

Editorial

Beyond LACC: Is There Still a Role for Minimally Invasive Surgery in Early-Stage Cervical Cancer?

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The Laparoscopic Approach to Cervical Cancer (LACC) trial [1] marked a major turning point in the management of early-stage cervical cancer and reshaped contemporary surgical practice worldwide. Before the publication of the LACC trial, minimally invasive surgery (MIS) was increasingly adopted for radical hysterectomy owing to its favorable perioperative profile, characterized by lower surgical morbidity, shorter hospital stay, and more rapid postoperative recovery. Retrospective studies and meta-analyses initially suggested comparable oncologic outcomes between MIS and laparotomy, supporting the widespread implementation of MIS in gynecologic oncology practice [2,3,4,5,6]. By 2017, the proportion of radical hysterectomies performed via MIS in the United States had reached about 75% [7]. This paradigm was challenged in 2018 when the randomized multicenter LACC trial reported significantly worse disease-free survival (DFS) and overall survival (OS) among patients undergoing MIS than among those undergoing laparotomy [1]. The trial enrolled 631 patients with stage IA1 (with lymphovascular invasion), IA2, or IB1 cervical cancer and reported a 4.5-year DFS of 86% in the MIS group vs. 96.5% in the laparotomy group (hazard ratio [HR] for disease recurrence or death, 3.74; 95% confidence interval [CI], 1.63–8.58). The 3-year OS was 93.8% vs. 99.0%, respectively (HR for death from any cause, 6.00; 95% CI, 1.77–20.30). In 2024, the final analysis of the LACC trial confirmed these findings with extended follow-up, reporting a 4.5-year DFS of 85.0% vs. 96.0% (HR, 3.91; 95% CI, 2.02–7.58; $p = 0.001$) and a 4.5-year OS of 90.6% vs. 96.2% (HR, 2.71; 95% CI, 1.32–5.59; $p = 0.007$) [8].

Those findings were rapidly reinforced by population-based analyses. Melamed et al. [9] reported a decline in 4-year relative survival associated with the adoption of MIS in the United States, with a 4-year mortality of 9.1% among women who underwent MIS compared with 5.3% among those who underwent open surgery (HR, 1.65; 95% CI, 1.22–2.22; $p = 0.002$). A subsequent systematic review and meta-analysis by Nitecki et al. [10] further corroborated those results, confirming that MIS was associated with a

higher risk of recurrence and death than was laparotomy, in real-world settings. Consequently, major international societies, including the European Society of Gynaecological Oncology (ESGO) and the National Comprehensive Cancer Network (NCCN), modified their recommendations and currently consider open radical hysterectomy the standard and recommended surgical approach for patients with early-stage cervical cancer [11,12]. After the LACC trial, the proportion of minimally invasive radical hysterectomies in the United States decreased dramatically, from 75.3% in 2017 to 11.4% in 2022 [7].

Despite this major paradigm shift, interest has persisted in understanding whether specific technical modifications, protective surgical strategies, and strict patient-selection criteria could potentially improve the oncologic safety of minimally invasive approaches in highly selected settings. One of the most discussed aspects concerns the interpretation of the LACC findings and whether the poorer oncologic outcomes are intrinsically related to the minimally invasive approach or rather to specific technical factors associated with surgical execution. The biological and technical reasons responsible for the poorer outcomes observed after MIS are uncertain and continue to be the subject of ongoing investigation. These include tumor dissemination associated with the use of uterine manipulators, exposure of the cervical tumor during intracorporeal colpotomy under CO₂ pneumoperitoneum with steep Trendelenburg positioning, and variability in surgeon experience and surgical standardization [11]. Additional considerations regarding the interpretation of the LACC findings include the lack of mandatory preoperative imaging assessment and the absence of standardized tumor-containment protocols.

In response to the concerns raised after LACC, several investigators have explored operative modifications intended to reduce the risk of intraoperative tumor dissemination. Proposed strategies have included manipulator-free surgery, vaginal closure before colpotomy, minimization of cervical manipulation, and protected specimen retrieval, all of which aim to reduce exposure of tumor tissue during the surgical procedure. A systematic review and meta-



analysis by Song et al. [13] (2024), including eight retrospective cohort studies with 2020 patients, reported no statistically significant differences in recurrence-free survival and overall survival compared with open surgery, although the included studies were retrospective and heterogeneous (pooled HR, 0.88 and 0.78, respectively). Similarly, a meta-analysis by Kampers et al. [14] showed that the application of protective measures (specifically, avoidance of uterine manipulators combined with vaginal colpotomy) was associated with more favorable DFS outcomes than were conventional minimally invasive approaches without protective measures. Nevertheless, current evidence is predominantly retrospective and potentially affected by important confounding factors, including selection bias, tumor-size imbalance, surgeon experience, institutional surgical volume, preoperative conization status, histologic subtype, margin status, and differences in adjuvant treatment strategies. Therefore, those findings remain insufficient to support the routine implementation of minimally invasive radical hysterectomy in clinical practice.

Another important issue concerns patient selection. Increasing attention has focused on tumor size as a potential determinant of oncologic risk after minimally invasive radical hysterectomy. The European SUCCOR study, a large European retrospective cohort study of 693 weighted patients with stage IB1 cervical cancer, demonstrated that MIS was associated with a 2.07-fold higher risk of recurrence (HR, 2.07; 95% CI, 1.35–3.15; $p = 0.001$) and a 2.45-fold higher risk of death (HR, 2.45; 95% CI, 1.30–4.60; $p = 0.005$) than was laparotomy [15]. Critically, however, the SUCCOR study also showed that patients who underwent MIS without a uterine manipulator were not significantly different, in DFS, from the open surgery group (HR, 1.58; 95% CI, 0.79–3.15; $p = 0.20$), and those who underwent MIS with protective vaginal closure were not significantly different, in relapse rates, from those with open surgery (HR, 0.63; 95% CI, 0.15–2.59; $p = 0.52$). The recently published SUCCOR 10-year update, analyzing 556 patients with extended follow-up, found no significant differences in 10-year DFS (92% for MIS vs. 88% for open; $p = 0.12$) or 10-year OS (92% vs. 88%; $p = 0.12$) between surgical approaches [16]. However, those findings should be interpreted with caution and within the context of the broader post-LACC literature. Unlike the original SUCCOR analysis, which demonstrated significantly worse oncologic outcomes associated with MIS, the 10-year update included a smaller cohort with longer follow-up intervals and may have been influenced by selection bias, differences in patient characteristics, treatment allocation, surgeon expertise, and loss of statistical power over time. Moreover, retrospective observational studies are inherently subject to residual confounding despite statistical adjustment. Therefore, the apparent absence of long-term survival differences in the SUCCOR update did not invalidate the findings of the LACC trial or the overall body of evidence supporting open

radical hysterectomy as the current standard approach. Several retrospective studies and subgroup analyses have further suggested that patients with tumors smaller than 2 cm may experience oncologic outcomes comparable to those observed after open surgery [13].

A multicenter study by Zhang et al. [17] demonstrated that among International Federation of Gynaecology and Obstetrics (FIGO) 2018 stage IA1-IB1 patients with low-risk cervical cancer (tumor ≤ 2 cm, $\leq 1/2$ stromal invasion, no lymph node involvement), laparoscopic radical hysterectomy showed no statistically significant differences in 5-year OS and PFS, compared with open surgery (98.6% vs. 99.3%, $p = 0.571$; 97.6% vs. 98.4%, $p = 0.418$, respectively). Those findings suggested that further investigation of minimally invasive approaches in carefully selected low-risk patients may be warranted; however, current evidence is insufficient to support routine clinical adoption.

Importantly, the contemporary discussion regarding low-risk early-stage cervical cancer is no longer limited to the comparison between minimally invasive and open radical hysterectomy, but also includes the possibility of surgical de-escalation [18]. The recently published SHAPE trial demonstrated that simple hysterectomy was not inferior to radical hysterectomy in terms of pelvic recurrence at 3 years (2.52% vs. 2.17%; absolute difference, 0.35 percentage points; 90% CI, -1.62 to 2.32) among selected patients with low-risk early-stage cervical cancer (FIGO 2009 stage IA2 or IB1, lesions ≤ 2 cm), but was associated with significantly lower rates of urinary morbidity and improved postoperative quality of life across multiple domains, including sexual-vaginal functioning, body image, and symptom experience [19]. Collectively, these results indicated that treatment individualization and accurate risk stratification may be more important than the choice of surgical access alone.

The potential role of robotic-assisted surgery also deserves consideration. The introduction of robotic platforms has generated interest because of their ability to enhance surgical ergonomics, instrument articulation, and three-dimensional visualization. Nevertheless, to date, evidence has not conclusively demonstrated better oncologic outcomes for robotic surgery than for standard laparoscopy in cervical cancer. At present, there is no high-level prospective evidence demonstrating that robotic-assisted radical hysterectomy overcomes the oncologic disadvantages associated with minimally invasive surgery observed in the LACC trial. Therefore, robotic surgery should still be considered within the broader context of MIS-related oncologic concerns. Whether robotic technology can mitigate the oncologic concerns observed after the LACC trial is uncertain. The ongoing multicenter, prospective, randomized, noninferiority Robotic Versus Open Surgery for Early-Stage Cervical Cancer (ROCC)/Gynecologic Oncology Group (GOG)-3043 study (NCT04831580) was specifically conceived to evaluate that question [20,21]. The

study incorporated strict surgical standardization measures, including mandatory preoperative pelvic magnetic resonance imaging (MRI), prohibition of transcervical uterine manipulators, standardized tumor-containment techniques with photographic documentation, and surgeon credentialing requirements. However, no oncologic outcome data from the ROCC/GOG-3043 trial are yet available; therefore, whether robotic-assisted radical hysterectomy can overcome the oncologic concerns associated with minimally invasive surgery remains unknown. Results are expected by 2030 and will be important to further clarify the oncologic safety of robotic-assisted radical hysterectomy.

The consequences of the LACC trial have extended beyond patient outcomes and have also affected the evolution of surgical training programs worldwide. A nationwide survey in Germany revealed that despite high awareness of the LACC trial results and recognition of their scientific quality, 40% of gynecological cancer centers were initially reluctant to change their standard of care to open surgery [22]. In many institutions, minimally invasive radical hysterectomy has been almost completely abandoned, resulting in reduced opportunities for surgical training in complex laparoscopic oncologic procedures. Although patient safety and adherence to currently recommended guidelines must remain the priority, ongoing scientific evaluation at expert centers may still be important for a better understanding of whether specific minimally invasive strategies can be optimized in the future. Notably, the shift toward open surgery has been associated with higher rates of minor complications, including blood transfusion (9.8% vs. 7.3%) and superficial surgical site infections (3.9% vs. 1.1%), although major complication rates have remained similar [7]. This issue is particularly relevant for maintaining advanced surgical expertise and supporting future prospective evaluation of standardized minimally invasive techniques within experienced referral centers.

Open surgery remains the standard approach according to current international guidelines. Minimally invasive radical hysterectomy should not currently be considered routine clinical practice and, if performed, should be restricted to highly selected patients treated in experienced, high-volume centers that adopt standardized tumor-containment strategies and rigorous, shared decision-making, ideally within the context of prospective clinical trials or structured registry-based evaluation. Importantly, patients considered for minimally invasive radical hysterectomy should receive detailed counseling on the currently available evidence, including the oncologic concerns raised after the LACC trial and the lack of definitive prospective data demonstrating oncologic equivalence to open surgery. In this context, minimally invasive approaches should preferably be limited to prospective clinical trials or structured institutional registries conducted in experienced referral centers. A recent consensus statement by the Society of Gynecologic Oncology (SGO), Ameri-

can College of Obstetricians and Gynecologists (ACOG), American Society for Colposcopy and Cervical Pathology (ASCCP), American Society for Radiation Oncology (ASTRO), and American Brachytherapy Society (ABS) stated that open radical hysterectomy remains the preferred surgical approach pending additional prospective evidence. The consensus document recommended transparent patient counseling that addresses both the perioperative benefits of MIS and the unresolved questions concerning oncologic outcomes [23]. Nevertheless, some important clinical and technical questions remain incompletely resolved and continue to warrant careful scientific investigation. The identification of low-risk patient subgroups, the implementation of standardized oncologic protective maneuvers, and the development of prospective studies evaluating optimized minimally invasive techniques may further clarify whether minimally invasive strategies can achieve acceptable oncologic safety in carefully selected patients under highly standardized conditions.

In conclusion, the LACC trial represented a major turning point in gynecologic oncology and appropriately led to the re-establishment of open radical hysterectomy as the standard surgical approach for early-stage cervical cancer. Although ongoing research is exploring whether standardized tumor-containment strategies and strict patient selection can improve the safety of minimally invasive approaches, current evidence does not support the routine use of minimally invasive radical hysterectomy in clinical practice. Any potential role for minimally invasive radical hysterectomy should currently remain limited to carefully selected patients managed in experienced high-volume centers, preferably within prospective clinical trials or registry-based evaluation programs. The results of ongoing prospective trials such as ROCC/GOG-3043, together with continued investigation into surgical standardization, quality control, and precise patient selection, will be essential to determine whether selected minimally invasive approaches can achieve acceptable oncologic safety under rigorously standardized conditions.

Abbreviations

ABS, American Brachytherapy Society; ACOG, American College of Obstetricians and Gynecologists; ASCCP, American Society for Colposcopy and Cervical Pathology; ASTRO, American Society for Radiation Oncology; CI, confidence interval; DFS, disease-free survival; ESGO, European Society of Gynaecological Oncology; FIGO, International Federation of Gynaecology and Obstetrics; GOG, Gynecologic Oncology Group; HR, hazard ratio; LACC, Laparoscopic Approach to Cervical Cancer; LVSI, lymphovascular space invasion; MIS, minimally invasive surgery; MRI, magnetic resonance imaging; NCCN, National Comprehensive Cancer Network; OS, overall survival; PFS, progression-free survival; ROCC, Robotic Versus Open Surgery for Early-Stage Cervical Cancer; SGO, Society of Gynecologic Oncology.

Author Contributions

SF and FB conceived and designed the study. SF, FB, and VGV contributed to the literature review and interpretation of the data. SF drafted the manuscript. FB and VGV critically revised the manuscript for important intellectual content. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

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During the preparation of this work the authors used ChatGPT-3.5 in order to check spelling and grammar. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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