



Clinical Research Study



PREDICTIVE ACCURACY OF THE COMPREHENSIVE COMPLICATION INDEX FOR CLINICALLY SIGNIFICANT MORBIDITY FOLLOWING METABOLIC BARIATRIC SURGERY

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323

patients

13.3%

complications

AUC 0.96

ROC performance

Clinical Context and Problem

Background

Bariatric surgery is effective, but morbidity requires objective, standardized monitoring.

Starting Point

Obesity increases the risk of diabetes, hypertension, and other chronic diseases.

Sleeve gastrectomy and Roux-en-Y gastric bypass are common and effective procedures.

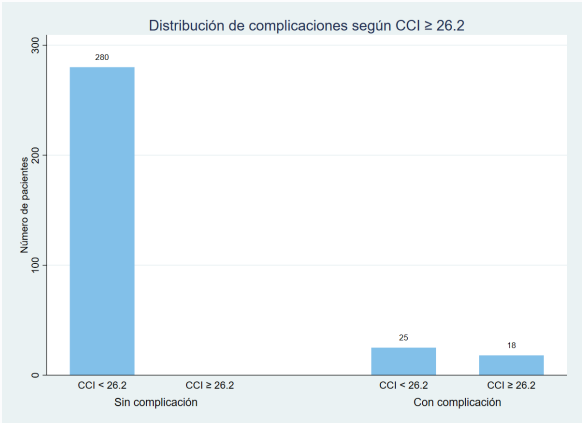
Postoperative morbidity may be underestimated when only the most severe complication is reported.

0.1–27.4%
reported complication
range

43/323
patients with
complications

Need for a
standardized metric

The lack of a universal reporting system limits comparisons across centers and hinders estimation of the true morbidity burden.



distribution using the CCI ≥ 26.2 cutoff

Appendix 1. Clavien–Dindo Classification

Grade		Definition
I		Any deviation from the normal postoperative course without pharmacological treatment or surgical, endoscopic, or radiological intervention. Allowed therapies include antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy. Includes wound infections opened at the bedside.
II		Pharmacological treatment beyond that allowed for grade I; also includes blood transfusions and total parenteral nutrition.
III		Requires surgical, endoscopic, or radiological intervention.
	a	Without general anesthesia.
	b	Under general anesthesia.
IV		Life-threatening complication requiring intermediate or intensive care.
	a	Single-organ dysfunction, including dialysis.
	b	Multiorgan dysfunction.
V		Death of the patient.

Comprehensive Complication Index (CCI)

Theoretical
framework

It complements Clavien–Dindo by integrating all adverse events into a continuous score.

Grade	CCI value	Weight (wC)
I	8.7	300
II	20.9	1750
IIIa	26.2	2750
IIIb	33.7	4550
IVa	42.4	7200
IVb	46.2	8550
V	100	Death

$$n = deff \times \frac{N\hat{p}\hat{q}}{\frac{d^2}{1.96^2}(N-1) + \hat{p}\hat{q}}$$

where

n = sample size
 $deff$ = design effect
 N = population size
 $\hat{p}$ = the estimated proportion
 $\hat{q} = 1 - \hat{p}$
 d = desired absolute precision or absolute level of precision

Advantages

- Quantifies morbidity from 0 to 100.
- Includes multiple complications per patient.
- Enables longitudinal comparisons across groups and centers.

Clinically relevant threshold in this study: CCI ≥ 26.2, equivalent to at least Clavien–Dindo grade IIIa.

Research Question, Hypothesis, and Objectives

The aim was to determine whether the CCI discriminates clinically significant postoperative morbidity.

Research question

How can the Comprehensive Complication Index be used to predict postoperative morbidity in patients undergoing bariatric surgery?

Hypothesis

The CCI predicts postoperative morbidity in bariatric surgery patients.

Primary objective

To evaluate the usefulness of the CCI as a predictor of clinically significant postoperative morbidity in patients undergoing bariatric surgery.

Summary of secondary objectives

Describe clinical and surgical characteristics.

Determine the prevalence of complications.

Compare morbidity burden by procedure.

Evaluate performance using the ROC curve and cutoff value.

Study Design

Methods

Retrospective cohort of patients who underwent bariatric surgery at Tláhuac General Hospital.



Inclusion criteria

Primary bariatric surgery at the HGT Obesity Clinic.
Roux-en-Y gastric bypass or sleeve gastrectomy.
More than one year of multidisciplinary follow-up.

Exclusion criteria

Surgery performed outside the center.
Age >65 years or follow-up <1 year.
Incomplete medical records or follow-up notes.

Measurements and Statistical Analysis

Complications, treatments, Clavien–Dindo grade, and total CCI were recorded.

Nombre	Expediente/NHC	Sexo	Edad	Fecha	Cirugía realizada

Data collection

Clinical and surgical data collection form.

Complications and treatments received were recorded.

CCI was calculated using the official tool.

Analysis

Chi-square/Fisher tests for categorical variables.

Student’s t test or Mann–Whitney U test according to distribution.

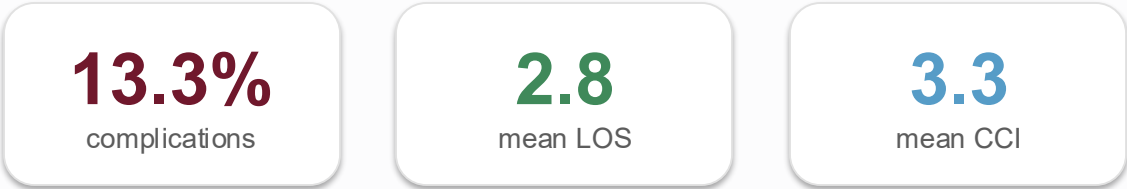
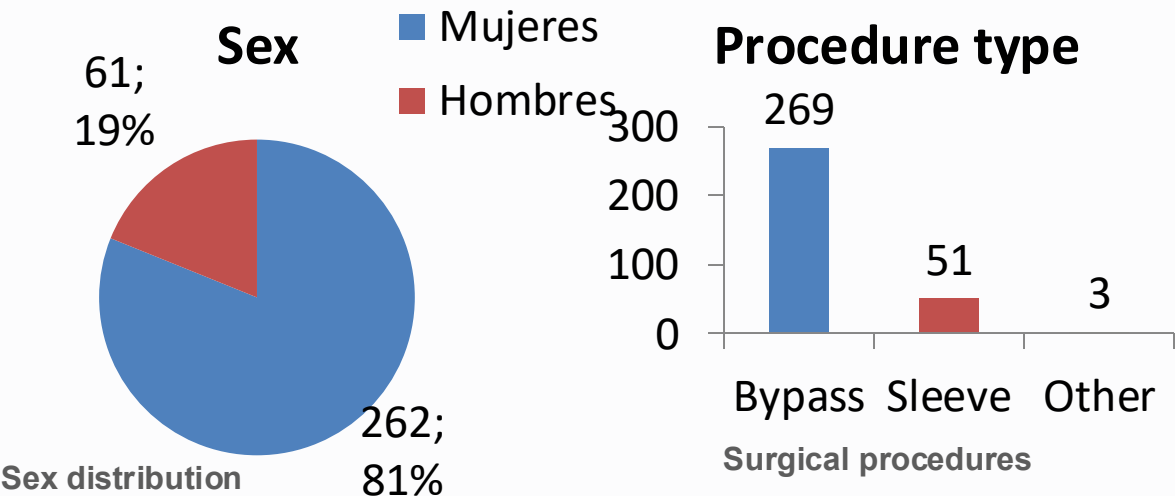
ROC curve, AUC, sensitivity, specificity, PPV/NPV, and likelihood ratios.

Significant morbidity: CCI ≥ 26.2 , corresponding to complications of at least Clavien–Dindo grade IIIa.

Results: Sample Characteristics

Table 1. Demographic and clinical characteristics of the cohort.

Variable	Value
N	323
Age, median (IQR)	40 (33–47)
Women, n (%)	262 (81.1)
Men, n (%)	61 (18.9)
Bypass, n (%)	269 (83.3)
Sleeve, n (%)	51 (15.8)
Other, n (%)	3 (0.9)
Complications, n (%)	43 (13.3)
CCI, mean (SD)	3.3 (9.7)
LOS, mean (SD)	2.8 (5.4)



Results: Comparison by Complication Status

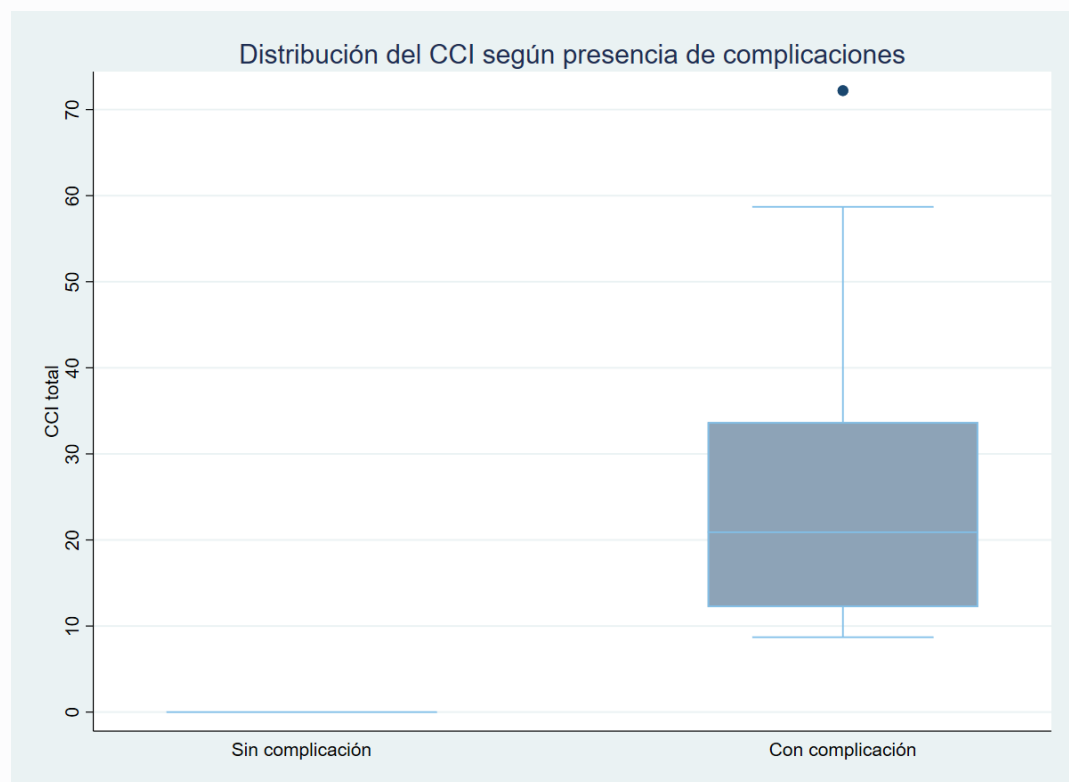
Table 2. Clinical variables by presence or absence of complications.

Variable	With complications (n=43)	Without complications (n=280)	p
Age, mean (SD)	38.4 (11.0)	40.3 (10.0)	0.25
Women, n (%)	36 (83.7)	226 (80.7)	0.62
Bypass	40 (93.0)	229 (81.8)	0.038
Sleeve	2 (4.7)	49 (17.5)	
Other	1 (2.3)	2 (0.7)	
CCI, median (IQR)	34.8 (20.9–58.7)	0 (0–0)	<0.001
LOS, median (IQR)	4 (2–12)	2 (2–2)	<0.001

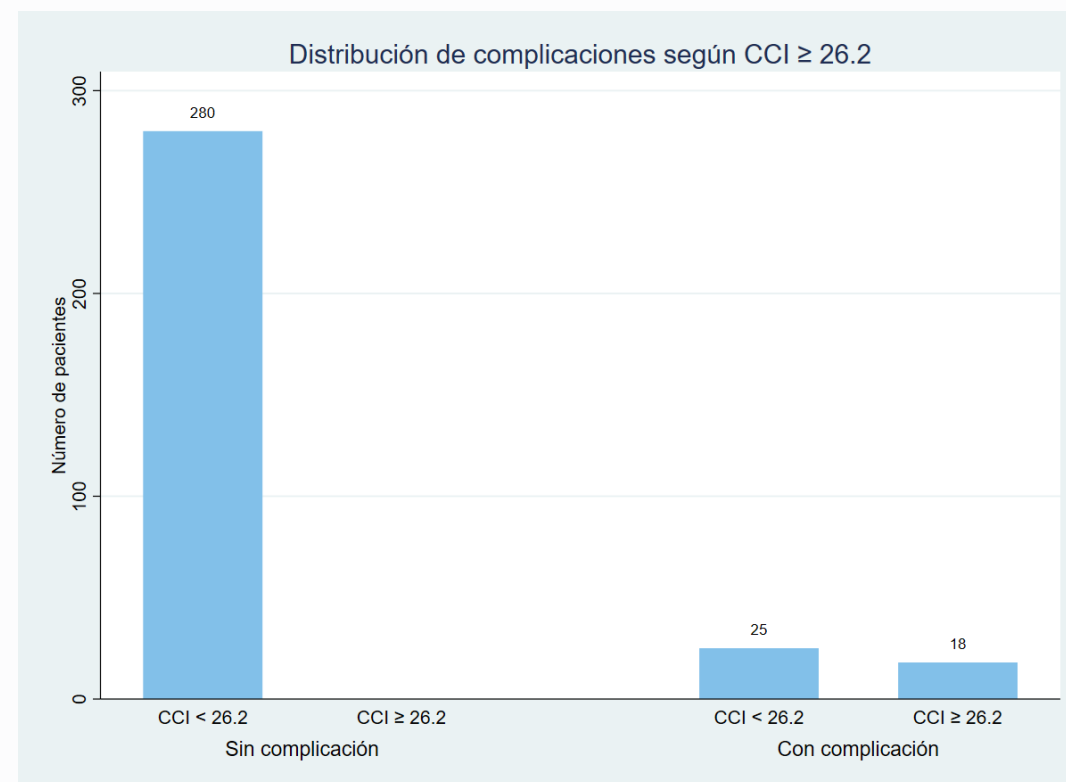
Key findings: bypass was associated with a higher proportion of complications (p=0.038); CCI and length of hospital stay were significantly higher among patients with complications (p<0.001).

Morbidity Burden Measured by CCI

The study figures show that high CCI values cluster among patients with complications.



Box plot: patients without complications cluster at CCI = 0; the complication group shows a higher median and greater dispersion.

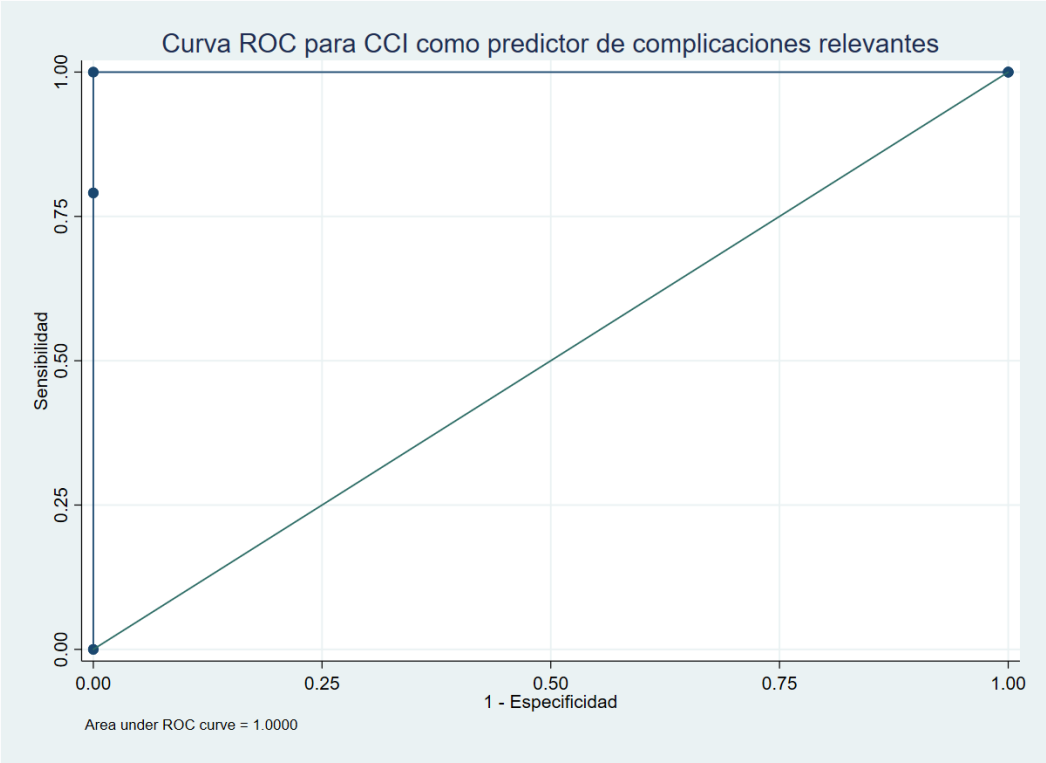


Bar chart: the CCI ≥ 26.2 cutoff identifies cases with clinically relevant morbidity.

Diagnostic Performance of the CCI

Results

Table 3 and ROC curve: excellent discrimination for clinically relevant morbidity.



Indicator	Result	95% CI
Sensitivity	41.9%	27.0–57.9
Specificity	100.0%	98.7–100.0
PPV	100.0%	—
NPV	91.8%	88.1–94.6
LR+	12.20	8.38–17.76
LR-	0.00	—
AUC	0.96	0.94–0.97

Interpretation: an AUC of 0.96 indicates excellent discrimination. A CCI ≥ 26.2 achieved 100% specificity and PPV for significant complications in this cohort.

Cutoff and Classification Matrix

Results

The CCI ≥ 26.2 threshold identifies clinically relevant complications with no false positives in this sample.

CCI	Complications YES	Complications NO	Total
CCI ≥ 26.2	18	0	18
CCI < 26.2	25	280	305
Total	43	280	323

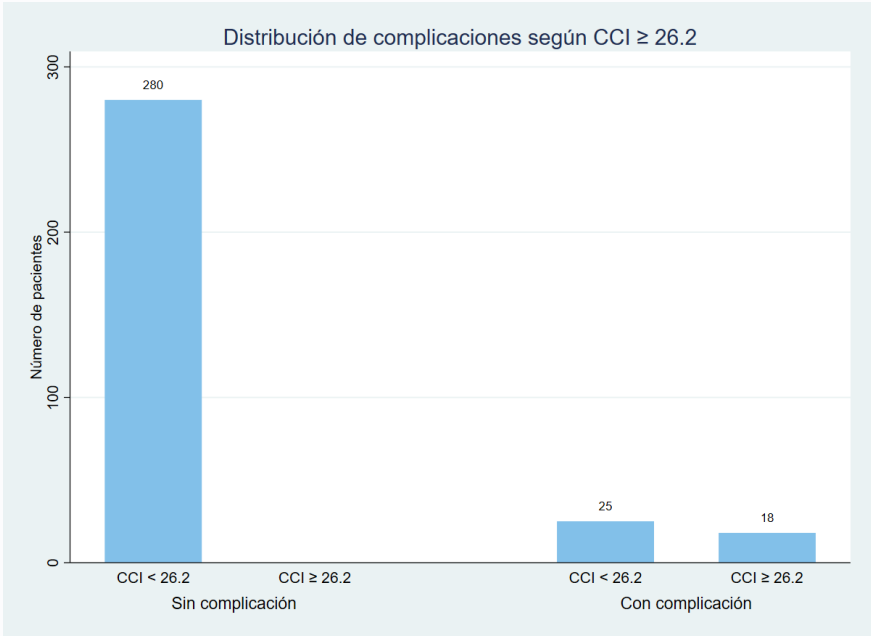
18
true positives

0
false positives

280
true negatives

Clinical interpretation of the cutoff

- A high CCI confirms significant morbidity.
- A low CCI does not rule out all complications; some were mild or moderate.
- Useful as a trigger for closer monitoring and early intervention.



Conclusions

The key finding is that the CCI quantifies the true postoperative morbidity burden using a single continuous metric.

13.3%

overall complication prevalence

AUC 0.96

excellent CCI discrimination

CCI $\geq$ 26.2

significant morbidity threshold

100%

specificity and PPV in this cohort

Conclusions

- Most patients had no clinically relevant complications; high CCI values clustered in the complication subgroup.
- The CCI complements Clavien–Dindo by integrating all adverse events, not only the most severe one.
- The 26.2 cutoff identifies clinically relevant events requiring intervention.

Clinical significance

- A high CCI represents cumulative morbidity burden rather than an isolated number.
- It facilitates comparisons across procedures, periods, and surgical teams.
- Routine use may strengthen monitoring, quality, and safety in bariatric care.

Conclusions

Closing

The CCI can be incorporated as a complementary metric for evaluating postoperative outcomes in bariatric surgery.

Main conclusion

Routine integration of the CCI into postoperative outcome assessment in bariatric surgery is recommended.

Standardizes

Quantifies the entire complication burden as a continuous score.

Identifies risk

Helps identify patients with adverse outcomes who require close monitoring.

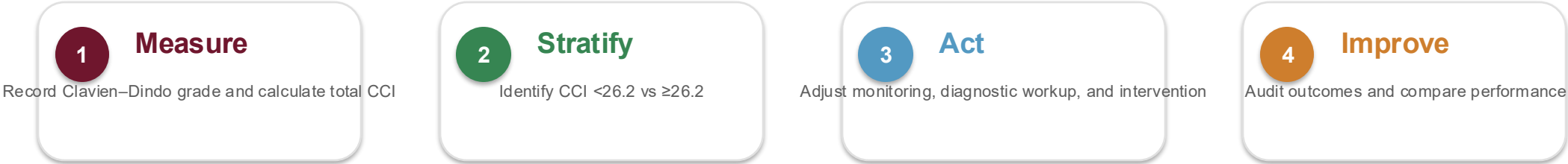
Optimizes decisions

Facilitates early intervention and outcome comparisons across groups and centers.

Key references: Slankamenac 2013; Kassir 2016; Kim 2021; Tsenteradze 2023; Eisenberg/ASMBS-IFSO 2022/2023.

Clinical Decision-Making Implications

The CCI transforms complication reporting into a practical tool for clinical intervention, resource allocation, and continuous improvement.



CCI result	Interpretation	Suggested action
CCI < 26.2	Absent, mild, or moderate morbidity; low risk of significant complications.	Routine follow-up, warning-sign education, and systematic documentation.
CCI ≥ 26.2	High probability of significant morbidity; there were no false positives in this cohort.	Close monitoring, active evaluation for complications, early intervention, and case review.

Routine CCI use enables a shift from “reporting complications” to objective, proactive decision-making.

Explore Premium →

0

CCI®

0

CCI®

0

CCI®

Comprehensive
Complication Index

0

Reset

Grade I

−

0

+

Grade II

−

0

+

Grade IIIa

−

0

+

Grade IIIb

−

0

+

Grade IVa

−

0

+

Grade IVb

−

0

+

Grade V

−

0

+

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