Article

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Impact of COVID-19 on Postoperative Complications in Minimal Invasive Radical Cystectomy: A Comprehensive Complication Index-Based Analysis

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Purpose: This study aimed to evaluate perioperative outcomes and postoperative complications following minimally invasive radical cystectomy with ileal conduit (RCIC) performed under an enhanced recovery after surgery (ERAS) protocol, using the Clavien-Dindo classification (CDC) and the comprehensive complication index (CCI).
Methods: An ambispective study (2018–2022) was conducted, collecting demographic, perioperative and postoperative data, with a focus on complications among patients treated during and outside the COVID-19 period. Results were compared between surgeries conducted during the COVID-19 pandemic, including the first wave, and those performed in a non-COVID period.
Results: Among these 90 patients, 49 underwent surgery during the complete COVID-19 period, compared with 41 patients in the pre- and post-pandemic control period. Additionally, 15 of the cases occurred during the first wave of the pandemic. The COVID-19 group showed a higher rate of pN0 staging (87.8% vs 67.5%, p = 0.021) and fewer pN1 cases (2% vs 20%, p = 0.005) than the control group. The most common complications were genitourinary (71, 78.9%), infectious (59, 65.6%) and gastrointestinal (54, 60%). Median CCI increased significantly with each ascending CDC (r = 0.934, $p < 0.001$). Notably, 20.3% of patients in CDC ≤3a were reclassified to severe morbidity (CCI ≥33.7), with elevated rates during COVID-19 periods (46.7% and 42.9% vs 34.1%). CCI showed a more consistent correlation with length of stay than CDC (r = 0.551, $p < 0.001$ vs r = 0.460, $p < 0.001$).
Conclusions: Minimally invasive RCIC during the COVID-19 pandemic was associated with increased postoperative morbidity. Compared with RCIC, the CCI provides a more accurate estimation of morbidity burden and should be incorporated into standard surgical outcome reporting.

Keywords: cystectomy; complication; minimally invasive surgery

Introduction

Radical cystectomy (RC) with lymphadenectomy remains the standard curative treatment for organ-confined muscle-invasive bladder cancer, as well as for high-risk non-muscle-invasive bladder cancer that is unresponsive to bacillus Calmette-Guérin (BCG) therapy or resistant to bladder-sparing protocols [1]. Delays in performing RC beyond 3 months yield poor clinical outcomes and reduced survival rates [2].

The global COVID-19 pandemic significantly disrupted healthcare systems; However, in the Cantabria region, the impact was relatively moderate. This allowed oncological surgical activity to continue with minimal delay [3–5]. Every RC was performed within 60 days of waitlist inclusion, and the enhanced recovery after surgery (ERAS) protocol was consistently applied with some modifications, even during three non-consecutive periods when postoperative care was provided in an alternative hospitalization unit due to COVID-related reorganization.

The ERAS protocol has demonstrated improvements in terms of complications and hospital stay [6]. Nonetheless, standardized reporting of surgical complications remains inadequate, particularly for RC [7].

The Clavien-Dindo classification (CDC) records only the most severe complication per patient, thereby underestimating total morbidity [8,9]. The comprehensive complication index (CCI) offers an accurate assessment by consolidating all postoperative events into a single score ranging from 0 (no complications) to 100 (death) [10]. Several studies have demonstrated its utility in patients undergo-

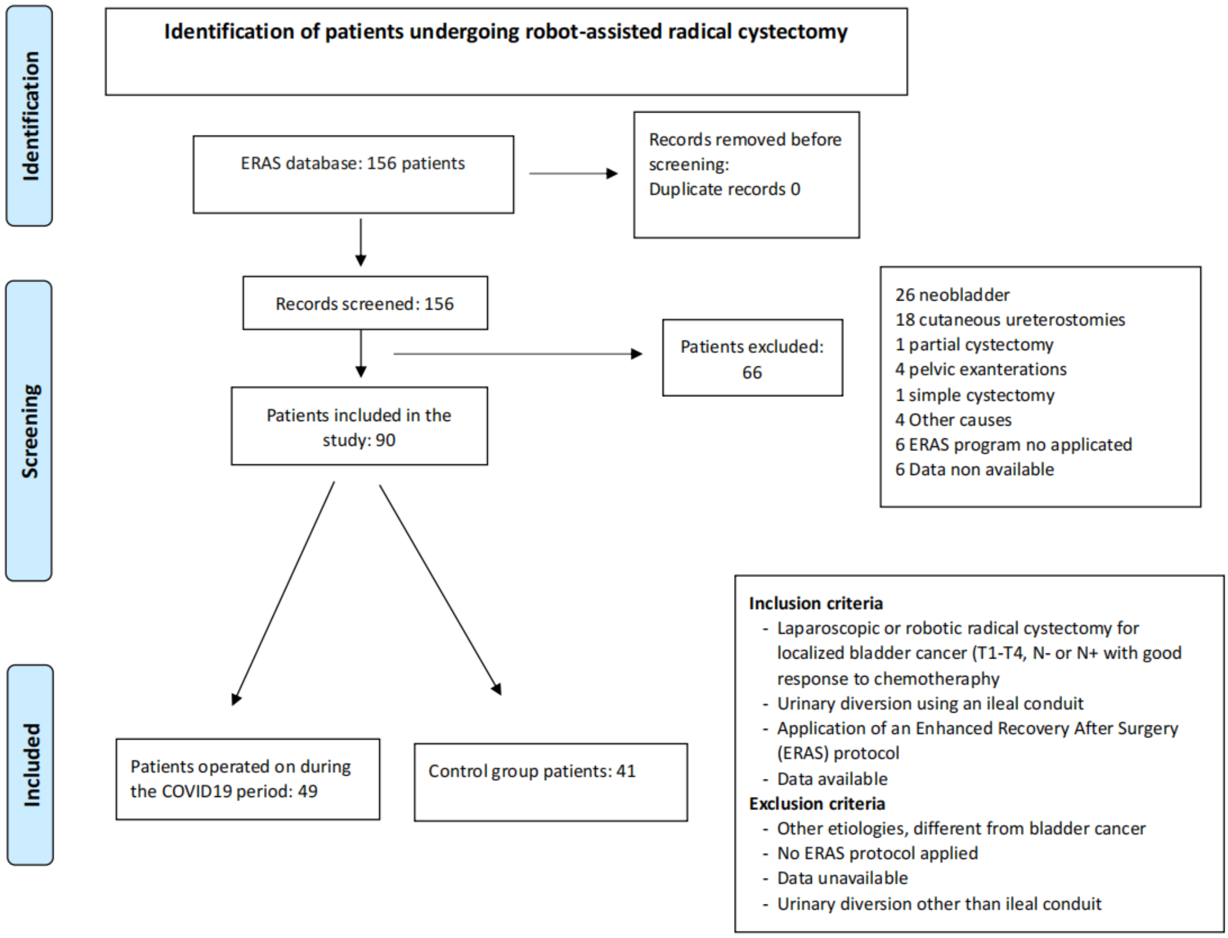

Fig. 1. Flowchart of patient inclusion in the study.

ing robot-assisted RC with intracorporeal urinary diversion (RARC-ICUD) [9,11,12]. Thus, we conducted an ambispective study comparing the use of the CCI and CDC in assessing the burden of surgical morbidity in patients undergoing laparoscopic or robotic RC under an ERAS protocol, during and outside the COVID-19 pandemic.

Patients and Methods

Study Population

We prospectively collected morbidity data from patients of our institution who underwent radical cystectomy with ileal conduit (RCIC) during the last quarter of 2018, and throughout 2019 and 2022.

Data from the years 2020 and 2021 were retrospectively retrieved because of the pandemic. Patients undergoing laparoscopic or robotic RC for localized bladder cancer (T1–T4, N− or N+ with good chemotherapy response) with ileal conduit (IC) urinary diversion and managed under an ERAS protocol were included. Exclusion criteria were non-bladder cancer aetiology, absence of ERAS protocol, unavailable data or urinary diversion methods other than IC. Perioperative care that adhered to ERAS cystectomy protocols started 6 months before. Neoadjuvant therapy was administered based on multidisciplinary tumour board recommendations. All surgeries were performed by four robotic experienced surgeons. As a result of the pandemic, some patients completed postoperative recovery in a non-urological ward (gynaecology unit).

Complication Reporting

Postoperative complications were recorded within 90 days following RC. Any specific deviation from the expected postoperative course was classified as a complication and documented by a resident or senior urologist. Outcomes included complication rates, hospital stay, readmissions, reinterventions and mortality at 30, 90 days and 1 year. Complications were categorized into 15 distinct groups, detailed and graded according to the corresponding CDC grade. The CCI was calculated for each patient using the validated online tool (https://www.cci-calculator.com/cciCalculator). A CCI of 33.7 corresponds to a CDC IIIb complication, so it was used as a threshold value for defining severe accumulative morbidity [7]. Finally, CDC and CCI were analysed independently.

Clinical, Surgical and Pathological Data

Collected data included demographics, comorbidity index, laboratory parameters, tumour stage and prior oncological treatments. Surgical variables included operative time and technical details such as surgical approach, type of intestinal and ureteroileal anastomosis, auxiliary procedures and conversion rate. Pathological evaluation included tumour (T), nodal (N) and metastatic (M) staging, total lymph node count, and histological subtype.

Statistical Analyses

A descriptive analysis was conducted to characterize the RC cohort. Patients were grouped by timing of surgery: Pre/post-COVID-19 (control), full COVID-19 period (March 2020–February 2022) and first wave subgroup (March–July 2020). Groups were matched by sample size for comparative analysis. Percentages were calculated using available data, excluding missing data. The normality of continuous variables was assessed using the Kolmogorov–Smirnov test. Continuous variables were reported as medians with interquartile range (IQR) and compared using the Mann–Whitney U test. Categorical variables were expressed as absolute and relative frequencies (%). Categorical comparisons employed Chi-square or Fisher's exact test as appropriate. Clavien-to-CCI reclassification data were obtained using paired data analysed with McNemar's test.

Spearman's rank correlation coefficient was utilized to evaluate the correlation between the CDC and CCI, and to assess the relationship of both scoring systems with postoperative hospital stay.

Subgroup analysis compared outcomes between patients managed during and outside the pandemic period, including a focused analysis on the initial COVID-19 wave. One-year survival was assessed via Kaplan–Meier analysis, and group differences were assessed with the log-rank test. Mortality at 30, 90 days and 1 year was also analysed. Statistical analyses were conducted using IBM SPSS Statistics v25 (IBM Corp., Armonk, NY, USA). $p < 0.05$ was considered statistically significant.

Results

Descriptive Analyses of Clinical, Pathological and Surgical Characteristics

During the study period, 156 cystectomies were performed, of which 90 met the inclusion criteria (Fig. 1). Among these, 49 patients underwent surgery during the complete COVID-19 period, compared with 41 in the pre- and post-pandemic periods (control out of COVID). Additionally, 15 of the cases occurred during the first pandemic wave.

All data and their classifications are depicted in Tables 1 and 2. A total of 72 patients (80%) were male, with a median age of 70.20 years (IQR = 9). Neoadjuvant chemotherapy was administered to 45 individuals (50%), and the median Charlson index was 3 (IQR = 2).

No statistically significant differences were observed between the groups for demographic and clinical variables, except for the preoperative Eastern Cooperative Oncology Group (ECOG) performance status, which was significantly higher in the first-wave group compared with its control group ($p = 0.016$). Prior anticoagulant therapy was also more prevalent in the first wave and the complete COVID-19 groups compared with their control groups ($p = 0.02$ and $p = 0.017$).

Patients in the first wave and complete COVID-19 groups had higher non-significant baseline haemoglobin levels compared with their respective control groups ($p = 0.541$ and $p = 0.055$). By contrast, renal function was significantly worse in the first wave of the pandemic than in the corresponding control out of the COVID period (creatinine pre 1.07 vs 0.86, $p = 0.01$) and (glomerular filtration rate (GFR) pre 63 vs 87, $p = 0.006$) (Table 1).

Regarding pathological characteristics, urothelial carcinoma was the most predominant histological type, representing 63.3% of all cases reported. A higher incidence of pT2 stage tumours was observed among patients who underwent surgery during the first wave of the pandemic (26.7% vs 4.9%, $p = 0.02$). In terms of nodal staging, a greater proportion of patients in the complete COVID-19 group was classified as pN0 compared with the control out of COVID-19 group (87.8% vs 67.5%, $p = 0.021$), but the control group had an elevated percentage of pN1 disease (20% vs 2%, $p = 0.005$) (Table 1).

A robotic-assisted approach was employed in 84 patients, whereas 6 underwent a laparoscopic approach. Surgical characteristics were comparable between groups. However, the operation duration was significantly shorter in the control group, especially compared with the complete COVID-19 period (328 min vs 381 min, $p = 0.01$). Conversion to open surgery for urinary diversion was required in 3 patients (3.3%) (Table 2).

The most frequently performed diversion was intracorporeal, mechanical and antiperistaltic. The Bricker technique (separate ureteroileal anastomosis) was used more often than the Wallace type 1 technique (72.2% vs 26.7%, $p < 0.001$), with significant differences between the groups. No other statistically significant differences were observed (Table 2).

Review of Complications within 90 Days Perioperatively

The 90-day complication rates are shown in Table 3. Genitourinary (78.9%), infectious (65.6%) and gastrointestinal (60%) complications were the most prevalent, whereas pulmonary (10%), wound-related (6.7%), haemorrhagic (6.7%) and neurological (11.1%) events were less frequent (Table 3).

Table 1. Demographic and pathological characteristics.

Items	Total	Control out of COVID-19	First wave	p^a	Complete COVID-19 period	p^b
Number of patients	90	41 (45.6)	15 (16.7)		49 (54.4)	
Male, n (%)	72 (80)	31 (75.6)	14 (93.3)	0.139	41 (83.7)	0.341
Age (years), median (IQR)	70.20 (9)	69.03 (11)	71.77 (10)	0.233	70.78 (9)	0.988
ASA, n (%)				0.421		0.755
2	58 (64.5)	28 (68.3)	8 (53.3)		30 (61.2)	
3	30 (33.3)	12 (29.3)	7 (46.7)		18 (36.8)	
4	2 (2.2)	1 (2.4)	0 (0.0)		1 (2.0)	
Charlson index, median (IQR)	3 (2)	3 (3)	4 (4)	0.439	3 (2)	0.813
ECOG, n (%)				0.016		0.273
0	69 (81.2)	34 (87.2)	8 (57.1)		35 (76.1)	
1	14 (16.5)	5 (12.8)	4 (28.6)		9 (19.6)	
2	2 (2.4)	0 (0)	2 (14.3)		2 (4.3)	
Haemoglobin pre (gr/dL), median (IQR)	12.6 (2.6)	12.4 (2.1)	13.2 (3.1)	0.541	13.2 (2.6)	0.055
Creatinine pre (mg/dL), median (IQR)	0.94 (0.38)	0.86 (0.37)	1.07 (0.55)	0.01	0.98 (0.35)	0.271
GFR pre (CKD-EPI), mL/min/1.73 m^2, median (IQR)	79.5 (32)	87 (29)	63 (32)	0.006	70.2 (28)	0.261
BMI (kg/m^2), median (IQR)	26.78 (6)	25.95 (6)	29.76 (6.9)	0.192	28.06 (6)	0.317
Neoadjuvant chemotherapy, n (%)	45 (50.0)	21 (51.2)	7 (46.7)	0.763	24 (49.0)	0.832
Antiplatelet therapy, n (%)	25 (27.8)	13 (31.7)	4 (26.7)	0.716	12 (24.5)	0.446
Anticoagulant therapy, n (%)	10 (11.1)	1 (2.4)	3 (20)	0.02	9 (18.4)	0.017
Days of admission, median (IQR)	13 (11)	13 (12)	13 (12)	0.795	13 (11)	0.845
Stage, n (%)						
pT0	32 (35.6)	13 (31.7)	6 (40)	0.565	19 (38.8)	0.486
pTa	1 (1.1)	0 (0)	0 (0)		1 (2.0)	0.365
pTis	8 (8.9)	4 (9.8)	1 (6.7)	0.722	4 (8.2)	0.792
pT1	7 (78)	3 (7.3)	1 (6.7)	0.939	4 (8.2)	0.875
pT2	8 (8.9)	2 (4.9)	4 (26.7)	0.02	6 (12.2)	0.228
pT3	21 (23.3)	12 (29.3)	3 (20)	0.49	9 (18.4)	0.226
pT4	13 (14.4)	7 (17.1)	0 (0)	0.089	6 (12.2)	0.512
pN0	70 (78.7)	27 (67.5)	12 (80)	0.368	43 (87.8)	0.021
pN1	9 (10.1)	8 (20.0)	0 (0.0)	0.063	1 (2.0)	0.005
pN2	10 (11.2)	5 (12.5)	3 (20.0)	0.486	5 (10.2)	0.766
Total number of lymph nodes, median (IQR)	24 (13)	24 (11)	30 (12)	0.058	24 (14)	0.591

n, number of patients; IQR, interquartile range; GFR, glomerular filtration rate; BMI, Body mass index. [a]Comparative analysis between the first COVID-19 wave and a non-COVID control cohort. [b]Comparative analysis between the entire COVID-19 period and a non-COVID control cohort. Patients' data availability: pN in total, 89; pN in control out of Covid, 40; ECOG in control out of COVID, 39; ECOG in first wave, 14; ECOG in complete COVID period, 46.

Among infectious complications, urinary tract infections were the most prevalent (42.2%). The overall transfusion rate was 32.2%, with a high rate observed during the first wave (40.0% vs 34.1%, $p = 0.69$) and a low rate in the complete COVID-19 cohort (30.6% vs 34.1%, $p = 0.721$) (Table 3). However, no transfusion was administered in the majority of patients.

Postoperative ileus developed in 25.6% of cases, with increased incidence in the pandemic groups (33.3% and 28.6% vs 22%). Additional nasogastric tube placement was required in 20%, and parenteral nutrition was necessary in 16.7% (Table 3).

Surgical complications occurred in 15.6% of patients, mainly involving urinary (n = 8) and intestinal (n = 4) fistulas. Reintervention was required in 8 patients (8.9%) (Table 3).

The 90-day readmission rate reached 27.8%, which significantly increased during COVID-19 periods (36.7% and 26.7% vs 17.1%). Three COVID-19-related readmissions were recorded, but no pandemic-associated mortality was observed (Table 4).

A total of 212 complications were reported. Overall, 76 (84.5%) patients developed at least one complication of any type. The distribution of complications according to the CDC is depicted in Fig. 2. About 80% of patients presented some minor complication (Clavien I or II), whereas 31.1% presented some major complications (Clavien III–V), with most of them classified as Clavien IIIa. During

Table 2. Surgical characteristics.

Items	Total	Control out of COVID	First wave	p^a	Complete COVID period	p^b
Surgical approach, n (%)						
Laparoscopic	6 (6.7)	4 (9.8)	1 (6.7)	0.72	2 (4.1)	0.282
Robotic	84 (93.3)	37 (90.2)	14 (93.3)		47 (95.9)	
Urinary diversion, n (%)						
Extracorporeal	6 (6.7)	2 (4.9)	1 (6.7)	0.792	4 (8.2)	0.534
Intracorporeal	84 (93.3)	39 (95.1)	14 (93.3)		45 (91.8)	
Auxiliary surgery, n (%)	8 (8.9)	6 (14.6)	2 (13.3)	0.9	2 (4.1)	0.08
Duration of surgery, min, median (IQR)	356 (87)	328 (81)	345 (104)	0.08	381 (82)	0.01
Blood loss, mL, median (IQR)	450 (250)	400 (450)	550 (225)	0.59	500 (200)	0.374
Type of anastomosis, n (%)						
Antiperistaltic	71 (78.9)	35 (92.1)	14 (93.3)	0.879	36 (75.0)	0.038
Isoperistaltic	15 (16.7)	3 (7.9)	1 (6.7)		12 (25.0)	
Uretrectomy, n (%)	8 (8.9)	2 (4.9)	1 (6.7)	0.79	6 (12.2)	0.221
Ureteroileal anastomosis, n (%)						
Bricker	65 (72.2)	35 (85.4)	12 (80.0)	0.647	30 (61.2)	0.012
Wallace 1	24 (26.7)	5 (12.2)	3 (20.0)		19 (38.8)	
Wallace 2	1 (1.1)	1 (2.4)	0 (0.0)		0 (0.0)	
Reconversion, n (%)	3 (3.3)	0 (0.0)	1 (6.7)	0.095	3 (6.1)	0.107

n, number of patients; IQR, interquartile range. [a]Comparative analysis between the first COVID-19 wave and a non-COVID control cohort. [b]Comparative analysis between the entire COVID-19 period and a non-COVID control cohort. Patients' data availability: Type of anastomosis in total, 86; Type of anastomosis in control out of COVID, 38; Type of anastomosis in complete COVID period, 48.

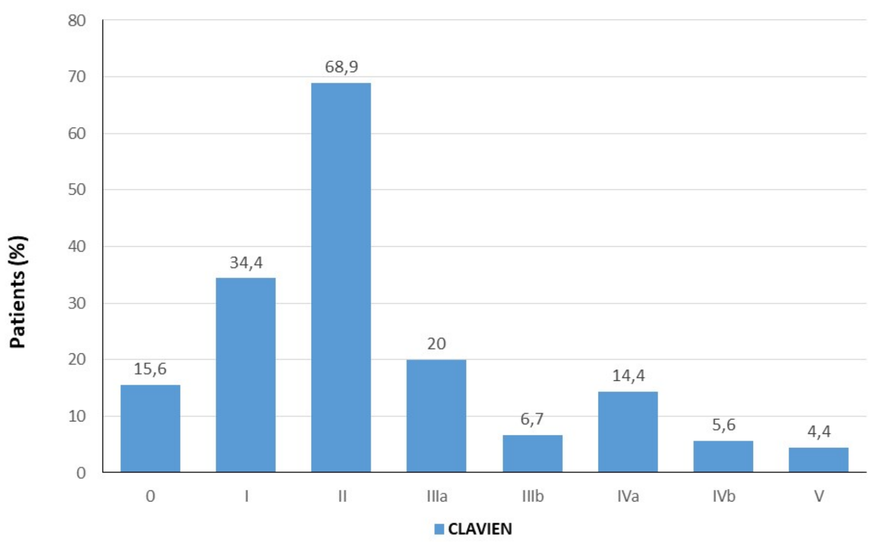

Fig. 2. Frequency of patients according to their Clavien-Dindo classification grade.

both COVID-19 periods analysed, we observed an increase in incidence of major complications (46.7% and 36.7% vs control group 24.4%, especially > Clavien IIIa) (Table 4).

To better reflect overall postoperative morbidity, we analysed the CCI per patient, which accounted for all complications cumulatively. The median 90-day CCI was 29.6, which increased to 33.5 during both COVID-19 periods (Table 4 and Fig. 3).

For comparative purposes, patients were stratified into groups based on CCI ≥33.7 and CDC ≥IIIb, as these thresholds corresponded to complications with a significant impact on postoperative recovery. Notably, 14 patients

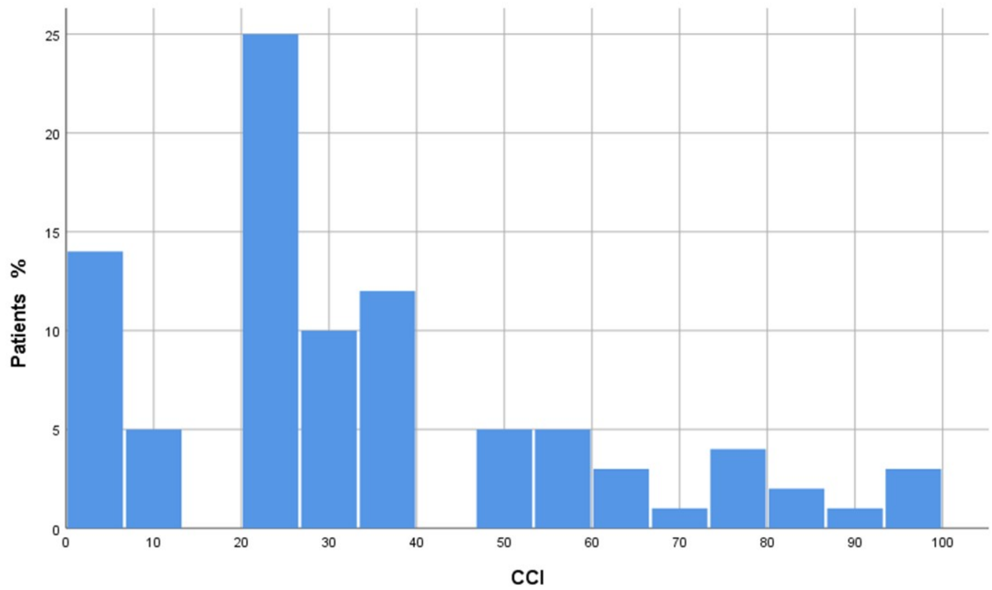

Fig. 3. Frequency of patients according to their CCI scores.

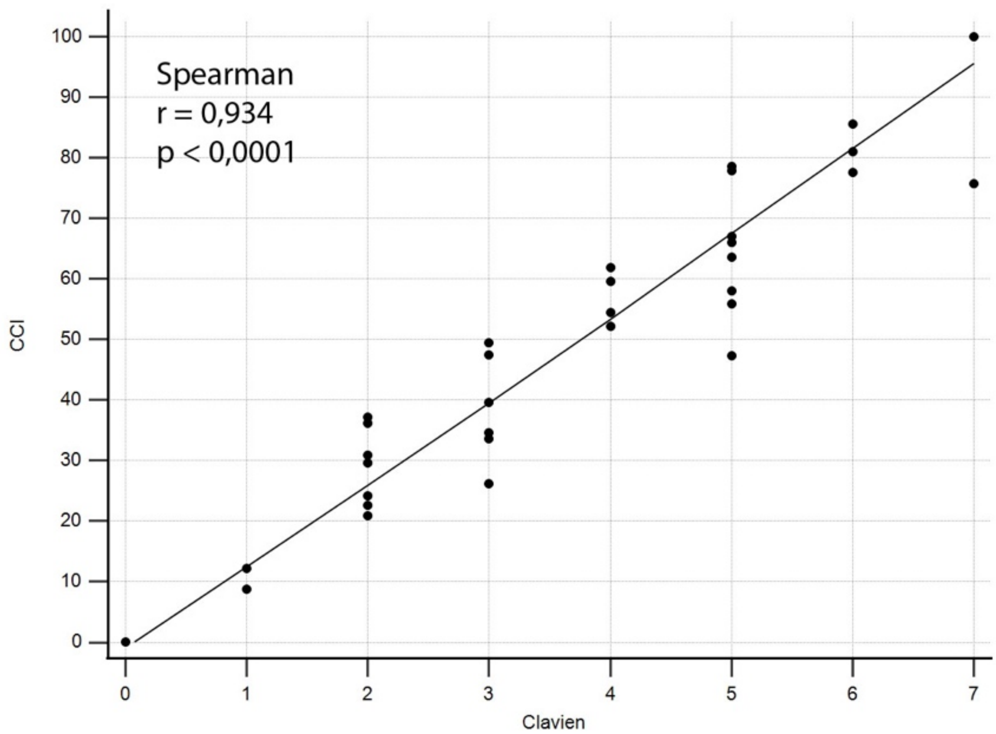

Fig. 4. Correlation between higher-grade complication (Clavien-Dindo classification, CDC) and the total CCI.

(15.6%) initially categorized under Clavien ≤IIIa were reclassified into the more severe group based on CCI ≥33.7. This trend was observed across all subgroups, with a particularly high rate during the first wave (26.7%, $p = 0.125$), followed by the complete COVID-19 period (14.3%, $p = 0.0146$), compared with the non-COVID-19 control period (17.1%, $p = 0.0156$). All patients with Clavien-Dindo ≥IIIb had a CCI ≥33.7, confirming the concordance between the two severity measures at this threshold. Fig. 4 demonstrates a significant increase in median CCI with each ascending Clavien–Dindo grade (r = 0.934, $p < 0.0001$).

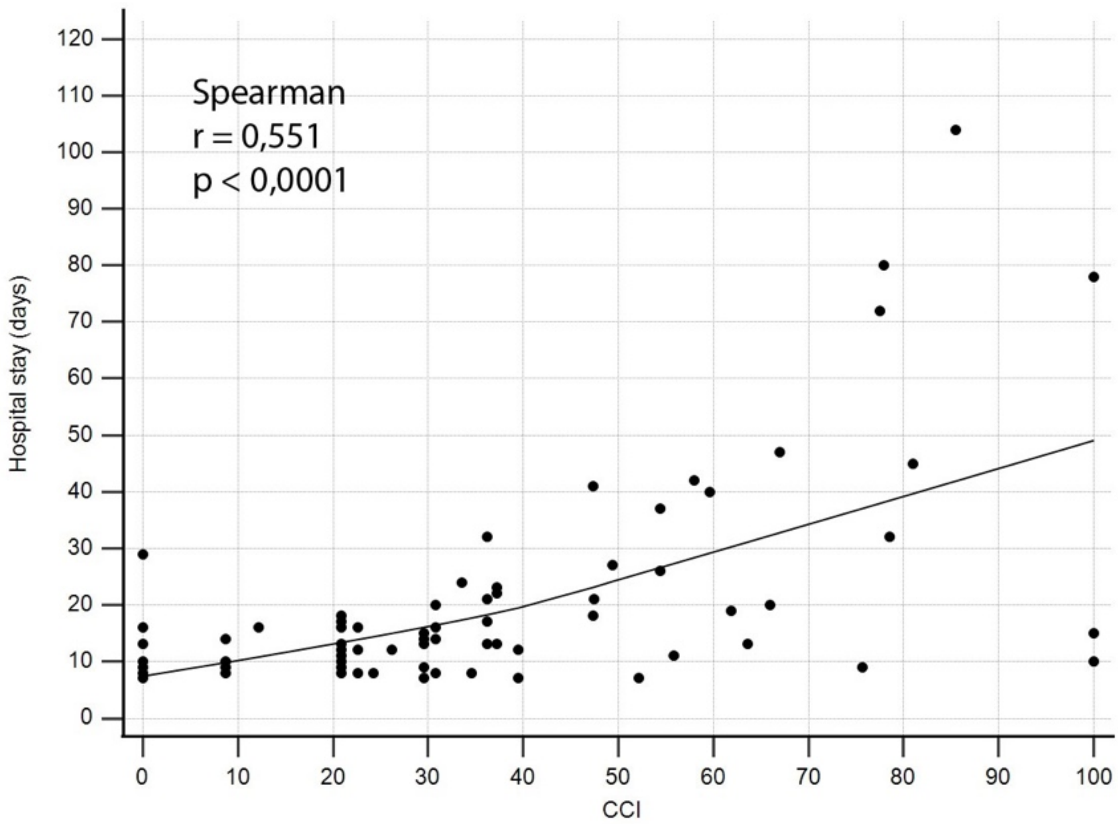

Fig. 5. Correlation between total CCI and length of hospital stay (r = 0.551, $p < 0.0001$).

Table 3. Frequencies, proportions and grading of perioperative 90-d complications.

Items	Total	Control out of COVID	First wave	p^a	Complete COVID period	p^b
Genitourinary complications, n (%)	71 (78.9)	33 (80.5)	13 (86.7)	0.59	38 (77.6)	0.73
Infectious complications, n (%)	59 (65.6)	27 (65.9)	10 (66.7)	0.96	32 (65.3)	0.96
Urinary infection, n (%)	38 (42.2)	17 (41.5)	7 (46.7)	0.73	21 (42.9)	0.894
Gastrointestinal complications, n (%)	54 (60.0)	24 (58.5)	9 (60.0)	0.92	30 (61.2)	0.8
Postoperative ileus, n (%)	23 (25.6)	9 (22.0)	5 (33.3)	0.38	14 (28.6)	0.473
Nasogastric tube, n (%)	18 (20.0)	6 (14.6)	4 (26.7)	0.29	12 (24.5)	0.244
Parenteral nutrition, n (%)	15 (16.7)	5 (12.2)	2 (13.3)	0.91	10 (20.4)	0.298
Cardiac complications, n (%)	16 (17.8)	5 (12.2)	3 (20.0)	0.46	11 (22.4)	0.205
Neurological complications, n (%)	10 (11.1)	5 (12.2)	2 (13.3)	0.91	5 (10.2)	0.765
Pulmonary complications, n (%)	9 (10.0)	2 (4.9)	2 (13.3)	0.28	7 (14.3)	0.138
Surgical complications, n (%)	14 (15.6)	4 (9.8)	1 (6.7)	0.72	10 (20.4)	0.165
Postoperative bleeding, n (%)	6 (6.7)	2 (4.9)	0 (0.0)	0.38	4 (8.2)	0.534
Transfusion, n (%)	29 (32.2)	14 (34.1)	6 (40.0)	0.69	15 (30.6)	0.721
Wound infection, n (%)	6 (6.7)	2 (4.9)	2 (13.3)	0.28	4 (8.2)	0.534
Symptomatic lymphocele, n (%)	6 (6.7)	4 (9.8)	0 (0.0)	0.21	2 (4.1)	0.28
Pelvic collection, n (%)	18 (20.0)	7 (17.1)	6 (40.0)	0.07	11 (22.4)	0.525
Abdominal collection, n (%)	6 (6.7)	0 (0.0)	1 (6.7)	0.09	6 (12.2)	0.020

n, number of patients; OR, odds ratio; CI, confidence interval. [a]Comparative analysis between the first COVID-19 wave and a non-COVID control cohort. [b]Comparative analysis between the entire COVID-19 period and a non-COVID control cohort.

We also examined the association between postoperative length of stay and CCI and CDC scores. The CCI showed a stronger correlation with length of stay than the CDC system, particularly when considering only the most severe complications (r = 0.551, $p < 0.0001$ vs r = 0.494, $p < 0.0001$) (Figs. 5 and 6).

Table 4. Frequencies, proportions and grading of perioperative 90-day complications and mortality.

Items	Total	Control out of COVID	First wave	p^a	Complete COVID period	p^b
Hospital readmission, n (%)	25 (27.8)	7 (17.1)	4 (26.7)	0.55	18 (36.7)	0.007
Surgical reintervention, n (%)	8 (8.9)	2 (4.9)	1 (6.7)	0.79	6 (12.2)	0.221
Tumoral relapse 90-d, n (%)	7 (7.8)	6 (14.6)	0 (0.0)	0.12	1 (2.0)	0.026
Death 30-d, n (%)	2 (2.2)	0 (0.0)	1 (6.7)	0.1	2 (4.1)	0.19
Death 90-d, n (%)	4 (4.4)	0 (0.0)	2 (13.3)	0.02	4 (8.2)	0.06
Death 1-year, n (%)	20 (22.2)	11 (26.8)	2 (13.3)	0.29	9 (18.4)	0.34
Major complications (Clavien ≤II), n (%)	72 (80.0)	34 (82.9)	13 (86.7)	0.74	38 (77.6)	0.53
Minor complications (Clavien ≥III), n (%)	28 (31.1)	10 (24.4)	7 (46.7)	0.11	18 (36.7)	0.21
CCI per patient, median (IQR)	29.6 (26.4)	22.6 (26.8)	33.5 (28.5)	0.19	33.5 (28.5)	0.18
CCI <33.7, n (%)	55 (61.1)	27 (65.9)	8 (53.3)	0.39	28 (57.1)	0.4
CCI ≥33.7, n (%)	35 (38.9)	14 (34.1)	7 (46.7)		21 (42.9)	
Clavien ≤IIIa, n (%)	69 (76.7)	34 (82.9)	12 (80.0)	0.8	35 (71.4)	0.2
Clavien ≥IIIb, n (%)	21 (23.3)	7 (17.1)	3 (20.0)		14 (28.6)	
Reclassification[c] difference, n (%), CI	14 (15.6) (8.07–23.04)	7 (17.1) (5.56–28.59)	4 (26.7) (4.29–49.05)		7 (14.3) (4.49–24.08)	
Reclassification, *p*	0.0001	0.0156	0.0125		0.0146	

n, number of patients; IQR, interquartile range. [a]Comparative analysis between the first COVID-19 wave and a non-COVID control cohort. [b]Comparative analysis between the entire COVID-19 period and a non-COVID control cohort. [c]Patients reclassified from Clavien ≤3a to CCI ≥33.7.

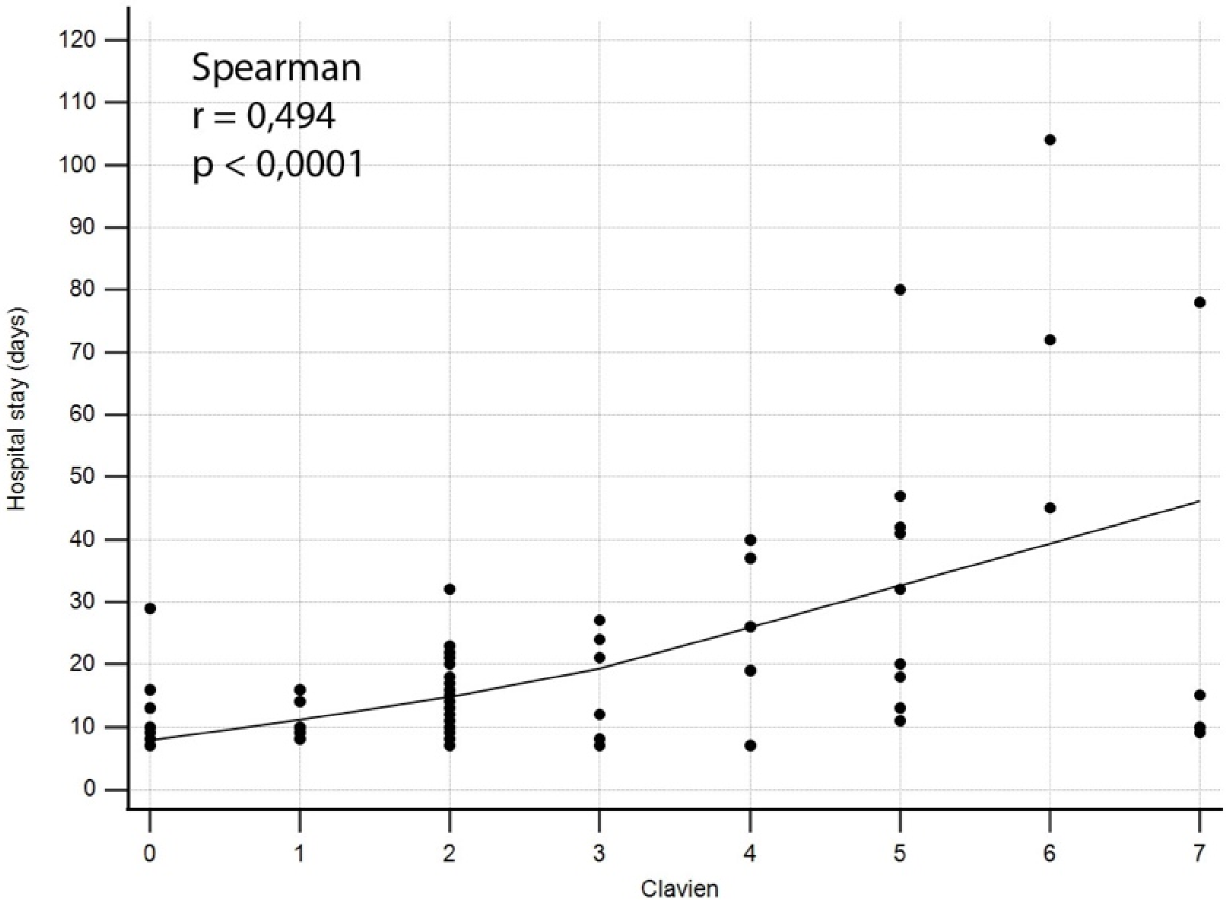

Fig. 6. Correlation between higher-grade complication (Clavien-Dindo classification) and length of hospital stay (r = 0.494, *p* < 0.0001).

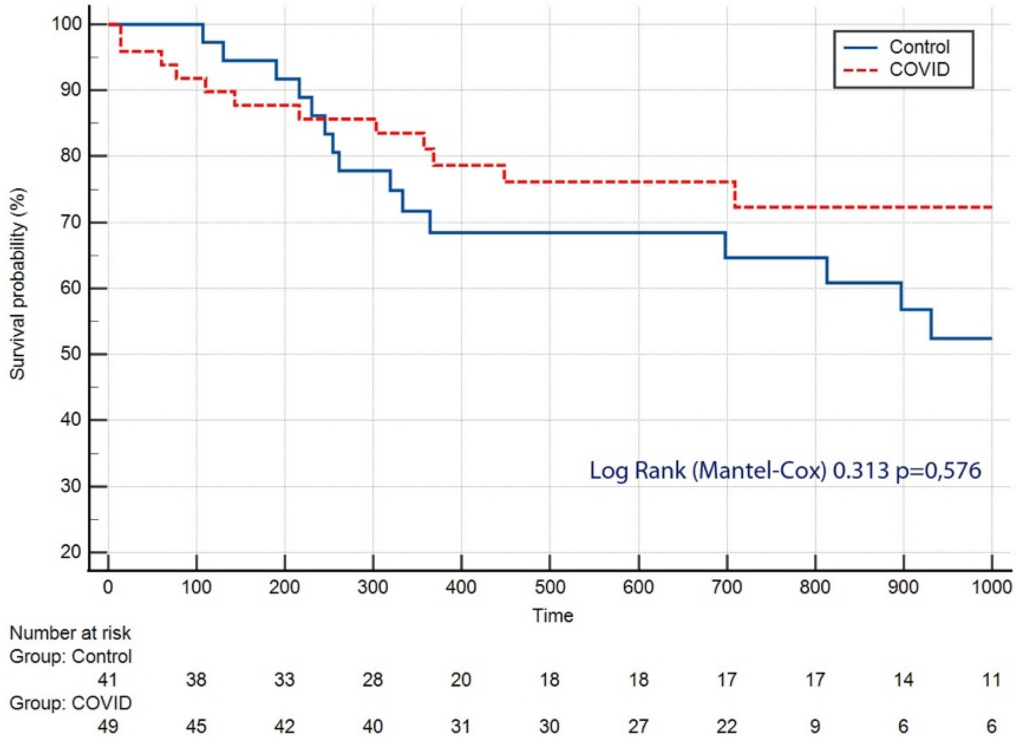

Fig. 7. Kaplan–Meier analyses according to control and COVID groups.

Crude and adjusted logistic regression analyses failed to identify any variables significantly associated with an increased risk of overall complications.

Recurrence and Mortality

At 3 months postoperatively, tumour recurrence was significantly higher in the control out of COVID-19 cohort than in pandemic groups (0.0% in the first wave and 2.0% in the complete COVID-19 group; $p = 0.12$ and $p = 0.026$, respectively). By contrast, mortality at 1 and 3 months was elevated in both COVID-19 cohorts. This difference reached statistical significance at 3 months (13.3% in the first wave and 8.2% in the complete COVID-19 group vs 0% in the control group; $p = 0.02$ and $p = 0.06$, respectively). No statistically significant differences were observed between groups when stratified by hospitalisation unit.

The overall mortality rates at 1, 3 and 12 months were 2.3%, 4.4% and 22.2%, respectively. All deaths within the first 3 months occurred during the COVID-19 periods. However, at 12 months, this trend reversed with non-significantly higher mortality observed in the control out of COVID-19 cohort compared with the complete COVID-19 group (26.8% vs 18.4%, $p = 0.34$) (Table 4). Fig. 7 illustrates the cumulative 1-year postoperative mortality by study group (log rank (Mantel-Cox) = 0.313, $p = 0.576$).

Discussion

The COVID-19 pandemic resulted in high occupancy rates in hospitals and intensive care units, prompting a substantial reorganization of healthcare services, including the suspension or redistribution of surgical procedures in numerous hospitals nationwide. Although less pronounced, this situation also affected our region [4,5].

Our analysis of RC outcomes revealed elevated postoperative complication rates, particularly during the first wave, with abdominal collections reaching statistical significance. This pattern was aligned with other reports noting increased frequency and severity of complications during the early pandemic period, although causality remains unverified due to unmeasured variables such as staffing variations, intensive care unit (ICU) access restrictions and modified infection protocols [13].

In our study, 84.5% of patients experienced at least one complication, reflecting a rigorous and systematic approach for reporting complications. This highlights the importance of standardized, comprehensive documentation in surgical series [7]. The literature indicates that reported complication rates vary widely (19%–99%), primarily due to imprecise definitions, interobserver variability and underreporting, rather than actual differences in surgical outcomes [7]. Despite advancements in standardisation through EAU guidelines, the absence of universally mandated reporting protocols remains a barrier to cross-study comparability [7,14].

The predominant complications observed in our cohort were genitourinary and infectious, particularly urinary tract infections (42.2%), followed by the need for blood transfusions and postoperative ileus. This distribution was aligned with prior studies; Nevertheless, we observed a particularly high incidence of infectious complications [15].

Although minimally invasive approaches limited wound infections, their initial surge (13.3% vs 6.7%) may reflect pandemic-driven resource constraints [16]. This increase in complications observed during the pandemic may be attributed to multiple factors. Although neither surgical delays nor the absence of ERAS protocol implementation appears to explain the findings in our cohort, the lack of precise data on the extent and quality of adherence may suggest that ERAS was suboptimally applied during the pandemic, potentially contributing to the outcomes observed.

Additionally, the burden on the healthcare system and the emotional stress endured by surgical personnel may have negatively influenced surgical outcomes, as evidenced in previous studies [17].

The CCI offers an advantage over the CDC by quantifying the cumulative burden of multiple complications, particularly in high-morbidity procedures such as RC [7,9,12].

We recorded a total of 212 postoperative complications, with a median of two complications per patient. Reliance on CDC alone, which accounted only for the most severe complication, would likely underestimate overall morbidity [9].

Notably, 14 patients (20.3%) classified as Clavien ≤3a demonstrated a CCI ≥33.7, highlighting the CCI's superior sensitivity in identifying cumulative postoperative morbidity. This was consistent with gastrointestinal oncology literature, including gastric cancer and pancreatic surgery, where the CCI has demonstrated better discriminatory ability than the CDC [18]. However, its advantage may diminish in low-complication urologic procedures, necessitating procedure-specific validation [9].

Furthermore, CCI scores in our study showed a slightly stronger correlation with postoperative length of stay than CDC scores, consistent with previous literature [9].

However, in urological procedures with few complications and short hospital stays (e.g., radical prostatectomy and partial nephrectomy), the advantage of CCI over CDC may be less evident [19].

The length of stay is an inadequate proxy for postoperative outcomes. Additional studies are warranted to evaluate the correlation of both grading systems with broad outcome measures, including quality of life, readmission rates and long-term morbidity [9].

In clinical trials, the use of CCI as an outcome measure may reduce the required sample size by accounting for a high number of events, thereby improving feasibility and cost-effectiveness [12].

A potential limitation of the original CCI is that scores may exceed 100 when multiple minor complications are present. Modified frameworks include the Berne CCI [20].

Multi-centre collaborations should prioritise checklist development to reduce reporting bias, subjectivity and underestimation, as well as implement roadmaps to enable benchmarking [7,21].

This study had some limitations. Recall bias and interobserver variability may have affected data collection despite efforts to ensure consistency. The small sample limited generalisability and statistical power, especially in subgroup analyses. Furthermore, minor complications may have disproportionately influenced the overall CCI scores, potentially exaggerating perceived morbidity.

Unaccounted intraoperative variables and pandemic-related institutional changes (staffing, infection control measures or ICU availability) are other biases that may have influenced postoperative outcomes.

Conclusions

Patients undergoing RC with IC diversion during the first wave and the complete period of the COVID-19 pandemic experienced increased frequency and severity of postoperative complications, despite the predominant implementation of an ERAS protocol.

Relying solely on the CDC may underestimate the true burden of postoperative morbidity. The CCI offers an accurate and sensitive measure of surgical outcomes and should be considered for integration into clinical audits, registries and future outcome reporting in RC.

Standardised reporting of surgical complications is needed to ensure high-quality outcomes and comparability across studies. Future research should aim to correlate CCI with patient-centred outcomes (e.g., quality of life and readmission rates) to further establish its clinical relevance.

Availability of Data and Materials

The datasets used and/or analysed during the current study were available from the corresponding author on reasonable request.

Author Contributions

RB—designed the study; RB, EA, NG, JG, MS and GA—conducted the study and collected and analyzed the data; RB and JLG—participated in drafting the manuscript; MD, FC and ER—contributed to critical revision of the manuscript for important intellectual content. All authors gave final approval of the version to be published. All authors participated fully in the work, took public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or completeness of any part of the work were appropriately investigated and resolved.

Ethics Approval and Consent to Participate

This study was approved by the Cantabria Medicines And Health Products Research Ethics Committee (CEIm) (institution review board number, 2024.220) and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

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Conflict of Interest

The authors declare no conflict of interest.

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