperative complications were recorded among 7 (4.0%) of 173 patients in period B and 5 (2.8%) of 180 patients in period C. Conversion to laparotomy for major bleeding was necessary among 4 (1.5%) of 269 patients who underwent TLH (3 in period B and 1 in period C); all the conversions were performed by an attending surgeon. The mean difference in hemoglobin levels between preoperative and postoperative measurements was small throughout the training period (13.5 ± 10.1 g/L) and did not differ between the three periods (Table 2).

Iatrogenic injuries of the urinary tract occurred among 8 (1.8%) of the 434 patients, with 5 (62.5%) cases occurring in operations performed by an attending surgeon and 3 (37.5%) in operations performed by a resident surgeon. No bowel injuries occurred. The frequency of iatrogenic injuries did not differ between the TLH (7/269 [2.6%]) and LSH groups (1/165 [0.6%]; $P = 0.269$). The mean BMI of the eight patients with iatrogenic injury was 24, and all had undergone previous abdominal surgery, including 5 (62.5%) who had previously undergone laparotomy.

The overall mean operative duration decreased from period A to period B ($P = 0.013$), but not from period B to period C ($P = 0.439$) (Table 2). Among attending surgeons, length of surgery decreased from 136 ± 60 minutes in period A to 117 ± 46 minutes in period B ($P = 0.009$), and to 108 ± 57 minutes in period C (A vs C: $P = 0.002$). By contrast, length of procedure among resident surgeons was 123 ± 38 minutes in period B (the first period in which they could be included), and 140 ± 49 minutes in period C ($P = 0.08$). Duration of TLH decreased with increasing experience for the attending surgeons, from 143 ± 57 minutes in period A to 119 ± 46 minutes in period B and 113 ± 63 minutes in period C (A vs C: $P = 0.019$). No such progression was seen for the resident surgeons: duration of TLH was 133 ± 33 minutes in period B, and 129 ± 44 minutes in period C ($P = 0.709$). Duration of LSH decreased nonsignificantly among the attending surgeons, from 126 ± 63 minutes in period A to 114 ± 47 minutes in period B and 100 ± 45 minutes in period C (A vs C: $P = 0.115$). Among the resident surgeons, the duration of LSH did not decrease between period B (117 ± 24 minutes) and period C (144 ± 44 minutes; $P = 0.04$).

Days of hospitalization decreased as the time progressed (Table 2). Overall, 30 (6.9%) of the 434 patients experienced postoperative complications, with 14 (3.2%) experiencing low-grade complications and 16 (3.7%) high-grade complications. The frequency of postoperative complications did not differ between the TLH (20/269 [7.4%]) and LSH (10/165 [6.1%]) groups ($P = 0.553$). Among the cases of postoperative complications, 21 (70.0%) occurred after procedures performed by

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