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Original Research Article

Assessment of Postoperative Complications in Elective Major Abdominal Surgeries Using the Clavien–Dindo Classification System: A Prospective Observational Study

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Abstract

Background: Postoperative complications following elective major abdominal surgeries remain a significant cause of morbidity and healthcare burden. The Clavien–Dindo Classification (CDC) provides an objective, therapy-based framework for standardized grading of surgical complications. This study aimed to assess postoperative complications using the CDC system and correlate their severity with postoperative morbidity.

Methods: A prospective cross-sectional observational study was conducted over 18 months in the Department of General Surgery, Gandhi Medical College and Hamidia Hospital, Bhopal. A total of 102 patients undergoing elective major abdominal surgeries were enrolled consecutively. Complications were graded using the Clavien–Dindo Classification (Grades I–V). Statistical analysis was performed using SPSS; Chi-square test and Student's t-test were applied. A p-value <0.05 was considered significant.

Results: Of 102 patients, 68.6% were male. The majority belonged to the 30–60 years age group. Comorbidities were present in 30.4% of patients. Grade I complications were the most frequent (39.2%), followed by Grade II (22.5%), Grade III (19.6%), Grade IV (11.8%), and Grade V (death) in 6.9%. Surgical site infections, wound gaping, seroma, and postoperative fever were the commonest complications. Higher CDC grade correlated significantly with prolonged hospital stay, ICU admission, and need for reintervention ($p<0.05$).

Conclusion: Most postoperative complications in elective major abdominal surgeries are low-grade and manageable. The Clavien–Dindo Classification is a simple, reliable, and reproducible tool for standardized complication reporting. Higher CDC grades reliably predict greater postoperative morbidity, making it a valuable prognostic instrument in surgical audit and clinical practice.

Keywords: Clavien–Dindo Classification; Postoperative Complications; Elective Abdominal Surgery; Surgical Morbidity; Complication Grading.

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Introduction

Surgical procedures, whether elective or emergency, carry an inherent risk of postoperative complications that significantly influence patient outcomes, healthcare costs, and quality of life. Despite major advances in surgical technique, anesthetic management, and perioperative care, postoperative morbidity continues to pose formidable challenges in modern surgical practice. [1] Historically, the assessment and reporting of postoperative complications lacked standardization. Many early classification systems categorized complications subjectively as 'minor' or 'major' without explicit definitions, limiting reproducibility and inter-institutional comparisons. [2] This inconsistency created an urgent need for a universally accepted, objective grading system. To address this, Clavien et al. in 1992 proposed a structured classification system that distinguished complications from sequelae and failure to cure, defining a complication as any deviation from the

expected postoperative course. [1] This was substantially revised and validated by Dindo et al. in 2004, giving rise to the widely used Clavien–Dindo Classification (CDC). [2] The CDC grades complications from Grade I (minor deviation requiring no pharmacological intervention) to Grade V (death), based objectively on the type of therapeutic intervention required — an approach that minimizes subjectivity and maximizes reproducibility. [3]

Major abdominal surgeries—including gastrointestinal, hepatobiliary, colorectal, and pancreatic procedures—are particularly susceptible to postoperative complications due to procedural complexity, patient comorbidities, and intraoperative risk factors. Complications such as surgical site infections (SSI), anastomotic leaks, intra-abdominal abscesses, and cardiopulmonary events contribute substantially to prolonged hospital stay and increased healthcare burden. [4]

Systematic grading of complications not only improves reporting accuracy but also aids risk stratification, outcome prediction, and quality improvement. Validated tools such as the American Society of Anesthesiologists (ASA) classification and POSSUM (Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity) facilitate preoperative risk assessment. [5] Furthermore, Enhanced Recovery after Surgery (ERAS) protocols have underscored the importance of early detection and standardized reporting of complications. [6]

This study aimed to assess postoperative complications in patients undergoing elective major abdominal surgeries at a tertiary care center, using the Clavien–Dindo Classification, and to correlate complication severity with postoperative morbidity outcomes.

Aims and Objectives

Primary Objective: To determine the incidence of postoperative complications in patients undergoing elective major abdominal surgeries using the Clavien–Dindo Classification system.

Secondary Objective: To correlate the severity of postoperative complications with postoperative morbidity — including hospital stay, ICU admission rates, and need for reintervention — using the Clavien–Dindo Classification.

Materials and Methods

Study Design and Setting: This was a prospective, cross-sectional observational study conducted in the Department of General Surgery, Gandhi Medical College and Associated Hamidia Hospital, Bhopal, Madhya Pradesh, India — a tertiary care teaching hospital. The study duration was 18 months, following approval from the Institutional Ethics Committee (IEC).

Study Population and Sampling: The study population comprised patients admitted to surgical wards for elective major abdominal surgeries. A consecutive sampling method was employed, enrolling all eligible patients during the study period until the required sample size was achieved.

Inclusion Criteria

- Patients aged >14 years
- Undergoing elective major abdominal surgery
- Willing to participate with written informed consent

Exclusion Criteria

- Patients with prior abdominal surgery
- Pregnant patients undergoing surgical procedures
- Patients unwilling to participate

Sample Size: Sample size was calculated using the formula: $n = 4PQ/d^2$, where P = prevalence of postoperative complications (assumed 50%), Q = 50, d = margin of error (10%). This yielded a minimum sample of n = 100; a total of 102 patients were enrolled.

Study Procedure: All patients underwent standardized preoperative evaluation including detailed history, clinical examination, laboratory investigations (CBC, LFT, RFT, coagulation profile, viral markers), and radiological imaging (ultrasonography). Surgical procedures were performed per standard institutional protocols. Postoperative monitoring was conducted for 30 days; patients discharged before 30 days were followed up via telephonic interview or outpatient visits. Any deviation from the normal postoperative course was recorded and graded using the Clavien–Dindo Classification.

Outcome Measures: Primary outcome: Incidence and grading of postoperative complications per CDC. Secondary outcomes: Correlation of CDC grade with hospital stay duration, ICU admission, need for reintervention, and mortality.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS software. Continuous variables were expressed as mean ± standard deviation; categorical variables as frequencies and percentages. Chi-square test was used for association between categorical variables; Student's t-test for comparison of means. A p-value <0.05 was considered statistically significant.

Clavien–Dindo Classification System

Table 1: Clavien–Dindo Classification of Surgical Complications

Grade	Definition	Example Interventions
I	Minor deviation from normal postoperative course; requiring no pharmacological, surgical, endoscopic, or radiological intervention beyond allowed medications	Wound care, physiotherapy, antiemetics, analgesics, antipyretics
II	Deviation requiring pharmacological treatment with drugs not allowed for Grade I complications	Antibiotics, blood transfusions, total parenteral nutrition, diuretics
IIIa	Surgical, endoscopic, or radiological intervention — not under general anesthesia	Drainage of seroma/abscess at bedside, pigtail insertion, endoscopy
IIIb	Surgical, endoscopic, or radiological intervention — under general anesthesia	Re-exploration, anastomotic leak repair, vascular repair under GA
IVa	Life-threatening complication requiring ICU management — single organ dysfunction	Respiratory failure, renal failure, pulmonary embolism
IVb	Life-threatening complication — multi-organ dysfunction	Sepsis with MODS (Multi-Organ Dysfunction Syndrome)
V	Death of the patient	—

Observations and Results

Demographic Profile: A total of 102 patients were enrolled. The age range extended from 15 to 79 years. The majority (50%) belonged to the 30–60 years age group, followed by elderly patients (>60 years) who constituted a significant subset associated with higher perioperative risk. Younger patients (<30 years) formed a smaller proportion. Sex distribution showed a clear male predominance: 70 males (68.6%) and 32 females (31.4%), with a male-to-female ratio of 2.2:1.

The higher proportion of males may be attributable to greater exposure to risk factors such as tobacco use, alcohol consumption, and occupational stressors predisposing to abdominal surgical conditions.

Table 2: Demographic and Comorbidity Profile of Study Population (n=102)

Parameter	Category	Number (n)	Percentage (%)
Age Group	<30 years	16	15.7
	30–60 years	51	50.0
	>60 years	35	34.3
Sex	Male	70	68.6
	Female	32	31.4
Comorbidities	Nil	72	70.6
	Diabetes Mellitus	9	8.8
	Hypertension	6	5.9
	COPD	5	4.9
	Others (Anemia, Jaundice, CAD, Asthma)	10	9.8

Comorbidities: Comorbid conditions were present in 30.4% (n=31) of patients. Diabetes mellitus was the most common comorbidity (8.8%), followed by hypertension (5.9%), COPD (4.9%), and others including anemia and jaundice. Patients with comorbidities demonstrated a higher incidence and severity of postoperative complications compared to those without.

Surgical Procedures Performed: The study encompassed a diverse range of elective major abdominal surgeries. Gastrointestinal surgeries (including intestinal resections, anastomoses, stoma closures, and gastrojejunostomy) formed the largest group.

Hepatobiliary procedures (cholecystectomy, CBD exploration, hepaticojejunostomy), colorectal surgeries (hemicolectomies, abdominoperineal resection, stoma closures), hernia repairs (onlay/sublay mesh hernioplasties), and complex procedures (Whipple's pancreaticoduodenectomy, splenectomy, gastrectomy) were also represented.

Table 3: Distribution of Surgical Procedures Performed (n=102)

Procedure Category	Number (n)	Percentage (%)
Gastrointestinal surgeries (resections, anastomoses, stoma closures)	38	37.3
Hepatobiliary procedures (cholecystectomy, CBD exploration)	18	17.6
Colorectal surgeries (hemicolectomy, APR, stoma closures)	17	16.7
Hernia repairs (onlay/sublay mesh hernioplasty)	14	13.7
Gastric surgeries (gastrectomy, gastrojejunostomy)	9	8.8
Complex/pancreatic surgeries (Whipple, splenectomy, others)	6	5.9

Grading of Postoperative Complications (Clavien–Dindo): Postoperative complications were recorded in all 102 patients and graded using the CDC system. Two patients had no complications (Grade 0). The distribution of complications is presented in Table 4.

Table 4: Distribution of Complications According to Clavien–Dindo Grading (n=102)

CDC Grade	Number (n)	Percentage (%)	Clinical Significance
Grade 0 (No complication)	2	2.0	Uneventful recovery
Grade I	40	39.2	Minor; no intervention needed beyond permitted medications
Grade II	23	22.5	Pharmacological treatment required (antibiotics, transfusion, TPN)
Grade IIIa	20	19.6	Intervention without GA (drainage, pigtail, secondary suturing)
Grade IIIb	3	2.9	Re-exploration under GA
Grade IVa	4	3.9	Single organ failure; ICU care required
Grade IVb	3	2.9	Multi-organ dysfunction
Grade V (Death)	7	6.9	Mortality

Types of Postoperative Complications Observed

Table 5: Types of Postoperative Complications Observed

Category	Complication	CDC Grade
Surgical Site	Wound infection / SSI	I–II
	Wound gaping	I–IIIa
	Seroma formation	I–IIIa
	Hematoma	IIIa
Systemic	Postoperative fever	I
	Tachycardia	I
	Urinary tract infection	II
	Pneumonia	II
	Blood transfusion required	II
	Total parenteral nutrition required	II
Anastomotic	Anastomotic leak	IIIb–IV
	Pelvic / intra-abdominal abscess	IIIa
Organ Failure	Pulmonary edema / ARDS	IVa
	Acute kidney injury (AKI)	IVa
	Renal failure	IVb
	Sepsis with MODS	IVb
Procedure-Specific	Dumping syndrome	I
	Diarrhea (non-infectious)	I
	Delayed gastric emptying	I–II
Mortality	Death	V

Correlation of Clavien–Dindo Grade with Postoperative Morbidity: A significant positive correlation was found between CDC grade and postoperative morbidity indicators. Higher-grade complications were associated with significantly prolonged hospital stay, increased ICU admissions, and greater need for reintervention ($p<0.05$), confirming that CDC grade is a reliable predictor of postoperative morbidity.

Table 6: Correlation of Clavien–Dindo Grade with Postoperative Morbidity Outcomes

CDC Grade	n (%)	Mean Hospital Stay (Days)	ICU Admission n (%)	Re-intervention n (%)	Mortality n (%)
Grade I	40 (39.2%)	4.2 ± 1.1	0 (0%)	0 (0%)	0 (0%)
Grade II	23 (22.5%)	6.8 ± 1.5	2 (8.7%)	0 (0%)	0 (0%)
Grade III	20 (19.6%)	10.5 ± 2.3	6 (30%)	20 (100%)	0 (0%)
Grade IV	12 (11.8%)	15.8 ± 3.2	12 (100%)	8 (66.7%)	3 (25%)
Grade V	7 (6.9%)	—	—	—	7 (100%)

$p<0.05$ (statistically significant for all morbidity parameters across CDC grades)

Discussion

Overview: The present study systematically evaluated postoperative complications using the Clavien–Dindo Classification in 102 patients undergoing elective major abdominal surgeries at a tertiary care center. The results demonstrate that the majority of complications were minor (Grade I–II, 61.7%), while severe complications (Grade III–V) were less frequent but carried disproportionate clinical impact — consistent with global surgical literature. [3]

Distribution of Complications: Grade I complications (39.2%) constituted the largest group, comprising predominantly surgical site infections, wound gaping, postoperative fever, and transient physiological disturbances. Grade II complications (22.5%) predominantly required antibiotic therapy or blood transfusions. These findings mirror those reported by Alves et al. and Bokey et al. in colorectal surgery cohorts, where minor complications constituted the majority of postoperative events. [9,10] Although often considered clinically less significant, minor complications play an important role in prolonging hospital stay and affecting patient satisfaction. Even Grade I complications can delay discharge and increase healthcare costs [12]. Early recognition and prompt management are therefore essential.

Severe Complications: Grade III complications were observed in 19.6% of patients, most commonly manifesting as wound gaping requiring secondary suturing, seroma drainage, pelvic abscess drainage, or anastomotic complications requiring re-exploration. Anastomotic leak — a feared complication in gastrointestinal and colorectal surgery — was associated with high CDC grades (IIIb). Frasson et al. similarly identified anastomotic leak as a major driver of higher-grade morbidity and mortality. [11] Grade IV complications (11.8%) involved organ failure requiring ICU management, including pulmonary edema, acute kidney injury, and sepsis with multi-organ dysfunction. These correlated with a 25% mortality rate in this subgroup. Grade V (death) occurred in 6.9% (n=7) of patients, predominantly in those with periampullary carcinomas undergoing complex bilioenteric procedures. Overall mortality is comparable to published literature from similar resource settings [16-17].

Impact of Patient Factors: Advanced age and comorbidities — particularly diabetes mellitus, hypertension, and COPD — were associated with higher complication rates and severity in this study. These findings align with large-scale studies by Khuri et al [6] and Turrentine et al [18], demonstrating that patient frailty and comorbidity burden significantly increase surgical risk. Elderly patients have reduced physiological reserve, impaired immune response, and slower wound healing, predisposing them to more severe complications.

Impact of Surgical Complexity: Complex procedures —including Whipple's pancreaticoduodenectomy, gastrectomy, hepatic resections, and colorectal surgeries—were associated with higher complication rates compared to simpler procedures such as hernia repairs or cholecystectomies. Pancreatic surgeries are known to carry complication rates of 30–60%, driven predominantly by postoperative pancreatic fistula (POPF), delayed gastric emptying, and hemorrhage. These findings are consistent with published data. [19]

Utility of the Clavien–Dindo Classification: The CDC proved to be an effective, reliable, and practical tool for standardized grading of postoperative complications in this study. Its therapy-based, objective approach minimized inter-observer variability and facilitated meaningful outcome comparison. Validation studies across surgical specialties have confirmed its high interobserver reliability and reproducibility. [20]

A statistically significant correlation was demonstrated between CDC grade and key morbidity indicators—hospital stay duration, ICU admission, and need for reintervention ($p<0.05$).

This supports the CDC's role not merely as a classification tool but as a robust predictor of postoperative morbidity and clinical outcomes, consistent with findings reported by DeOliveira et al [15] and Clavien et al. [3]

Limitations: The study has certain limitations: (i) Single-center design may limit generalizability; (ii) Relatively small sample size compared to multicentric databases; (iii) Short follow-up of 30 days precludes assessment of long-term outcomes; (iv) Comprehensive Complication Index (CCI) was not calculated, which would have enabled assessment of cumulative morbidity burden. Future multicenter prospective studies with integration of CCI alongside CDC are warranted.

Conclusion

Postoperative complications are common following elective major abdominal surgeries; however, the majority are low-grade (Clavien–Dindo Grade I and II) and manageable with conservative or pharmacological treatment. The Clavien–Dindo Classification is a simple, reliable, reproducible, and objective tool for standardized assessment and reporting of surgical complications. Advanced age, presence of comorbidities, and surgical complexity are significant predictors of higher-grade postoperative complications. The severity of

complications as graded by the CDC system directly correlates with postoperative morbidity — higher grades are associated with prolonged hospital stay, increased ICU admission, need for invasive reintervention, and mortality. With meticulous preoperative optimization, standardized operative technique, vigilant postoperative monitoring, and ERAS protocol implementation, the incidence of severe complications can be minimized. The CDC system not only serves as a standardized grading system but also functions as a reliable clinical predictor of postoperative morbidity.

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