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The potential for de-escalation radical surgery in women with stage IB2 cervical cancer (FIGO 2018): a multi-institutional experience of 63,926 cases over a 14-year period in China

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Abstract

Objective To compare the long-term survival outcomes, recurrence patterns and morbidity of type B and type C radical hysterectomy (RH) for stage IB2 cervical cancer (FIGO 2018).

Methods Based on FOUR-C database, patients who underwent type B or C RH in 47 hospitals from 2004 to 2018 were reviewed. Univariate and multivariate analyses were performed to compare 5-year overall survival (OS) and recurrence-free survival (RFS), recurrence patterns and morbidity between the two groups after propensity score matching (PSM).

Results A total of 1308 patients were enrolled in this study, 840 and 468 patients underwent type B and type C. There was no difference in 5-year survival outcomes between groups type B and type C, either before or after matching (OS: unmatched 95.6% vs. 93.3%, matched 95.6 vs. 93.0%, $P>0.05$; RFS: unmatched: 90.5% vs. 90.1%, matched: 91.2% vs. 89.7%, $P>0.05$). Type B group had a shorter operative time, less blood loss, earlier recovery of intestinal function, eariler removal of catheter and shorter hospitalization ($P<0.01$). Intraoperative complications were similar (0.1% vs. 0.2%, $P>0.05$), but postoperative complications occurred more frequently in the type C group (8.3% vs. 12.1%, $P<0.05$), especially lymphocysts and urinary retention. The surgical dissection does not appear to influence tumor recurrences significantly ($P>0.05$).

Conclusions For cervical cancer patients with stage IB2, type B RH demonstrated comparable long-term oncological outcomes and recurrence patterns to type C RH, while being associated with fewer intra-and postoperative complications. Type B RH is a feasible and appropriate surgical option, but the conclusions need to be confirmed by prospective studies.

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Keywords Cervical cancer, IB2, Type B, Type C, Complications, Recurrence

Introduction

Cervical cancer is the fourth most common cancer among women worldwide, with approximately 570,000 new cases and 311,000 deaths annually [1]. Fortunately, most early-stage patients can achieve a cure rate of 80–95% with timely surgical treatment [2–4]. However, surgical treatment often causes tissue damage and complications, making it crucial for gynecologic oncologists to balance precision treatment with minimizing harm.

The 2018 FIGO staging system reclassified stage IB into IB1, IB2, and IB3, excluding lymph node-positive cases. While postoperative pathological risk factors for stage IB cervical cancer have decreased, the treatment guidelines remain consistent, with abdominal QM type C radical hysterectomy (RH) still recommended for IB2 stage [5, 6]. Type C RH is technically complex and requires advanced skills, with extensive parametrial resection increasing risks like bladder, rectal, and sexual dysfunction, significantly impacting patients' quality of life [7–9].

Prior studies have shown that early-stage cervical cancer carries a low risk of parametrial invasion (5.4-25%), suggesting that the extensive resection in Type C RH may result in overtreatment, whereas Type B RH, with its more conservative resection, achieves comparable oncological outcomes [10–12]. However, existing studies have analyzed early-stage cervical cancer patients as a homogeneous group, including cases with larger tumor diameters (> 4 cm) or positive lymph nodes, while lacking specific research focused on patients with tumor diameters of 2.1–4 cm [13–15]. Moreover, a limited number of studies focusing on this subgroup have reported inconsistent conclusions [4, 16]. And these studies frequently lack a comprehensive assessment of recurrence rates as well as intra- and postoperative complications. While the NCCN guidelines recommend laparotomy as the standard surgical approach [6], many studies have utilized alternative surgical approaches, including laparoscopy, transvaginal, and robotic techniques, potentially affecting the reliability of the findings.

Therefore, utilizing the Chinese Cervical Cancer Clinical Treatment Project Database (FOUR C), this study compares the oncological outcomes, recurrence patterns, and intra-and postoperative complications between abdominal QM-B and QM-C surgeries in patients with stage IB2 (FIGO 2018) cervical cancer across 47 hospitals in mainland China from 2004 to 2018. The study aims to evaluate the feasibility and safety of de-escalation surgery for stage IB2 cervical cancer patients.

Materials and methods

Data source

This study was a large-sample, multicenter, retrospective study. The Four C database included a total of 63,926 patients with cervical cancer from 47 hospitals in mainland China between 2004 and 2018. The study was approved by the Ethics Committee of Nanfang Hospital of Southern Medical University (Ethics No. NEEC-2017-135) and registered under the International Clinical Trial Registration No. CHiCTR1800017778 (http://apps.who.int/trialsearch/).

The database comprised 506 variables, covering general clinical information, preoperative biopsy pathology and laboratory results, surgery-related indicators, preoperative and postoperative adjuvant treatments, postoperative pathology reports, follow-up information, related complications, disease recurrence, and costs. All data were independently entered by two trained gynecologists using EPIDATA software (version 3.1, EPIDATA Association, Odense, Denmark). The data underwent consistency checking, logical proofreading, outlier validation, sample review, and desensitization to ensure accuracy and reliability. According to the latest FIGO 2018 staging criteria [5], we re-staged all cases originally classified as stage IB in the database. The specific methodology was as follows: First, we selected patients with pathologically confirmed negative lymph nodes. Then, based on the FIGO 2018 staging criteria, we categorized tumors with a diameter ≤ 2 cm as FIGO 2018 stage IB1, those with a diameter > 2 cm but ≤ 4 cm as stage IB2, and those with a diameter > 4 cm as stage IB3.

Patients selection

We included female patients with FIGO 2018 stage IB2 cervical cancer who underwent open abdominal type B or C radical hysterectomy(Querleu-Morrow classification [17]). The exclusion criteria were as follows: (1) patients with non-squamous cell carcinoma, non-adenocarcinoma, or non-adenosquamous carcinoma; (2) those who received preoperative adjuvant therapy; (3) patients who did not undergo pelvic lymphadenectomy (with or without para-aortic lymphadenectomy/biopsy) or had unknown lymphadenectomy status; (4) pregnancy-associated cervical cancer; (5) patients with other malignancies; (6) cervical stump carcinoma (cancer in the residual cervix after subtotal hysterectomy; excluded due to differences in tumor behavior, surgical management, and recurrence patterns compared to primary cervical cancer, ensuring a homogeneous cohort for analysis); (7) cases lost to follow-up; and (8) patients who received non-standard postoperative adjuvant therapy (including those

not treated according to high-/low-risk factor guidelines, Sedlis criteria, or with unclear regimen.

Surgical procedure and postoperative management

Preoperative evaluation involved comprehensive assessment by at least two senior gynecologic oncologists through detailed pelvic examination to evaluate tumor characteristics (including tumor location and diameter, parametrial involvement, and vaginal invasion). This was supplemented by pelvic MRI/CT/PET-CT for precise assessment of tumor features, extent of invasion, and nodal status, along with LEEP/conization biopsies to confirm histological type, LVSI status, and stromal invasion depth. All cases strictly followed NCCN/FIGO guidelines, with individualized surgical plans determined through multidisciplinary team discussions. Detailed intraoperative records were maintained for every patient. The type of surgery is defined according to the classification criteria of Querleu and Morrow [17]. Type B (resection of parametrial tissue up to the ureter) involves resection of parametrial tissue to the level of the ureteral tunnel, partial resection of the uterosacral and vesicouterine ligaments, without resection of the sacral plexus below the deep uterine vein in the parametrial tissue, and removal of at least 1 cm of the vagina. Type C (resection of parametrial tissue up to the junction with the internal iliac vascular system) involves resection of the vesicouterine ligament at the bladder level and removal of the vagina 1.5–2 cm below the tumor or cervical margin, along with the associated para vaginal tissue. Pelvic lymph node dissection involves the removal of all fatty lymph node tissue anterior, lateral, and posterior to the common iliac, external iliac, and internal iliac vessels, as well as lymph node tissue anterior, lateral, and inferior to the obturator nerve. If suspicious or enlarged lymph nodes are identified in the para-aortic region during surgery, para-aortic lymph node dissection is performed. Para-aortic lymph node dissection includes the removal of lymph nodes along the paracaval, interaortocaval, and para-aortic regions, extending up to the level of the renal vessels.

Postoperative pathological examination results determine whether adjuvant therapy is administered based on NCCN and FIGO guidelines [6, 18]: if any high-risk factors are present (positive surgical margins, parametrial invasion, or lymph node metastasis), adjuvant concurrent chemoradiotherapy is given; if intermediate-risk factors (e.g., large tumor diameter, deep stromal invasion, or lymph vascular space invasion) are present, radiotherapy, with or without concurrent chemotherapy, is administered according to the "Sedlis criteria" [19]. External beam radiation therapy is delivered using three-dimensional conformal radiation therapy or intensity-modulated radiation therapy, with the entire pelvis receiving 45 Gy to 50.4 Gy of radiation in 25–28 fractions. Patients receiving radiotherapy and concurrent chemotherapy are administered 40 mg/m^2 of cisplatin once weekly for 5 weeks.

Follow-up is conducted every 3 months for the first 2 years after treatment, every 6 months from the 3rd to the 5th year, and then annually. Follow-up includes systemic and gynecological examinations, with laboratory and/or imaging tests performed as necessary. After 5 years of continuous follow-up, further follow-up is continued based on the patient's condition.

Definitions

The 5-year overall survival (OS) was defined as the time from surgery to death from any cause or the last recorded follow-up. The Recurrence-Free Survival (RFS) was defined as the time from surgery to the first documented recurrence or the last follow-up. Recurrence was defined as disease relapse diagnosed during follow-up and confirmed by CT and/or MRI and/or histology and/or cytology. Local-regional recurrence was defined as recurrence in the vaginal stump and pelvic lymph node regions below the aortic bifurcation, while distant recurrence referred to any site outside the local region. Complications were defined as any intraoperative or postoperative events that required further intervention.

Statistical analysis

SPSS 23.0 (IBM Corporation, Armonk, NY, USA) was used for statistical analysis. The measurement data were expressed by the mean standard deviation, the independent sample *T* tests was used for the comparison between groups, the percentage (%) was used for counting data, and the chi-square test or Fisher's exact probability method was used for the comparison of inter-group rates. Kaplan-Meier survival analysis was performed using the log-rank test. Cox proportional hazards regression model was used to determine independent risk factors, including age, tumor diameter, parametrial involvement, vaginal margin, LVSI, depth of tumour invasion, postoperative adjuvant therapy, and calculate the risk ratio and 95% confidence interval (CI). All analyses were two-sided, and $P < 0.05$ was interpreted as significant.

Considering the possible differences in clinical information between the two groups, we used 1:2 propensity score matching (PSM) to balance these factors and improve the scientific validity the study (the caliper value was 0.02).

Results

Patient characteristics

After strict screening, a total of 1308 patients were enrolled in this study, 840 and 468 patients underwent type B and type C. After 1:2 PSM, 1133 patients were

included (688 vs. 445) (Fig. 1). In particular, 3,014 cases of nonabdominal radical hysterectomy and 1,615 cases of substandard postoperative therapy were excluded from the study screening. In both Group B and Group C, over 80% of patients did not require additional adjuvant therapy postoperatively, while the remaining less than 20% received appropriate adjuvant treatment.

Baseline characteristics of patients before and after matching are listed in Table 1. There were no differences in age, tumor size, histologic type, parametrial involvement, vaginal margin, depth of stromal invasion, lymph nodes but differences existed in LVSI and postoperative therapy between the two groups in unadjusted analysis ($P<0.01$). After 1:2 matching, 1133 patients were included and the clinical characteristics were well balanced between the two groups.

Survival outcomes

In the total study population, the median follow-up time were 43 months. In the Kaplan–Meier analysis, the 5-year OS rates were 95.6% and 93.3% ($P>0.05$), and the 5-year RFS rates were 90.5% and 90.1% ($P>0.05$) in the type B and type C groups (Fig. 2A, B). Similar to the pre-matching results, there is no difference in 5-year OS and RFS for the two groups after matching (OS: 95.6 vs. 93.0%, $P>0.05$; RFS: 91.2 vs. 89.7%, $P>0.05$) (Fig. 2C, D).

Cox multivariate further revealed that the surgery types was not an independent risk factor for 5-year OS

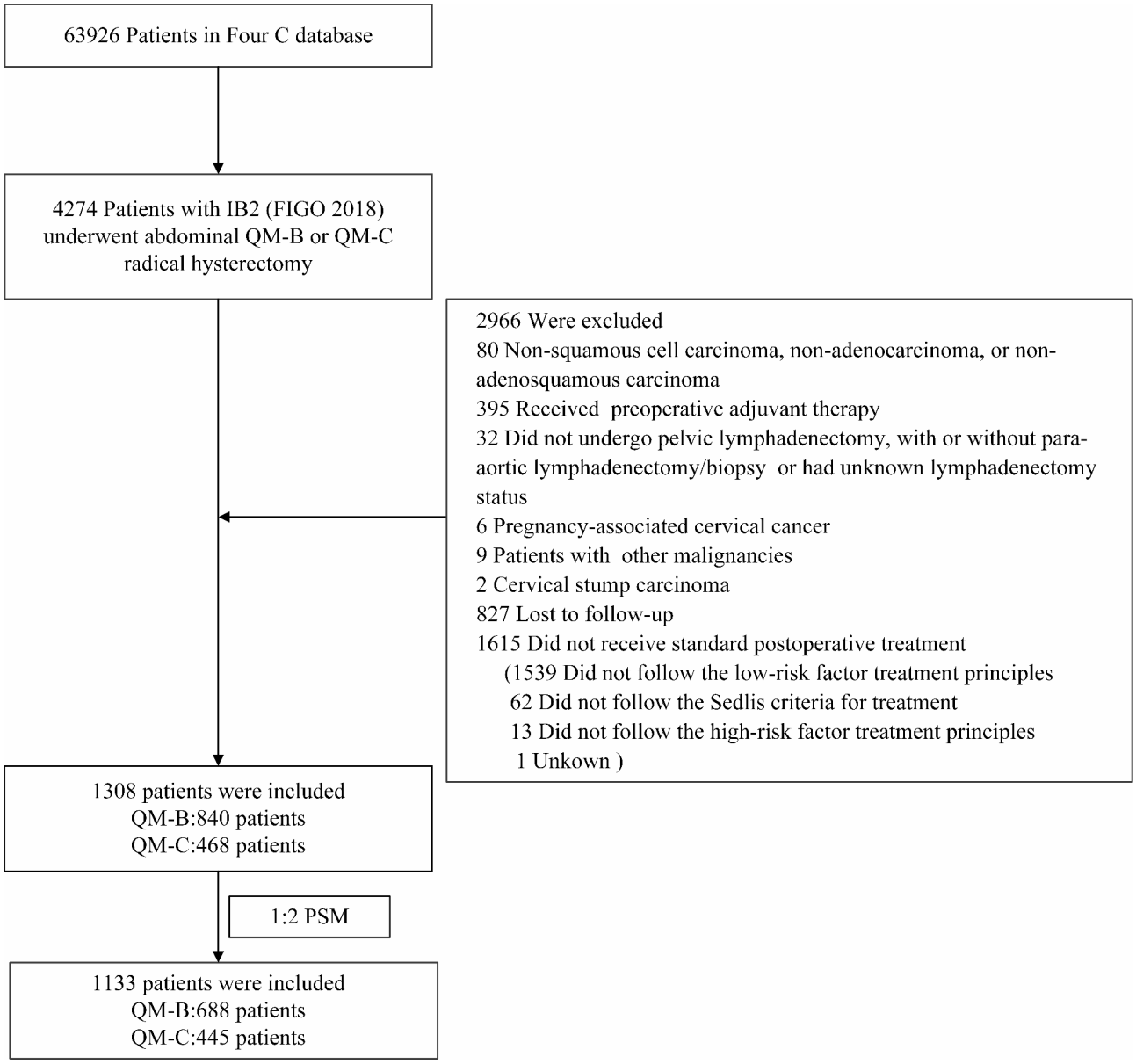

Fig. 1 Flowchart

Table 1 The clinicopathological characteristics of patients

	Before Matching			After Matching		
	Type B Group (*n* = 840,%)	**Type C Group (*n* = 468, %)**	***P***	**Type B Group (*n* = 688,%)**	**Type C Group (*n* = 445, %)**	***P***
Age, years	46.61 ± 9.419	47.65 ± 9.844	0.059	46.56 ± 8.891	46.99 ± 9.084	0.436
Tumor Diameter, cm			0.911			0.819
2.1 ~ 3.0	550(65.5)	305(65.2)		456(66.3)	292(65.6)	
3.1 ~ 4.0	290(34.5)	163(34.8)		232(33.7)	153(34.4)	
x ± s (rang)	3.1 ± 0.5 (2.1 ~ 4.0)	3.2 ± 0.6 (2.1 ~ 4.0)	0.074	3.1 ± 0.6 (2.1 ~ 4.0)	3.2 ± 0.5 (2.1 ~ 4.0)	0.069
Histologic type			0.190			0.460
Squamous cell	758(90.2)	407(87.0)		615(89.4)	387(87.0)	
Adenocarcinoma	72(8.6)	54(11.5)		64(9.3)	51(11.5)	
Adenosquamous	10(1.2)	7(1.5)		9(1.3)	7(1.5)	
Parametrial involvement			0.233			0.408
Negative	832(99.0)	460(98.3)		681(99.0)	438(98.4)	
Positive	8(1.0)	8(1.7)		7(1.0)	7(1.6)	
Vaginal margin			0.579			0.178
Negative	832(99.0)	462(98.7)		684(99.4)	439(98.7)	
Positive	8(1.0)	6(1.3)		4(0.6)	6(1.3)	
LVSI			<0.001			0.376
Negative	632(75.2)	391(83.5)		561(81.5)	372(83.6)	
Positive	208(24.8)	77(16.5)		127(18.5)	73(16.4)	
Depth of stromal invasion			0.169			0.583
≤ 1/2	423(50.4)	259(55.3)		337(49.0)	235(52.8)	
>1/2	417(49.6)	209(44.7)		351(51.0)	210(47.2)	
Pelvic lymph nodes removed	26.2 ± 5.0 (21 ~ 81)	26.6 ± 6.5 (21 ~ 76)	0.174	26.1 ± 5.1 (21 ~ 81)	26.5 ± 6.2 (21 ~ 76)	0.334
Para-aortic lymph nodes removed			0.348			0.289
No	713(84.9)	388(82.9)		591(85.9)	372(83.6)	
Yes	127(15.1)	80(17.1)		97(14.1)	73(16.4)	
Standard postoperative therapy			<0.001			0.466
No adjuvant required	633(75.4)	397(84.8)		570(82.8)	376(84.5)	
Standard adjuvant therapy	207(24.6)	71(15.2)		118(17.2)	69(15.5)	

LVSI, lymphovascular space invasion

and 5-year RFS (P>0.05). Tumor diameter was identified as a poor prognostic factor for both OS and RFS. After adjustment, deep stromal invasion was associated with worse RFS but not with OS. Other variables did not show a significant correlation with OS or RFS Table 2.

Recurrence patterns

At the time of the last follow-up, a total of 62 recurrences (7.4%, 62/840) were observed in the type B group and 35 recurrences (7.5%, 35/468) in the type C group, with no statistically significant difference between the two groups (P > 0.05) Table 3. The surgical dissection does not appear to influence tumor recurrences significantly, as details about pattern of pelvic recurrences were pelvic (unmatched:46.8% vs. 40.0%; matched:44.7% vs. 40.0%), extra-pelvic (unmatched:53.2% vs. 60.0%; matched:55.3% vs. 60.0%) Table 3.

Operating data, intra- and postoperative complications

Both before and after matching, when compared with type C group, type B group had a shorter operative time(unmatched: 186.6 min vs. 219.9 min, P<0.001; matched:187.3 min vs. 221.5 min, P<0.001), less blood loss(unmatched: 337.7 ml vs. 383.0 ml, P<0.001; matched:350.4 ml vs.381.0ml, P<0.01), earlier recovery of intestinal function (unmatched: 4.1 days vs. 4.5 days, P<0.001; matched: 4.1 days vs. 4.5 days, P<0.001), eariler removal of catheter (unmatched: 9.1 days vs. 11.3 days,P<0.001; matched: 9.2 days vs. 11.3 days, P<0.001) and shorter hospitalization (unmatched: 12.1 days vs. 16.2 days,P<0.001; matched: 12.0 days vs. 15.6 days, P<0.001). Anal exhaust time were similar in the two arms of patients (Table 4).

Intraoperative complications (including major vascular injury, ureteral injury, etc.), postoperative complications (including hemorrhage, infection, deep vein thrombosis, etc.) were compared between the two groups in the

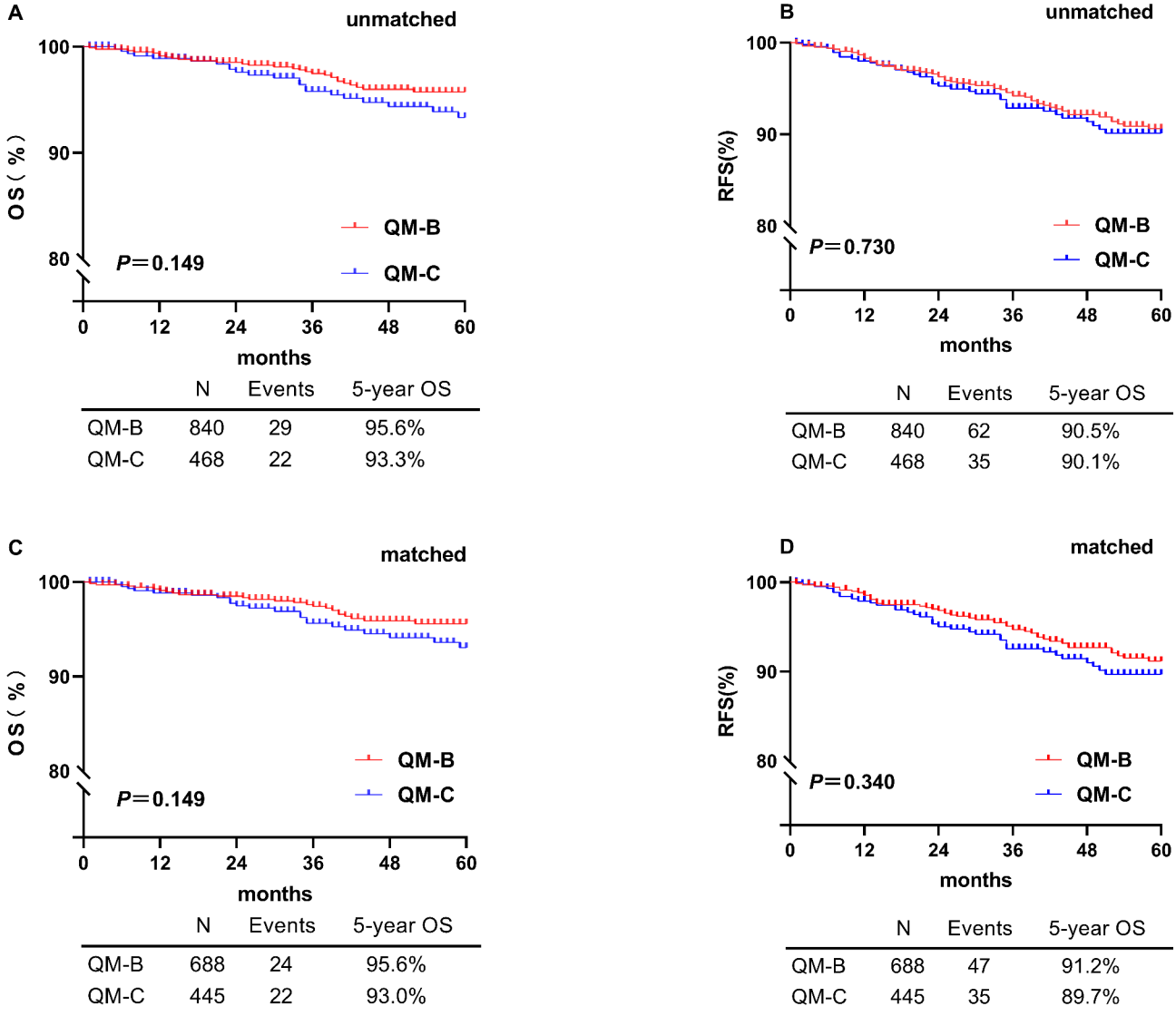

Fig. 2 Kaplan–Meier curves analysis comparing type B and type C before and after matching. *OS* overall survival, *RFS* recurrence-free survival. **A**, **B** unadjusted: 5-year OS (type B vs. type C); 5-year RFS (type B vs. type C); **C**, **D** adjusted: 5-year OS (type B vs. type C); 5-year RFS (type B vs. type C)

study. Overall, the rate of postoperative complications was higher than intraoperative complications in both groups (unmatched: type B 7.9% vs. 0.4%, type C 13.0% vs. 0.2%; matched: type B 8.3% vs. 0.1%, type C 12.1% vs. 0.2%). Intraoperative complications were similar in type B and C (unmatched: 0.4% vs. 0.2%; matched:0.1% vs. 0.2%, *P>0.05*). A total of 3 cases (3/840) occurred in type B, including two cases of ureteral injury and one case of bladder injury, and only one ureteral injury was reported in group C. Fortunately, there were no major vascular injury bowel injury and other in both groups. (Table 4)

Postoperative complications occurred more frequently in the type C group (unmatched:7.9% vs. 13.0%, $P<0.01$; matched:8.3% vs. 12.1%, $P<0.05$). Of all postoperative complications, urinary retention had the highest incidence, followed by lymphocysts. Moreover, patients who underwent type C surgery had higher rates of urinary retention than type B group (22/840, 2.6% vs. 30/468, 6.4%, $P<0.001$), respectively. And the matched population also showed similar result (22/688, 3.2% vs. 28/445, 6.3%, $P<0.05$). Before matching, patients in group C had a higher incidence of lymphocysts than those in group B(19/688, 2.3% vs. 21/445, 4.5%, $P<0.05$) and after balancing by PSM, there was no difference between the two groups ($P>0.05$). Additionally, the incidences of hemorrhage, infection, deep vein thrombosis, bowel obstruction and abdominal incision healing bad were similar between the two groups ($P>0.05$). There were no cases of ureterovaginal fistula, vesicovaginal fistula, rectovaginal fistula, and chylous leakage in either group (Table 4).

Table 2 Cox multivariate survival analysis

	Before Matching						After Matching					
	5-year OS			5-year RFS			5-year OS			5-year RFS		
	OR	95%CI	*P*	OR	95%CI	*P*	OR	95%CI	*P*	OR	95%CI	*P*
Surgical types (Type B vs.Type C)	1.682	0.945 ~ 2.995	0.077	1.210	0.788 ~ 1.858	0.383	1.643	0.907 ~ 2.978	0.102	1.315	0.837 ~ 2.064	0.234
Age (< 45 vs. ≥ 45)	0.621	0.322 ~ 1.264	0.152	0.639	0.306 ~ 1.325	0.226	0.723	0.358 ~ 1.357	0.196	0.759	0.417 ~ 1.568	0.524
Histology types (SCC vs. non-SCC)	1.011	0.391 ~ 2.615	0.981	0.633	0.274 ~ 1.461	0.284	1.062	0.408 ~ 2.763	0.902	0.693	0.298 ~ 1.614	0.395
Tumor size (≤ 3 vs. ≥3)	2.993	1.666 ~ 4.378	0.000	1.621	1.079 ~ 2.436	0.020	3.434	1.827 ~ 4.454	0.000	1.686	1.082 ~ 2.629	0.021
LVSI (Negative vs.Positive)	0.528	0.063 ~ 3.462	0.558	1.747	0.612 ~ 3.985	0.297	0.676	0.081 ~ 3.633	0.717	2.422	0.789 ~ 3.439	0.122
Parametrial involvement (Negative vs.Positive)	0.900	0.091 ~ 3.881	0.928	1.423	0.302 ~ 3.701	0.656	1.061	0.103 ~ 3.918	0.960	2.049	0.407 ~ 3.301	0.384
Vaginal margin (Negative vs.Positive)	0.688	0.051 ~ 3.180	0.777	2.680	0.728 ~ 3.866	0.138	1.137	0.081 ~ 3.024	0.924	1.594	0.192 ~ 3.236	0.666
Depth of stromal invasion (≤ 1/2 vs.>1/2)	1.918	0.941 ~ 3.909	0.073	1.592	0.947 ~ 2.678	0.079	2.009	0.968 ~ 4.166	0.061	1.779	1.036 ~ 3.053	0.037
Pelvic lymph nodes removed (≤ 30 vs. ≥30)	1.075	0.310 ~ 3.732	0.909	1.238	0.466 ~ 3.284	0.668	1.095	0.308 ~ 3.897	0.888	0.991	0.337 ~ 2.910	0.986
Para-aortic lymph nodes removed (No vs.Yes)	0.871	0.272 ~ 2.793	0.817	0.733	0.287 ~ 1.871	0.516	1.073	0.326 ~ 2.533	0.907	0.817	0.295 ~ 1.763	0.697
Standard postoperative therapy (No adjuvant required vs.Standard adjuvant therapy)	2.706	0.285 ~ 4.665	0.386	0.880	0.272 ~ 2.853	0.832	2.020	0.211 ~ 4.324	0.542	0.580	0.163 ~ 2.066	0.400

CI, confidence interval

Table 3 Recurrence patterns

	Before Matching			After Matching		
	Type B Group (*n* = 840,%)	**Type C Group (*n* = 468, %)**	***P***	**Type B Group (*n* = 688,%)**	**Type C Group (*n* = 445, %)**	***P***
Total recurrence	62(7.4)	35(7.5)	0.948	47(6.8)	35(7.9)	0.512
Recurrence patterns			0.519			0.672
Pelvic recurrence	29(46.8)	14(40.0)		21(44.7)	14(40.0)	
Extra pelvic recurrence	33(53.2)	21(60.0)		26(55.3)	21(60.0)	

Table 4 Operating data, intra- and postoperative complications

	Before Matching			After Matching		
	Type B Group (*n* = 840,%)	**Type C Group (*n* = 468, %)**	***P***	**Type B Group (*n* = 688,%)**	**Type C Group (*n* = 445, %)**	***P***
Operating data, mean (range)						
Operating time (min)	186.6 (68.0-385.0)	219.9 (65.0-510.0)	< 0.001	187.3 (68.0-385.0)	221.5 (86.0-510.0)	< 0.001
Blood loss (mL)	337.7 (30.0-2200.0)	383.0 (20.0-2500.0)	< 0.001	350.4 (30.0-2200.0)	381.0 (20.0-2500.0)	0.003
Anal exhaust time (days)	2.9(1.0–7.0)	2.9(1.0–7.0)	0.246	2.9(1.0–7.0)	2.9(1.0–7.0)	0.217
Intestinal Function Recovery (days)	4.1(1.0–9.0)	4.5(1.0–14.0)	< 0.001	4.1(1.0–9.0)	4.5(1.0–14.0)	0.001
Removal of catheter (days)	9.1(3.0–36.0)	11.3(5.0–42.0)	< 0.001	9.2(3.0–36.0)	11.3(5.0–42.0)	< 0.001
Hospitalization days	12.1(6.0–30.0)	16.2(10.0–26.0)	< 0.001	12.0(6.0–29.0)	15.6(10.0–26.0)	0.002
Any one complication	68(8.1)	62(13.2)	0.003	58(8.4)	55(12.4)	0.031
Intraoperative complication	3(0.4)	1(0.2)	0.652	2(0.1)	1(0.2)	0.833
Major vascular injury	0(0.0)	0(0.0)	-	0(0.0)	0(0.0)	-
Ureteral injury	2(0.2)	1(0.2)	0.929	1(0.1)	1(0.2)	0.932
Bladder injury	1(0.1)	0(0.0)	0.455	1(0.1)	0(0.0)	0.421
Bowel injury	0(0.0)	0(0.0)	-	0(0.0)	0(0.0)	-
Postoperative complication	66(7.9)	61(13.0)	0.002	57(8.3)	54(12.1)	0.033
Hemorrhage	1(0.1)	0(0.0)	0.455	1(0.1)	0(0.0)	0.421
Infection	7(0.8)	2(0.4)	0.395	3(0.4)	2(0.4)	0.974
Deep vein thrombosis	5(0.6)	6(1.3)	0.192	4(0.6)	4(0.9)	0.533
Bowel obstruction	9(1.1)	3(0.6)	0.434	8(1.2)	3(0.7)	0.413
Abdominal incision healing bad	6(0.7)	4(0.9)	0.780	5(0.7)	3(0.7)	0.918
Vesicovaginal fistula	0(0.0)	0(0.0)	-	0(0.0)	0(0.0)	-
Ureterovaginal fistula	0(0.0)	0(0.0)	-	0(0.0)	0(0.0)	-
Rectovaginal fistula	0(0.0)	0(0.0)	-	0(0.0)	0(0.0)	-
Chylous leakage	0(0.0)	0(0.0)	-	0(0.0)	0(0.0)	-
Lymphedema	1(0.1)	1(0.1)	0.675	1(0.1)	1(0.2)	0.756
Lymphocyst	19(2.3)	21(4.5)	0.025	17(2.5)	19(4.3)	0.092
Urinary retention	22(2.6)	30(6.4)	<0.001	22(3.2)	28(6.3)	0.013

Discussion

In this multicenter, large-sample, retrospective cohort study, 1,308 cases of IB2 (FIGO 2018) cervical cancer from 47 hospitals in mainland China over a 14-year period were included. The study found that type B RH and type C RH demonstrated comparable long-term OS and RFS, as well as similar tumor recurrence patterns. Additionally, type C RH was associated with a higher incidence of postoperative complications, such as urinary retention and lymphocyst formation, while type B RH featured shorter operative time, less blood loss, faster recovery, and shorter hospital stays. Overall, Type B RH offers a preferable option for patients with FIGO 2018 IB2 stage cervical cancer, as it is associated with fewer surgery-related complications without compromising oncological outcomes.

Lymph node metastasis (LNM) has been conclusively demonstrated to impact survival outcomes in cervical cancer through clinical studies. A significant advancement in the 2018 FIGO staging system was the incorporation of LNM into the diagnostic criteria, classifying patients with nodal involvement as stage IIIC. According to current FIGO/NCCN guidelines, there exist substantial differences in treatment regimens between stage IB2

(tumors > 2 cm but ≤ 4 cm without LNM) and stage IIIC (requiring definitive chemoradiation rather than surgical). In strict adherence to these guidelines, our study exclusively enrolled pathologically confirmed node-negative IB2 cases to ensure cohort homogeneity.

On the topic of reducing the scope of surgery for early-stage cervical cancer, scholars both domestically and internationally have conducted extensive research, with studies such as SHAPE, ConCerv, and LESSER yielding encouraging results [20–22]. Simple or conservative surgeries have been shown to achieve similar oncological outcomes and recurrence patterns, along with fewer complications. Unfortunately, these studies have limited tumor size to 2 cm or smaller, leaving a gap in effective evidence for whether a smaller surgical scope is viable for cervical cancer patients with tumors measuring 2.1–4 cm (IB2).

Previous studies often analyzed early-stage cervical cancer patients as a homogeneous group, overlooking the bias introduced by large tumor diameters (> 4 cm) and positive lymph nodes on the research outcomes. Landoni's RCT [13] compared Class II and Class III procedures for stage IB-IIA cervical cancer, demonstrating similar 5-year oncologic outcomes between the two surgical approaches (5-year os: 81% vs. 77%, $P = 0.7$, 5-year DFS 75% vs. 73%, $P = 0.9$). And multivariate survival analysis confirmed that survival was not dependent on the type of surgery. We reached similar results that type B RH and type C RH had comparable long-term oncological outcomes, and RH type was not an independent risk factor for 5-year OS and 5-year RFS (unmatched 95.6% vs. 93.3%, matched 95.6 vs. 93.0%, $P > 0.05$; unmatched:90.5% vs. 90.1%, matched:91.2% vs. 89.7%, $P > 0.05$). The recurrence rates were also consistent (CLASS II 24%, CLASS III 26%, $P > 0.05$), but the recurrence rate in the present study (7.4% vs. 7.5%, $P > 0.05$) was significantly lower, which may be related to surgical advances by gynecologists, earlier treatment, and adequate postoperative adjuvant therapy. In addition, Landoni's study included 24% of patients with tumors larger than 4 cm, and lymph node metastasis may also account for the difference. Subsequently, another RCT by landoin in 2012 [23] confirmed that for patients with stage IB-IIA cervical cancer undergoing class I and class III there was no significant difference in recurrence and overall survival (5 years OS: 85% vs. 95%, $P < 0.11$), with a higher morbidity rate after class III surgery (84% vs. 45%). In Wang's study [24], which included patients with IA2, IB1, IB2, and IIA1 stages, the differences in 5-year OS and DFS between type B and type C groups were not statistically significant, further supporting the feasibility of less extensive surgical procedures.

Unfortunately, these studies were small-sample, single-center investigations. In a multicenter study [15], Q-M Type B RH was found to be applicable for treating stage IAI to IIA2 cervical cancer, with Iower 5-year OS and DFS (OS: 89.5 vs. 92.0%, risk ratio: 1.393; DFS: 84.3 vs. 87.4%, risk ratio: 1.342. However, this study also included 1,298 (17.7%) patients with tumor diameters > 4 cm, and the inclusion of patients with larger tumors in the survival analysis undoubtedly introduced additional postoperative pathological risk factors, which also influenced tumor recurrence. Xiong's previous study [25] demonstrated that tumor size is the sole factor influencing recurrence rate ($P = 0.018$), RFS ($P = 0.038$), and OS ($P = 0.029$), which is consistent with Bezerra's findings [26]. Our study further confirmed that tumor diameter significantly correlates with poorer OS and RFS ($P < 0.05$).

There are very few specific studies focusing on patients with tumor diameters of 2.1–4 cm, and they have reported inconsistent conclusions. In Tseng's study [4] comparing survical outcomes between LRS (less radical surgery) and MRS (more radical surgery) of stage IB1 (FIGO2009) patients, there was no difference in 10-year DSS when stratified according to tumor size ≤ 2 cm (LRS 95.1% vs. MRS 95.6%, $P = 0.80$) and > 2 cm (LRS 90.1% vs. MRS 88.2%, $P = 0.48$). Factors independently associated with increased risk of death included tumors > 2 cm (HR1.82). Compared to MRS, LRS was not associated with a higher risk of death, which aligns with our findings that de-escalated radical surgery does not compromise patient survival outcomes. However, a multi-institutional retrospective study by Derks [16] in the Netherlands reported 5-year DFS rates for less radical versus more radical surgery as follows: ≤2 cm, 97% vs. 95% ($P = 0.348$); 2.1–4 cm, 89% vs. 79% ($P < 0.001$); >4 cm, 79% vs. 64% ($P = 0.004$). The study concluded that the extent of parametrial resection did not affect outcomes for tumors smaller than 2 cm, whereas more extensive hysterectomy may improve DFS for larger tumors. This difference may stem from the inclusion of lymph node metastasis cases in the 2.1–4 cm group, which significantly impacted multivariate analysis (HR 2.1, 95% CI 1.4-3.0, $P < 0.001$). Notably, 41% of the cohort received adjuvant therapy, and the study focused exclusively on DFS without reporting OS or detailed recurrence data.

Although these studies have some limitations in design that may lead to inevitable bias, most research indicates the feasibility of less extensive surgeries (e.g., Type B surgery). Additionally, we note that, although the differences remain within the range of statistical error, multiple studies, including ours (e.g., Landoni, Ditto, Tseng, etc.), consistently show slightly better survival outcomes with type B surgery compared to type C surgery, though this phenomenon currently lacks a clear explanation. By analyzing multiple potential influencing factors (e.g., tumor size, patient age, pathological type, LVSI, cervical stromal invasion, vaginal margin, lymph node dissection,

and postoperative standard treatment), we found that surgical type is not an independent risk factor for OS or RFS, while tumor diameter and deep stromal invasion are identified as significant prognostic predictors. Other variables showed no significant correlation with OS or RFS, suggesting that these factors are unlikely to confound the results. We believe this phenomenon may be related to advancements in surgical techniques, lower complication rates associated with less radical surgery, and more effective postoperative treatments, all of which collectively contribute to improved disease recovery and survival outcomes. These findings underscore the importance of individualized treatment plans based on tumor characteristics and risk factors, and we look forward to further exploration of this issue through future prospective studies.

In addition to considering oncologic outcomes, early and late morbidity as well as operating data should also be taken into account. In Landoni's study [13], the mean operative time for Class II hysterectomy was significantly shorter (135 vs. 180 min, $P<0.05$), while the mean blood loss (530 vs. 580 ml) and the proportion of patients requiring blood transfusions (35% vs. 43%) were similar. We partially agree with Landoni's findings, as our study demonstrated that type B RH had a shorter operative time (186.6 min vs. 219.9 min, $P<0.001$), less blood loss (337.7 ml vs. 383.0 ml, $P<0.001$), earlier recovery of bowel function, earlier catheter removal, and shorter hospital stays ($P<0.001$). The mean operative time (3.8 and 4.7 h, $P=0.001$) and postoperative hospitalization (7.3 and 9.2 days, $P=0.001$) were lower for class II than for class III hysterectomies in Guy J's study [27]. Additionally, while this study suggested that complications were unrelated to the extent of surgical resection, our results indicated a higher incidence of postoperative complications in the type C group (matched, 8.3% vs. 12.1%, $P<0.05$), particularly urinary retention and lymphocysts. Most patients resolved these issues through bladder training, catheterization, and regular imaging surveillance, though some experienced recurrent episodes, leading to long-term discomfort or rehospitalization. Although these complications did not significantly impact survival rates, the potential for chronic morbidity and increased follow-up burden added to the challenges for both patients and healthcare systems. Sun's RCT [28] also supported our findings, showing fewer cases of urinary retention (5/46 vs. 11/47, $P=0.109$) and bladder injuries in patients undergoing Type II hysterectomy. Heterogeneity in outcomes may be attributed to sample size, outpatient care, delayed complications, and postoperative adjuvant therapy. Overall, Type B surgery, due to its less radical approach, is associated with reduced surgical trauma, fewer complications, faster recovery, and simplified long-term management and follow-up protocols. Without compromising oncologic outcomes, it ensures a better quality of life and minimizes the high complication rates linked to Type C surgery, which could otherwise impact the timing and tolerance of adjuvant therapy.

It is noteworthy that, regarding the issue of surgical approaches, the 2018 LACC trial [29] demonstrated that minimally invasive laparoscopic surgery, including robot-assisted procedures, is associated with Iower survival rates and higher recurrence rates. This finding has been further supported by several studies, including the final results of the LACC trial [30–32]. For stages IA1 with LVSI to IB2 and selected IB3-IIA1 cases, the NCCN recommends laparotomy as the preferred approach. However, in most prior studies, surgical approaches were not standardized uniformly (e.g., a single study cohort might include laparoscopy, robot-assisted surgery, transvaginal surgery, laparotomy, or mixed approaches). Additionally, recent research from South Korea has further confirmed that for patients with stage IB2 cervical cancer (FIGO 2018) [33], total laparoscopic radical hysterectomy (TLRH) is associated with significantly Iower 5-year progression-free survival (PFS) rates compared to total abdominal radical hysterectomy (TARH) ($P=0.034$). It is reasonable to conclude that surgical choices, including laparoscopic methods, may significantly impact outcomes. Therefore, to minimize potential bias and enhance the scientific rigor of our study, we excluded 3,014 non-abdominal cases, which included 2,338 laparoscopic cases.

This study has several limitations. First, although we implemented multiple measures (strict adherence to NCCN guidelines and Chinese expert consensus to establish unified standards, exclusion of cases not meeting surgical criteria or Sedlis criteria for adjuvant therapy, and use of PSM with multivariate Cox regression to control for confounders) to minimize variations in clinical practice across multiple centers and extended time frames, potential biases may still exist. Second, due to the inherent constraints of the retrospective design, while we systematically reviewed original medical records and excluded cases with incomplete data, detailed information on post-recurrence treatment remains lacking. Finally, given the increasing incidence among younger patients, we were unable to systematically collect long-term outcomes such as quality of life (QoL) measures. We therefore recommend future studies incorporate standardized assessment tools in prospective evaluations. These methodological refinements have enhanced the objectivity of our findings in reflecting real-world clinical practice and provided evidence-based support for establishing standardized treatment protocols.

Conclusion

For cervcal cancer patients with FIGO IB2, type B RH provided similar long-term oncological outcomes, recurrence patterns, and fewer intra-and postoperative complications than type C RH. Type B RH is a feasible and appropriate operation, but the conclusions need to be confirmed by prospective studies.

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Author contributions
Jiaxin Fu: Methodology, Software, Data curation, Writing- original draft, Writing- review & editing. Pengfei Li: Methodology, Data curation, Writing -original draft. Jilong Yao: Methodology, Data curation, Writing - original draft. Zhonghai Wang: Resources, Data curation. Shaoguang Wang: Visualization, Resources. Qiubo Lv: Visualization, Resources. Xiaonong Bin: Formal analysis. Jinghe Lang: Supervision. Chunlin Chen: Funding acquisition, Conceptualization, Supervision. Ping Liu: Funding acquisition, Conceptualization, Supervision.

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Data availability
The datasets used and/or analyzed for the current study are available from the corresponding author upon reasonable request.

Declarations

Ethical statement and consent to participate
The study was accomplished following the ethical principles according to the Declaration of Helsinki 1964. This retrospective study was approved by the Ethics Committee of the Nanfang Hospital of Southern Medical University (approval number NFEC-2017–135 and clinical trial number CHiCTR1800017778; International Clinical Trials Registry Platform Search Port, https://trialsearch.who.int/Trial2.aspx?TrialID=ChiCTR1800017778, registered at 14/08/2018), who deemed that written informed consent was not necessarily due to the retrospective nature of the research and concealment of patient information.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Arbyn M, Weiderpass E, Bruni L, et al. Estimates of incidence and mortality of cervical cancer in 2018: a worldwide analysis. Lancet Glob Health. 2020;8(2):e191–203.
2. Panici PB, Cutillo G, Angioli R. Modulation of surgery in early invasive cervical cancer. Crit Rev Oncol Hematol. 2003;48(3):263–70.
3. Benedet JL, Odicino F, Maisonneuve P, et al. Carcinoma of the cervix uteri. J Epidemiol Biostat. 2001;6(1):7–43.
4. Tseng JH, Aloisi A, Sonoda Y, et al. Less versus more radical surgery in stage IB1 cervical cancer: a population-based study of long-term survival. Gynecol Oncol. 2018;150(1):44–9.
5. Corrigendum to. Revised FIGO staging for carcinoma of the cervix uteri [Int J Gynecol Obstet 145(2019) 129–135]. Int J Gynaecol Obstet. 2019;147(2):279–280.
6. National Comprehensive Cancer Network (US). NCCN clinical practice guideline in oncology. Version 1. Cervical cancer. 2025.
7. Wu J, Logue T, Kaplan SJ et al. Less radical surgery for early-stage cervical cancer: a systematic review. Am J Obstet Gynecol. 2021;224(4):348–58.
8. Balaya V, Mathevet P, Magaud L, et al. Predictive factors of severe perioperative morbidity of radical hysterectomy with lymphadenectomy in early-stage cervical cancer: a French prospective multicentric cohort of 248 patients. Eur J Surg Oncol. 2019;45(4):650–8.
9. Bergmark K, Avall-Lundqvist E, Dickman PW et al. Lymphedema and bladder-emptying difficulties after radical hysterectomy for early cervical cancer and among population controls. Int J Gynecol Cancer. 2006;16(3):1130–9.
10. Kodama J, Kusumoto T, Nakamura K, et al. Factors associated with parametrial involvement in stage IB1 cervical cancer and identification of patients suitable for less radical surgery. Gynecol Oncol. 2011;122(3):491–4.
11. Gemer O, Eitan R, Gdalevich M, et al. Can parametrectomy be avoided in early cervical cancer? An algorithm for the identification of patients at low risk for parametrial involvement. Eur J Surg Oncol. 2013;39(1):76–80.
12. Liang C, Jiang H, Sun L, et al. Which factors predict parametrial involvement in stage IB cervical cancer? A Chinese multicentre study. Eur J Surg Oncol. 2023;49(9):106936.
13. Landoni F, Maneo A, Cormio G, et al. Class II versus class III radical hysterectomy in stage IB-IIA cervical cancer: a prospective randomized study. Gynecol Oncol. 2001;80(1):3–12.
14. Ditto A, Martinelli F, Ramondino S et al. Class II versus class III radical hysterectomy in early cervical cancer: an observational study in a tertiary center. Eur J Surg Oncol. 2014;40(7):883–90.
15. Chen C, Wang W, Liu P, et al. Survival after abdominal Q-M type B versus C2 radical hysterectomy for early-stage cervical cancer. Cancer Manag Res. 2019;11:10909–19.
16. Derks M, van der Velden J, de Kroon CD, et al. Surgical treatment of early-stage cervical cancer: a multi-institution experience in 2124 cases in the Netherlands over a 30-year period. Int J Gynecol Cancer. 2018;28(4):757–63.
17. Querleu D, Morrow CP. Classification of radical hysterectomy. Lancet Oncol. 2008;9(3):297–303.
18. Bhatla N, Aoki D, Sharma DN et al. Cancer of the cervix uteri. Int J Gynaecol Obstet. 2018;143 Suppl 2:22–36.
19. Sedlis A, Bundy BN, Rotman MZ et al. A randomized trial of pelvic radiation therapy versus no further therapy in selected patients with stage IB carcinoma of the cervix after radical hysterectomy and pelvic lymphadenectomy: a gynecologic oncology group study. Gynecol Oncol. 1999;73(2):177–83.
20. Plante M, Kwon JS, Ferguson S et al. Simple versus radical hysterectomy in women with low-risk cervical cancer. N Engl J Med. 2024;390(9):819–29.
21. Schmeler KM, Pareja R, Lopez BA et al. ConCerv: a prospective trial of Conservative surgery for low-risk early-stage cervical cancer. Int J Gynecol Cancer. 2021;31(10):1317–25.
22. Carneiro V, Batista TP, Andrade MR, et al. Proof-of-concept randomized phase II non-inferiority trial of simple versus type B2 hysterectomy in early-stage cervical cancer ≤ 2 cm (LESSER). Int J Gynecol Cancer. 2023;33(4):498–503.
23. Landoni F, Maneo A, Zapardiel I, et al. Class I versus class III radical hysterectomy in stage IB1-IIA cervical cancer. A prospective randomized study. Eur J Surg Oncol. 2012;38(3):203–9.
24. Wang L, Liu P, Duan H, et al. Abdominal type B vs. type C radical hysterectomy in early-stage cervical cancer: a matched single center cohort report. Front Surg. 2023;10:1166084.
25. Xiong Y, Liu JH, Zheng M, et al. Use of preoperative clinicopathologic characteristics to identify patients with low-risk cervical cancer suitable for Piver class II radical hysterectomy. Int J Gynaecol Obstet. 2013;122(1):52–6.

26. Bezerra AL, Martins MR, Bezerra SM, et al. Class II radical hysterectomy for stage I-IIA cervix cancer: prognostic factors associated to recurrence and survival in a Northeast Brazil experience. J Surg Oncol. 2011;104(3):255–9.
27. Photopulos GJ, Zwaag RV. Class II radical hysterectomy shows less morbidity and good treatment efficacy compared to class III. Gynecol Oncol. 1991;40(1):21–4.
28. Sun H, Cao D, Shen K et al. Piver type II vs. type III hysterectomy in the treatment of early-stage cervical cancer: midterm follow-up results of a randomized controlled trial. Front Oncol. 2018;8:568.
29. Ramirez PT, Frumovitz M, Pareja R, et al. Minimally invasive versus abdominal radical hysterectomy for cervical cancer. N Engl J Med. 2018;379(20):1895–904.
30. Ramirez PT, Robledo KP, Frumovitz M, et al. LACC trial: final analysis on overall survival comparing open versus minimally invasive radical hysterectomy for early-stage cervical cancer. J Clin Oncol. 2024;42(23):2741–6.
31. Melamed A, Margul DJ, Chen L et al. Survival after minimally invasive radical hysterectomy for early-stage cervical cancer. N Engl J Med. 2018;379(20):1905–14.
32. Nitecki R, Ramirez PT, Frumovitz M, et al. Survival after minimally invasive vs open radical hysterectomy for early-stage cervical cancer: a systematic review and meta-analysis. JAMA Oncol. 2020;6(7):1019–27.
33. Yoon HJ, Kwon BS, Rho HJ et al. Comparison of survival outcome of open, total laparoscopic, and laparoscopy-assisted radical vaginal hysterectomy for stage IB2 cervical cancer patients: a multicenter retrospective study. Med (Baltimore). 2024;103(10):e37426.

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