Long-term Experience of Single-port and Multi-port Total Laparoscopic Hysterectomy in a Single Center

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Abstract. Background/Aim: Short-term feasibility and safety of single-port total laparoscopic hysterectomy (TLH) compared with conventional multi-port TLH have been previously demonstrated. However, recent studies are insufficient. This study aimed to analyze long-term data from our center to examine the current status of single-port and multi-port TLH. Patients and Methods: In 766 patients who received TLH from 2005 to 2019, 325 were single-port and 441 were multi-port. Inclusion criteria were benign and premalignant uterine diseases. To reduce the impact of treatment selection bias and potential confounding factors, inverse probability of treatment weighting was applied. Results: Single-port TLH showed significantly better clinical outcomes for hospital stay, operative time, hemoglobin decrease, and complication rate than the multi-port TLH after correction of biases. C-reactive protein increased after the single-port TLH. Conclusion: As laparoscopic surgical instruments and surgeon’s skill have been improved, some surgical outcomes have become significantly better in single-port TLH after long-term observation.

Hysterectomy is one of the most commonly performed surgeries in women worldwide. The first laparoscopic hysterectomy was reported in 1991, which was also the first single-port total laparoscopic hysterectomy (TLH) (1). Advances in laparoscopic surgical instruments and improved surgeon skills have enabled less invasive surgeries. Recently, laparoscopic hysterectomy has been established as the prevailing method for benign uterine diseases, such as adenomyosis and leiomyoma. With these advancements, single-port TLH emerged.

Since 2010, the feasibility and safety of single-port TLH have been compared with conventional multi-port TLH (2-4). Comparable clinical outcomes have been reported, including perioperative complications and hospital stays. These have also been demonstrated in some meta-analyses since 2016 (5-7). However, single-port TLH has not been a universal surgical method because of its uncomfortable manipulation and unclear benefits, such as postoperative pain scores or patient satisfaction (8).

Moreover, long-term studies on the feasibility and safety of single-port TLH are limited. In a recent study, the authors have reported significantly better cosmetic effects and comparable complications in the single-port TLH group within a mean follow-up period of 25 months (9). Thus, this study aimed to review and compare the long-term experience of single-port and multi-port TLH in our institute to evaluate their current status.

Patients and Methods

Patients. We retrospectively reviewed the data of 766 patients who received laparoscopic hysterectomy between January 2005 and May 2019 in two Kyungpook National University-affiliated hospitals. The inclusion criteria were benign and premalignant uterine diagnoses such as uterine fibroid, endometrial hyperplasia, and cervical dysplasia. The exclusion criteria were malignancy of the cervix, endometrium, or ovary. Patients without intraoperative information, such as operative time and uterine weight, were also excluded. The requirement for informed consent was waived owing to the retrospective design of the study, and this study was approved by the institutional review board of our institute (numbers: KNUCH 2020-04-021, KNUH-05-031).

Clinical factors and outcomes. The medical records were reviewed for clinical parameters, including age, gravidity, parity, body mass index, preoperative hemoglobin (Hb) level, previous pelvic operations, and uterine weight. Surgical outcomes were evaluated by reviewing the length of hospital stay, operative time, postoperative Hb decrease, C-
IBM SPSS Statistics (version 25; IBM, Armonk, NY, USA) was used for all analyses. Analysis of all variables was performed using a logistic regression, Fisher’s exact test, and continuous variables were compared using multivariate logistic regression analysis, and all covariates used to reduce the selection bias caused by the different operative methods between the two groups.

Correction of biases. To reduce the impact of treatment selection bias and potential confounding factors, we applied inverse probability of treatment weighting (IPTW) to the patient demographics (15, 16). The propensity score (PS) was estimated using multivariate logistic regression analysis, and all covariates were included to determine the PS values. With this technique, the weights for patients in the single-port TLH group were the inverse of 1−PS, and the weights for patients in the multi-port TLH group were the inverse of 1−PS. The PS matching method was used to reduce the selection bias caused by the different operative methods between the two groups.

Statistical analysis. Normally distributed continuous variables are reported as means and standard deviations. Summary statistics for categorical variables are reported using proportions and frequencies. Categorical variables were compared using the chi-square test or Fisher’s exact test, and continuous variables were compared using the two-sample t-test or Mann-Whitney U-test. A multivariate analysis of all variables was performed using a logistic regression model. IBM SPSS Statistics (version 25; IBM, Armonk, NY, USA) was used for all analyses.

Results

Among the 766 patients, 325 patients received single-port TLH, and 441 received multi-port TLH over the whole period. From February 2005 to December 2011, 382 (93.2%) of 410 patients received hysterectomy with multi-port surgery. From January 2012 to May 2019, 297 (83.4%) patients received hysterectomy with single-port surgery.

Uterine fibroids were the most common indication for hysterectomy in both groups, although the multi-port TLH group had significantly more cases [197 (60.6%) vs. 394 (89.3%), p<0.001]. Other indications included adenomyosis without leiomyoma, endometriosis, and uterine prolapse. Significant demographic differences were observed between the single-port TLH and multi-port TLH groups before weighting. However, after IPTW, some characteristics were controlled for, such as age, parity, preoperative Hb, and uterine weight (Table I).

The comparison of the surgical outcomes between the two methods is demonstrated in Table I. Comparing both weighted groups, single-port TLH was associated with significantly shorter hospital stay (p<0.001) and operative time (p<0.003), lower Hb decrease (p=0.002), and lower complication rate (p=0.004). However, the postoperative CRP level increased significantly in the single-port TLH group (p<0.001). Initially, the decrease in Hb was not significantly different, although it became significantly lower in the single-port TLH group after IPTW (Table I). The odds ratios and 95% confidence intervals for each surgical outcome were evaluated, and significant differences were observed in terms of hospital stay [p<0.001 (95%CI=0.571-0.708)], CRP level increase [p<0.001 (95%CI=1.247-1.405)], and complication rate [p<0.001 (95%CI=0.139-0.502)], whereas the operative time (p=0.146) and Hb decrease

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Table I. Demographic characteristics and surgical outcomes after correction of the biases with inverse probability of treatment weighting.

<table>
<thead>
<tr>
<th>Indications for hysterectomy [N (%)]</th>
<th>Before correction of biases</th>
<th>After correction of biases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single-port TLH* (N=325)</td>
<td>Multi-port TLH (N=441)</td>
</tr>
<tr>
<td>Uterine fibroid</td>
<td>197 (60.6%)</td>
<td>394 (89.3%)</td>
</tr>
<tr>
<td>Cervical dysplasia</td>
<td>109 (33.5%)</td>
<td>36 (8.2%)</td>
</tr>
<tr>
<td>Endometrial pathology</td>
<td>4 (1.2%)</td>
<td>9 (2.0%)</td>
</tr>
<tr>
<td>Others</td>
<td>15 (4.6%)</td>
<td>2 (0.4%)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>51.9±9.8</td>
<td>47.1±6.2</td>
</tr>
<tr>
<td>Gravida (N)</td>
<td>3.7±1.9</td>
<td>3.7±1.9</td>
</tr>
<tr>
<td>Parity (N)</td>
<td>2.1±0.9</td>
<td>1.9±0.9</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>24.2±3.7</td>
<td>23.9±3.3</td>
</tr>
<tr>
<td>Preoperative Hb (g/dl)</td>
<td>12.5±1.5</td>
<td>12.2±1.4</td>
</tr>
<tr>
<td>Pelvic operation history [N (%)]</td>
<td>83 (26%)</td>
<td>129 (29%)</td>
</tr>
<tr>
<td>Uterine weight (g)</td>
<td>257.6±235.2</td>
<td>361.2±205.7</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>3.4±1.3</td>
<td>4.2±1.5</td>
</tr>
<tr>
<td>Operative time (minutes)</td>
<td>80.8±32.2</td>
<td>94.7±35.6</td>
</tr>
<tr>
<td>Hb decrease (g/dl)</td>
<td>1.3±2.2</td>
<td>1.8±2.2</td>
</tr>
<tr>
<td>CRF increase (mg/dl)</td>
<td>3.1±2.5</td>
<td>2.0±1.7</td>
</tr>
<tr>
<td>Complications [N (%)]</td>
<td>10 (3%)</td>
<td>29 (7%)</td>
</tr>
</tbody>
</table>

Data are presented as number or mean±SD. N/A: Not analysed; CRP: C-reactive protein; Hb: Hemoglobin. *Total laparoscopic hysterectomy. **Statistically significant.
were not significantly different between both groups. After IPTW, the complication rate, which was initially not significant, became significantly lower in the single-port TLH group (Table II).

Discussion

In comparing the long-term perioperative outcomes between single-port TLH and multi-port TLH, significant differences for some characteristic factors, such as diagnosis and age, were identified. However, despite applying IPTW to correct biases, we could not control for the biases from the improvement in laparoscopic instruments and the surgeon skills. These might have influenced the significantly better clinical outcomes in the single-port TLH group, including the shorter hospital stay and operative time and lower Hb decrease and complication rates.

Here, the shorter hospital stay associated with single-port surgery could have resulted from fewer perioperative complications and the introduction of the concept of enhanced recovery after surgery in the 2010s (17). The shorter operative time could be influenced by advanced surgical devices or materials, such as vessel sealers and barbed sutures. The lower Hb decrease was possible with the improved vessel sealer, shorter operative time, and the non-requirement of additional lateral trocars.

Inferior epigastric arterial injury has been reported to occur in 2% of cases during the insertion of lateral trocars in multi-port TLH (18). In the subgroup analysis conducted on the complications after each surgical method, statistical significance was evaluated using Fisher’s exact test (Table III). Hemorrhage from the trocar site and bladder injury were more frequent in the multi-port TLH group, although the difference was not significant \( (p=0.076, p=0.148) \). Bowel injury included incisional laceration of the serosa or muscular layer of the rectum or sigmoid colon. Surgical site infection included stump disruption and abscess formation at the umbilicus or pelvic cavity. Other complications included ileus, pulmonary embolism, and fever of unknown origin, although no significant differences were observed in these perioperative complications. According to a previous study, an umbilical hernia can occur in 2.4% of patients undergoing single-site laparoscopic surgery (19). In a recent study that compared the long-term outcomes between the single-port

\[ \text{Table II. Logistic regression analysis for the data between single-port TLH and multi-port TLH after correction of the biases with inverse probability of treatment weighting.} \]

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\begin{array}{cccc}
\text{Before correction of biases} & \text{After correction of biases} \\
\text{Odds ratio} & 95\% \text{CI} & p\text{-Value} & \text{Odds ratio} & 95\% \text{CI} & p\text{-Value} \\
\hline
\text{Hospital stay (days)} & 0.634 & 0.572-0.703 & <0.001** & 0.636 & 0.571-0.708 & <0.001** \\
\text{Operative time (min)} & 1.000 & 0.997-1.004 & 0.879 & 0.997 & 0.993-1.001 & 0.146 \\
\text{Hb decrease (g/dl)} & 0.827 & 0.743-0.920 & <0.001** & 0.907 & 0.811-1.014 & 0.086 \\
\text{CRP increase (mg/dl)} & 1.311 & 1.239-1.387 & <0.001** & 1.324 & 1.247-1.405 & <0.001** \\
\text{Complications}^{+} (N) & 0.876 & 0.529-1.450 & 0.606 & 0.264 & 0.139-0.502 & <0.001** \\
\hline
\end{array}
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TLH: Total laparoscopic hysterectomy; CI: confidence interval; Hb: Hemoglobin; CRP: C-reactive protein. **Statistically significant. ‡Compared with multiport TLH.

\[ \text{Table III. Comparison of complication rates after single-port TLH and multi-port TLH.} \]

\[
\begin{array}{cccc}
\text{Single-port TLH} & \text{Multi-port TLH} & p\text{-Value} \\
\text{N=325} & \text{N=441} & \\
\hline
\text{Hemorrhage from trocar site [N (%)]} & 0 & 5 (1.1%) & 0.076 \\
\text{Bladder injury [N (%)]} & 1 (0.3\%) & 7 (1.6\%) & 0.148 \\
\text{Bowel injury* [N (%)]} & 2 (0.6\%) & 2 (0.5\%) & <1.000 \\
\text{Vaginal injury [N (%)]} & 0 & 3 (0.7\%) & 0.266 \\
\text{Ureteral injury [N (%)]} & 0 & 2 (0.5\%) & 0.511 \\
\text{Hemorrhage from stump [N (%)]} & 2 (0.6\%) & 2 (0.5\%) & <1.000 \\
\text{Surgical site infection}^{†} [N (%)] & 3 (0.9\%) & 6 (1.4\%) & 0.740 \\
\text{Others}^{‡} [N (%)] & 2 (0.6\%) & 2 (0.5\%) & <1.000 \\
\hline
\end{array}
\]

TLH: Total laparoscopic hysterectomy. *Included injury of rectal serosa. †Included formation of pelvic abscess, abscess in umbilical incision site. ‡Included fever of unknown origin, ileus.

\( (p=0.086) \) were not significantly different between both groups. After IPTW, the complication rate, which was initially not significant, became significantly lower in the single-port TLH group (Table II).
and conventional multi-port TLH, an umbilical hernia was discovered in two patients in the single-site surgery group (2/40), while this was not observed in the multi-port surgery group (0/40) (9). Considering its incidence, it may have occurred in the patients in this study as well, although we could not review such late complications because most patients were referred to local clinics postoperatively.

Despite the comparable complication rates, the postoperative serum CRP level was significantly higher in the single-port TLH group than in the multi-port TLH group. Hence, this may be due to the limited use of suction devices to drain bloody fluid from the intra-abdominal cavity. We used three ports as the main port for the single-port TLH, which enabled the simultaneous use of three types of instruments through one umbilical incision. To avoid collisions between the laparoscopic instruments or prolonged operative times, the surgeon should use the suction device as limited as possible. The bloody fluid may have remained in the abdominal cavity for a longer time because of the head-down lithotomy position, thereby resulting in a more severe inflammatory condition postoperatively.

Four meta-analyses comparing single-port hysterectomy with conventional laparoscopy were identified (5-8). In our study, the single-port and multi-port TLH had comparable complication rates, and the odds ratio, before the correction of biases, was also similar to that of the two meta-analyses (7, 8). Two meta-analyses of randomized controlled trials have reported that the operative time may be comparable or significantly longer in the single-port group (5, 6); however, it was significantly shorter in our study. This discrepancy could have been enabled by the advanced laparoscopic surgical instruments and improvements in the surgeon skills.

This study has some limitations. First, this study was retrospectively conducted using long-term data. Second, the comparison between the two surgical techniques might not be appropriate for generalization because of some confounding factors. Last, the late complications of single-port TLH were evaluated because only the complications during and immediately after the operations were reviewed.

Conclusion

This study showed that some surgical outcomes have become significantly better in single-port TLH compared to multi-port TLH after long-term observation as laparoscopic surgical instruments and surgeon’s skill have been improved. Not only certain surgical outcomes such as operative time, but also hospital stay or complication rate can be achieved with single-port TLH for benign uterine diseases. This is enabled by advances in laparoscopic surgical instruments such as camera, vessel sealer, or barbed suture material, as well as advances in patient management or surgeon’s proficiency. A skilled gynecologic laparoscopist can perform a single-port TLH with clinical outcomes comparable to those of conventional multi-port TLH. Single-port TLH will be able to replace many parts of multi-port TLH.

Conflicts of Interest

The Authors have no conflicts of interest to disclose in relation to this study.

Authors’ Contributions

YS Lee conceived the study. DG Hong supervised the study. YS Lee processed the clinical data and performed analytic calculations. J Lee designed the tables. All Authors drafted the manuscript and contributed to the final manuscript.

References


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