Primary and Repeated Surgeries for Ectopic Pregnancies and Distribution by Patient Age, Surgeon Age, and Hospital Levels: An 11-Year Nationwide Population-Based Descriptive Study in Taiwan

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ABSTRACT

Study Objective: To describe the changing trend, repeat operation rate, and distribution of laparoscopy, as compared with laparotomy, in treating ectopic pregnancy, according to patient age, preoperative conditions, surgeon age, and hospital accreditation level, in Taiwan over 11-years.

Design: Retrospective cohort study (Canadian Task Force classification II-2).

Setting: Population-based nationwide insurance database.

Patients: Women who underwent either laparotomy or laparoscopy because of ectopic pregnancy.

Interventions: Women who had National Health Insurance (NHI) underwent various surgical procedures to treat ectopic pregnancy. Data for this study were obtained from the Inpatient Expenditures by Admissions files of the NHI Research Database, released by the NHI program in Taiwan between 1997 and 2007.

Measurements and Main Results: A total of 43,170 women with 44,928 operations were identified. Only the primary surgeries, via either laparotomy or laparoscopy, performed because of ectopic pregnancy were included for analysis. The annual number of procedures to treat ectopic pregnancies decreased in the later years of the 11-year study. Laparotomy decreased significantly, from 81.2% in 1997 to 26.2% in 2007, whereas laparoscopic procedures increased significantly, from 18.8% in 1997 to 73.8% in 2007, as evidenced at log-linear regression analysis (p < .001). The rate of repeat operations because of persistent ectopic pregnancy was higher in the laparoscopy group than in the laparotomy group (0.38% vs 0.14%; p < .001). Patients were more likely to undergo the same type of operation for the repeated surgery (i.e., laparotomy to laparotomy in 73.1% or laparoscopy to laparoscopy in 80.2%; p = 0.43). Use of laparoscopy (58.1%) and laparotomy (41.9%) differed according to patient age, preoperative comorbidities, surgeon age, and hospital accreditation level and ownership type. With older patients, those with preoperative anemia or shock, and elder surgeons, there was a greater chance that laparotomy would be performed. The probability of undergoing laparotomy was greater in patients in regional hospitals, local hospitals, and office-based clinics compared with those in medical centers.

Conclusions: There has been considerable change in the type of surgical approach used to treat ectopic pregnancy in Taiwan over the past 11 years. Laparoscopy is preferred to laparotomy, and has become the standard surgical approach to treating ectopic pregnancies in Taiwan. However, laparoscopy is associated with a higher rate of repeat operations. The laparoscopic Supported by grants CMFHR10027 and CMFHR 10079 from Chi Mei Foundation Hospital (M.-P.W).

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Drs. M.-I. Hsu and Tang contributed equally to this work.

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Ectopic pregnancy, which accounts for approximately 1.5% to 2.0% of all pregnancies [1,2], is a common and serious condition with considerable health risks in women of reproductive age [3]. The incidence of ectopic pregnancy in the United States increased from 0.5% in 1970 to 2.0% in 1992 [2,4], and has remained stable thereafter [5]. Women with ectopic pregnancies are at risk of subsequent infertility and recurrence [3]. The risk of recurrence of ectopic pregnancy is approximately 10% in women with 1 previous ectopic pregnancy, and at least 25% in women with ≥2 previous ectopic pregnancies [6]. The associated mortality markedly decreased to 0.5 deaths per 1000 pregnancies, primarily because of early diagnosis and treatment before rupture [2]. Nevertheless, ruptured ectopic pregnancies continue to occur, often because patients, and sometimes clinicians, do not recognize the early signs and symptoms of the condition [7]. Early diagnosis has led to the development of minimally invasive surgical and nonsurgical options. The choice of treatment, including expectant, medical, and surgical management, depends on the location of the ectopic pregnancy, symptoms, gestational age, and desire to preserve fertility [3].

Despite remarkable advances in diagnosis and treatment, ectopic pregnancies still account for 9% of all maternal deaths [8]. It is the leading cause of pregnancy-related death in women in the first trimester of pregnancy [9]. Although unruptured ectopic pregnancies can be treated via intramuscular administration of methotrexate (a folic acid antagonist) [10,11], surgical intervention is still the mainstay treatment, especially when a woman is not a good candidate for medical therapy [12,13]. Minimally invasive surgery to treat gynecologic diseases has increased during the past few decades [14,15]. The popularity of minimally invasive approaches may also profoundly affect the surgical choice for treatment of ectopic pregnancy. The advantages of surgical treatment include less time for resolution of an ectopic pregnancy and avoidance of the need for prolonged monitoring [13]. Surgical treatment of an ectopic pregnancy may also affect the prognosis for subsequent fertility [3]. However, the laparoscopic approach is associated with a higher failure rate [16].

With our previous experience in analyzing the changing trend in gynecologic surgical procedures [14], the primary objective of this 11-year population-based nationwide study was to describe the changing trend in surgeries performed to treat ectopic pregnancies, based on National Health Insurance (NHI) claims data in Taiwan. Secondary objectives were to evaluate the rate of repeat operations for laparoscopy or laparotomy, and the effect of primary surgery on the choice of repeated surgical procedure; and to evaluate related variables including patient age, preoperative comorbidities (e.g., anemia due to acute blood loss or hemorrhagic shock), surgeon age and sex, and hospital data where the surgical procedures were performed including accreditation (medical center, regional hospital, local hospital, office-based clinics) and ownership (government-owned, nonprofit, and private).

**Materials and Methods**

*NHI Program in Taiwan*

The NHI has been described in detail in our previous work [14]. In brief, the NHI program in Taiwan began in 1995, and is characterized by its comprehensiveness and universality. The benefit package of the NHI includes preventive medicine, dental care, outpatient and inpatient services, prescription drugs, and Chinese traditional herbal remedies. Approximately 93.1% of the total population in Taiwan had NHI in 1996, which increased to 99.3% in 2007. Between1996 and 2007, approximately 96.2% of hospitals in Taiwan were under contract with the Bureau of NHI (BNHI) [17].

**Data Sources**

The data used in the present study were obtained from the NHI Research Database (NHIRD). The NHIRD was established by the National Health Research Institute, in cooperation with the BNHI, with the objective of promoting research on current and emerging medical issues in Taiwan. Three sets of files from the NHIRD were used in the present study. First, inpatient expenditures by admission contains information on all NHI-reimbursed hospital discharges including inpatient characteristics, dates of admission and discharge, 1 major and 4 minor diagnosis codes (*International Classification of Diseases, 9th revision, Clinical Modification* [ICD-9-CM]), 1 major and 4 minor surgery codes, and ownership of the medical facility. Second, the registry of medical facilities under contract provides data on each medical institution’s accreditation level and geographic...
location. Third, the registry of medical personnel consists of data including each medical professional’s date of birth, sex, type of profession, and specialties. Confidentiality was assured by abiding by the data regulations of the BNHI, and international review board approval was waived.

**Study Participants**

The study included women with a diagnosis of ectopic pregnancy who underwent surgical procedures in Taiwan between January 1, 1997, and December 31, 2007. The diagnoses used to identify patients with ectopic pregnancy included ruptured ectopic pregnancy (ICD-9-CM code 633), abdominal or intraperitoneal pregnancy (code 633.0), tubal pregnancy, fallopian tube pregnancy, rupture of a fallopian tube due to pregnancy, or tubal abortion (code 633.1), ovarian pregnancy (code 633.2), other ectopic pregnancy including cervical intraligamentous, combined mesometric, or cornual mural pregnancy (code 633.8), and unspecified ectopic location (code 633.9). Women with a diagnosis of ectopic pregnancy who had undergone various surgical procedures, either at laparotomy (surgical code without 54.21) or laparoscopy (surgical code with 54.21), were recruited for the study. Surgical approaches to ectopic pregnancy included salpingotomy (code 66.01), salpingostomy (code 66.02), salpingectomy with removal of a tubal pregnancy (code 66.62), and removal of an ectopic pregnancy (code 74.3).

**Variables**

Repeat operation because of persistent ectopic pregnancy is defined as repeated surgery performed within 3 months after the primary surgery, and repeat operation because of recurrent ectopic pregnancy is defined as repeated surgery ≥3 months after the primary surgery. Variables used in this study include the following 3 categories: (1) patient characteristics including age and preoperative comorbidities including anemia due to acute blood loss (ICD-9-CM code 285.1) and hemorrhagic shock (code 785.59); (2) surgeon characteristics such as age and sex; and (3) hospital characteristics including accreditation level and ownership. Patients were divided into five 5-year age groups ranging from <25 to ≥40 years. Surgeon age was divided into six 5-year age groups ranging from <35 to ≥55 years. In Taiwan, hospitals are accredited by the Taiwan Joint Commission on Hospital Accreditation, which is supervised by the Department of Health, Executive Yuan (Taiwan), and classified into 3 levels (medical centers, regional hospitals, and local hospitals) on the basis of health care quality, medical teaching ability, clinical capabilities, and bed capacity. In addition, office-based clinics can also perform some gynecologic surgical procedures, with insurance coverage. Hospital ownership was classified as nonprofit hospitals, government-owned hospitals, and private hospitals.

**Statistical Analysis**

Log-linear regression was used to identify yearly trends for the 2 types of surgeries (i.e., laparotomy and laparoscopy) performed during the study. We determined the statistical significance of regression coefficients with 2-sided \(t\) tests [18]. The Pearson \(\chi^2\) test was used to examine differences in the distributions of the 2 types of surgeries, according to patient age, preoperative status, surgeon age and sex, and hospital accreditation and ownership. Multivariable logistic regression was used to examine the independent effects of individual variables in choosing open laparotomy to treat ectopic pregnancies. Statistical significance was determined at \(p < .05\). All analyses were performed using commercially available software (SAS for Windows, version 9.13; SAS Institute, Inc., Cary, NC).

**Results**

**Overall Trend Changes in Surgical Procedures**

A total of 43 170 women with 44 928 operations were identified. Only the primary surgeries at either laparotomy or laparoscopy to treat an ectopic pregnancy were included in the analysis. The total number of procedures for ectopic pregnancies annually decreased in the last few years of the 11-year study. The surgical trend for ectopic pregnancies dramatically changed during the study. The incidence of laparoscopy increased by 2.9-fold, from 18.8% in 1997 to 73.8% in 2007, whereas the incidence of laparotomy decreased, from 81.2% in 1997 to 26.2% in 2007 (Fig. 1). The changing trend toward increased laparoscopy, accompanied by decreased laparotomy, was evidenced at log-linear regression. The mean annual change was 8.5% (standard deviation [SD] 3; 95% confidence interval [CI], 1.4 to 15.5; \(p = .02\)) for laparoscopy, and −10.8% (SD, 0.69%; 95% CI, −12.4 to −9.3; \(p < .001\)) for laparotomy.

**Effect of Primary Surgery on the Choice for Repeated Surgery Because of Either Persistent or Recurrent Ectopic Pregnancy**

After the primary surgery in the 43 170 women, 1694 women were admitted for repeat surgery. The repeat operations were performed because of either persistent or recurrent ectopic pregnancy according to the interval after the primary surgery (Table 1). One hundred twenty-two women (0.28%) with persistent ectopic pregnancy underwent repeat operation within 3 months. The rate of repeat operation because of persistent ectopic pregnancy was higher in the laparoscopy group (n = 96) than in the laparotomy group (n = 26) (0.38% vs 0.14%; \(p < .001\)). Most of the patients with persistent ectopic pregnancy underwent the same type of repeat operation (laparotomy to laparotomy or laparoscopy to laparoscopy), with rates of 73.1% (19 of 26) and 80.2% (77 of 96), respectively (\(p = .43\)).
A total of 1572 women (3.64%) required repeat operation because of recurrent ectopic pregnancy (>3 months). Contrary to the above findings, the rate of repeat operation because of recurrent ectopic pregnancy was higher in the laparotomy group than in the laparoscopy group (3.94% vs 3.43%; p<.005). The rates of using the same type of operation for the second operation for laparotomy and laparoscopy were 54.5% and 77.1%, respectively (p<.001). Both the laparoscopy and laparotomy groups exhibited a higher tendency to choose laparoscopy as the second operation. Patient age of the women who underwent repeat operations (persistent plus recurrent) is given in Table 2. Older women tended to undergo fewer repeat operations (p<.001).

Types of Surgery Among Various Patient Factors

Ratios of laparoscopy to laparotomy in different age groups significantly differed (p<.001) (Fig. 2). Younger women were more likely to undergo laparoscopy. Ratios of laparoscopy to laparotomy differed among various preoperative conditions (e.g., anemia due to acute blood loss, and/or shock; p<.001) (Fig. 2). Women with preoperative anemia and/or shock were less likely to undergo laparoscopy.

Types of Surgery by Surgeon Age and Sex

Ratios of laparoscopy to laparotomy among surgeon age groups significantly differed (p<.001) (Fig. 3). Younger surgeons were more likely to perform laparoscopy. Ratios of laparoscopy to laparotomy according to surgeon sex significantly differed (p<.001). Female surgeons were more likely to perform laparoscopy (Fig. 3).

Types of Surgery by Hospital Accreditation Levels and Ownership Types

Ratios of laparoscopy to laparotomy among hospital accreditation levels significantly differed (p<.001) (Fig. 4).
Laparoscopy was more likely to be performed in medical centers, followed by regional hospitals, local hospitals, and office-based clinics. Ratios of laparoscopy to laparotomy among various hospital ownership types significantly differed (p < .001). Laparoscopy was more likely to be performed in nonprofit hospitals, followed by government-owned and private hospitals (Fig. 4).

**Multivariable Logistic Regression Analysis for Laparotomy vs Laparoscopy**

To eliminate possible confounding factors, multivariable logistic regression was used to evaluate the association between individual variables and use of laparotomy to treat ectopic pregnancies (Table 3). Older patients (>40 years) had the highest possibility of undergoing laparotomy (odds ratio [OR], 1.12; 95% CI, 1.02–1.23), whereas women aged 25 to 29 years had the lowest possibility of undergoing laparotomy (OR, 0.90; 95% CI, 0.84–0.96) compared with younger patients (<25 years) (OR, 1.12–12.3; 95% CI, 4.4–14.3). Women who had anemia preoperatively were more likely to undergo laparotomy than were those in stable condition (OR, 4.95; 95% CI, 3.92–6.24). Older surgeons (>40 years) were more likely to perform laparotomy than were younger surgeons (<40 years) (OR, 1.15–1.60). Surgeon sex did not have a significant effect on choosing laparotomy.

Insofar as hospital accreditation, patients in regional hospitals (OR, 1.25; 95% CI, 1.18–1.32), local hospitals (OR, 2.83; 95% CI, 2.64–3.02), and office-based clinics (OR, 30.05; 95% CI, 30.33–33.04) were more likely to undergo laparotomy than were those in medical centers. Both

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**Table 3**

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. (%)</th>
<th>Repeat operation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>41 476</td>
<td>1694 (3.9)</td>
<td>43 170</td>
</tr>
<tr>
<td>Patient age, y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;25</td>
<td>7446 (94.3)</td>
<td>448 (5.7)</td>
<td>7894</td>
</tr>
<tr>
<td>25–29</td>
<td>10 983 (95.0)</td>
<td>578 (5.0)</td>
<td>11 561</td>
</tr>
<tr>
<td>30–34</td>
<td>12 018 (96.2)</td>
<td>469 (3.8)</td>
<td>12 487</td>
</tr>
<tr>
<td>35–39</td>
<td>8237 (97.9)</td>
<td>177 (2.1)</td>
<td>8414</td>
</tr>
<tr>
<td>≥40</td>
<td>2792 (99.2)</td>
<td>22 (0.8)</td>
<td>2814</td>
</tr>
</tbody>
</table>
less perioperative blood loss (79 vs 195 mL), shorter significantly shorter operation times (73 vs 88 minutes), et al [16] reported laparoscopic salpingostomy resulted in the standard treatment for managing ectopic pregnancies has some benefits over laparotomy [19]. Currently, it is well accepted that laparoscopic treatment of ectopic pregnancies resulted in a higher persistent trophoblast rate [20]. Two randomized controlled trials with 165 patients reported that laparoscopic salpingostomy was significantly less successful than laparotomy in eliminating tubal ectopic pregnancies (OR, 0.28; 95% CI, 0.09–0.86) because of a significantly higher persistent trophoblast rate (OR, 3.5; 95% CI, 1.1–11) [21,22]. Therefore, a prophylactic single intramuscular injection of methotrexate immediately postoperatively significantly reduced persistent trophoblasts after laparoscopic salpingostomy (relative risk, 0.89; 95% CI, 0.82–0.98; number needed to treat, 10) [20]. Another less common condition is extratubal secondary trophoblastic implants [23]. Peritoneal implants secondary to a tubal ectopic pregnancy or extratubal secondary trophoblastic implants occur rarely; the incidence is often underestimated or unknown. It can also be responsible for increase in beta-human chorionic gonadotropin titer after salpingectomy to treat ectopic tubal pregnancy [23].

The present study reported a higher repeat operation rate for laparoscopy over laparotomy performed to treat persistent ectopic pregnancy. This could be due to inadequate or incomplete removal of all of the gestational tissue and to a higher persistent trophoblast rate [20]. Two randomized controlled trials with 165 patients reported that laparoscopic salpingostomy was significantly less successful than laparotomy in eliminating tubal ectopic pregnancies (OR, 0.28; 95% CI, 0.09–0.86) because of a significantly higher persistent trophoblast rate (OR, 3.5; 95% CI, 1.1–11) [21,22]. Therefore, a prophylactic single intramuscular injection of methotrexate immediately postoperatively significantly reduced persistent trophoblasts after laparoscopic salpingostomy (relative risk, 0.89; 95% CI, 0.82–0.98; number needed to treat, 10) [20]. Another less common condition is extratubal secondary trophoblastic implants [23]. Peritoneal implants secondary to a tubal ectopic pregnancy or extratubal secondary trophoblastic implants occur rarely; the incidence is often underestimated or unknown. It can also be responsible for increase in beta-human chorionic gonadotropin titer after salpingectomy to treat ectopic tubal pregnancy [23].

Insofar as future fertility, approximately 30% of women treated because of an ectopic pregnancy later have difficulty in conceiving. The overall conception rate is approximately 66% regardless of treatment [24]. The rate of recurrent ectopic pregnancy is 5% to 20%; however, the risk increases to 32% in women who have had 2 consecutive ectopic pregnancies [24,25]. The present study reports a higher repeat operation rate for laparotomy compared with laparoscopy for recurrent ectopic pregnancy. This could be the consequence of more complications associated with laparotomy (e.g., postoperative pelvic adhesions) [26]. According to the literature, laparoscopic treatment resulted in a higher rate of intrauterine pregnancies (77% vs 66%)

### Table 3

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (95% CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient age, y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;25 Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25–29</td>
<td>0.90 (0.84–0.96)</td>
<td>.002</td>
</tr>
<tr>
<td>30–34</td>
<td>0.95 (0.89–1.02)</td>
<td>.15</td>
</tr>
<tr>
<td>35–39</td>
<td>1.03 (0.96–1.10)</td>
<td>.48</td>
</tr>
<tr>
<td>&gt;39</td>
<td>1.13 (1.03–1.25)</td>
<td>.01</td>
</tr>
<tr>
<td>Preoperative status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alone Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anemia</td>
<td>2.09 (1.84–2.38)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Shock</td>
<td>4.85 (3.84–6.13)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Surgee age, y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;35 Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35–39</td>
<td>0.99 (0.92–1.07)</td>
<td>.87</td>
</tr>
<tr>
<td>40–44</td>
<td>1.14 (1.06–1.24)</td>
<td>.001</td>
</tr>
<tr>
<td>45–49</td>
<td>1.34 (1.24–1.46)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>50–54</td>
<td>1.45 (1.32–1.60)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&gt;54</td>
<td>1.57 (1.40–1.76)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Surgeon sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1.06 (0.98–1.15)</td>
<td>.18</td>
</tr>
<tr>
<td>Hospital accreditation</td>
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</tr>
<tr>
<td>Medical center Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional hospital</td>
<td>1.27 (1.20–1.34)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Local hospital</td>
<td>2.85 (2.66–3.06)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Office-based clinic</td>
<td>30.61 (27.77–33.73)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hospital ownership</td>
<td></td>
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<tr>
<td>Government Reference</td>
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<tr>
<td>Nonprofit</td>
<td>0.54 (0.50–0.57)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Private</td>
<td>0.41 (0.38–0.44)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

CI = confidence interval; OR = odds ratio.

nonprofit hospitals (OR, 0.54; 95% CI, 0.51–0.57) and private hospitals (OR, 0.41; 95% CI, 0.38–0.44) were associated with fewer laparotomy procedures than were government-owned hospitals.

### Discussion

The present study offers observational data exhibiting a growing trend for using laparoscopy to treat ectopic pregnancies, in particular in the last few years of the 11-year study, as evidenced at log-linear regression. Before the advent of laparoscopy, salpingectomy via laparotomy was the standard treatment for managing ectopic pregnancies [19]. Currently, it is well accepted that laparoscopic treatment of ectopic pregnancies has some benefits over laparotomy [3]. The randomized trials reviewed by Hajenius et al [16] reported laparoscopic salpingostomy resulted in significantly shorter operation times (73 vs 88 minutes), less perioperative blood loss (79 vs 195 mL), shorter duration of hospital stay (1–2 vs 3–5 days), and shorter convalescence (11 vs 24 days). Laparoscopy is becoming the preferred surgical approach for treatment of ectopic pregnancies [16,20]. Laparotomy is reserved for use in patients with extensive intraperitoneal bleeding, intravascular compromise, or poor visualization of the pelvis at laparoscopy [13]. The present study confirmed the growing trend toward laparoscopy rather than laparotomy as the mainstay surgical option for treatment of ectopic pregnancies. The possible explanation for the decrease in total ectopic pregnancies is increased patient alertness and early diagnosis by the surgeons and the hospitals. A combination of highly sensitive pregnancy tests and transvaginal ultrasonography enables early and accurate diagnosis [3]. These lead to the feasibility of medical treatment using single or multiple doses of methotrexate [11,13,20]. Whether the actual incidence of ectopic pregnancy in Taiwan has decreased is unclear from the data. The incidence of ectopic pregnancy in the United States increased in the late 20th century, and remains stable at approximately 2% of all recognized pregnancies [5].

The present study reported a higher repeat operation rate for laparoscopy over laparotomy performed to treat persistent ectopic pregnancy. This could be due to inadequate or incomplete removal of all of the gestational tissue and to a higher persistent trophoblast rate [20]. Two randomized controlled trials with 165 patients reported that laparoscopic salpingostomy was significantly less successful than laparotomy in eliminating tubal ectopic pregnancies (OR, 0.28; 95% CI, 0.09–0.86) because of a significantly higher persistent trophoblast rate (OR, 3.5; 95% CI, 1.1–11) [21,22]. Therefore, a prophylactic single intramuscular injection of methotrexate immediately postoperatively significantly reduced persistent trophoblasts after laparoscopic salpingostomy (relative risk, 0.89; 95% CI, 0.82–0.98; number needed to treat, 10) [20]. Another less common condition is extratubal secondary trophoblastic implants [23]. Peritoneal implants secondary to a tubal ectopic pregnancy or extratubal secondary trophoblastic implants occur rarely; the incidence is often underestimated or unknown. It can also be responsible for increase in beta-human chorionic gonadotropin titer after salpingectomy to treat ectopic tubal pregnancy [23].

Insofar as future fertility, approximately 30% of women treated because of an ectopic pregnancy later have difficulty in conceiving. The overall conception rate is approximately 66% regardless of treatment [24]. The rate of recurrent ectopic pregnancy is 5% to 20%; however, the risk increases to 32% in women who have had 2 consecutive ectopic pregnancies [24,25]. The present study reports a higher repeat operation rate for laparotomy compared with laparoscopy for recurrent ectopic pregnancy. This could be the consequence of more complications associated with laparotomy (e.g., postoperative pelvic adhesions) [26]. According to the literature, laparoscopic treatment resulted in a higher rate of intrauterine pregnancies (77% vs 66%)
[24,27] and a lower rate of recurrent ectopic pregnancies (7% vs 17%) [24,28] as compared with laparotomy, irrespective of the type of tubal surgery. Therefore, laparoscopic surgery is regarded as a cost-effective surgical treatment of tubal ectopic pregnancies [16,29]. According to long-term follow-up in Cochrane Database Systematic Reviews, laparoscopic salpingostomy showed no evidence of a difference in the intrauterine pregnancy rate (OR, 1.2; 95% CI, 0.59–2.5); however, there was a nonsignificant tendency toward a lower rate of repeated ectopic pregnancy (OR, 0.47; 95% CI, 0.15–1.5) [16].

The present observational study is the first to report the effect of primary surgery on the choice of repeated surgical procedure. The same-type operation (laparotomy to laparotomy or laparoscopy to laparoscopy) was chosen for treatment of persistent ectopic pregnancy. This is understandable because both primary and repeated surgeries were performed by the same surgeon, with his or her own preference. Patients with recurrent ectopic pregnancy did not necessarily receive the same type of operation for the secondary operation because both the laparoscopy and laparotomy groups exhibited a higher tendency to choose laparoscopy as the repeat surgery. This reflects the changing trend toward minimally invasive surgery in Taiwan during the study.

In the present study, young women (<30 years) tended to undergo laparoscopy to treat ectopic pregnancies. This finding may be attributed to the higher expectations of quality of life in younger women, including self-esteem, body image, confidence, future fertility, and sexuality [30–33]. This result, in combination with the findings of our previous study [14] suggests that patient age should be taken into account when selecting an appropriate type of surgery. In addition, patients with preoperative medical conditions, especially those with shock, are less likely to undergo laparoscopic procedures. This finding may result from the nature of the emergency condition, which favors laparotomy because of its potentially shorter preparation time and less technical requirements [3]. Further studies are needed to confirm this hypothesis.

Younger surgeons (<40 years) tended to choose laparoscopy, as compared with older surgeons (> 40 years). Different training between surgeons at different ages may have contributed to this phenomenon. Eckert et al [34] reported that nationwide trends toward an increased use of minimally invasive endoscopic techniques in the United States were altering the operative experience of surgeons and residents in training. This trend may radically change the abilities and expectations in the field of general surgery. A similar condition was observed in the field of gynecology in Taiwan. Surgeon preferences are possibly significantly influenced by their training background. Although in our univariate analysis, female surgeons tended to perform more laparoscopic procedures, the sex effect was no longer statistically significant after controlling for surgeon age in our multivariable logistic regression model. The explanation for the conflicting results for the sex factor is that more female surgeons were in the younger age group.

Significant differences in choosing the surgical method for treatment of ectopic pregnancies were found in terms of different hospital accreditation levels and ownership types. In the present study, regional local hospitals and, in particular, office-based clinics performed fewer laparoscopic procedures than did medical centers. A plausible explanation for this finding is that the generalization of minimally invasive surgeries began in medical centers [35]. Various levels of hospital accreditation may have different specialized surgical training styles, including apprenticeship-style training, and curriculum- and case-based programs [36]. Therefore, the choice of surgical procedure depends to some extent on the hospital at which a patient is admitted [35,37]. Medical centers may have better equipment and sufficient medical staff, in particular at night and on holidays. Laparoscopy has become the standard approach for surgically managing ectopic pregnancies if adequate expertise and equipment are available [3]. Insofar as hospital ownership, nonprofit and private hospitals performed more laparoscopic procedures than did government-owned hospitals. This may have been due to the more-conservative and traditional characteristic of government-owned hospitals. This variability would, in turn, have implications for both patients and the surgical methods selected [37].

Limitations of the present study included the following, due to its retrospective observational nature. First, conversions from laparoscopy to laparotomy, for any reason, were not identified. Second, patients who were receiving medical treatment were not recruited into the study. Randomized trials comparing medical therapy with laparoscopic salpingostomy showed a nonsignificantly higher success rate with multiple-dose methotrexate (relative success rate, 1.8; 95% CI, 0.73–4.6) and a significantly lower success rate with single-dose methotrexate (relative success rate, 0.82; 95% CI, 0.72–0.94) compared with laparoscopic salpingostomy [16,20]. Third, the exact procedures performed were not specified (e.g., salpingectomy, salpingostomy, or salpingectomy). For tubal pregnancies, either linear salpingostomy or salpingectomy can be performed laparoscopically in most patients. For interstitial pregnancies, cornuostomy or cornual resection can often be performed laparoscopically [38]. Insofar as reimbursement for medical costs, the NHI program covers 98% of patients and 98% of hospitals; therefore, the effect of insurance coverage on the choice of surgical procedure may have been minor. Despite these limitations, the present study provides a descriptive analysis of surgeries to treat ectopic pregnancies, including surgical trends, repeat operation rate, patient age, preoperative comorbidities (e.g., anemia and/or shock), surgeon age and sex, and hospital accreditation and ownership.

The present study offers population-based nationwide observations of the popularity of laparoscopy over laparotomy
as the surgical approach to treatment of ectopic pregnancies. The repeat operation rate for persistent ectopic pregnancy was higher in the laparoscopy group as compared with the laparotomy group. Most patients underwent the same type of operation (laparotomy to laparotomy or laparoscopy to laparoscopy) for the repeat surgery because of persistent ectopic pregnancy. The surgical method depends on patient age and clinical status, surgeon experience and judgment, and the hospital where the operation is performed.

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References