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Validation of the Classification of Intraoperative Complications for Gastrointestinal Surgery

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ABSTRACT

Introduction: In recent, a new classification system for intraoperative adverse events (iAEs) was proposed, called "the Classification of Intraoperative Complications (CLASSIC)." Our aim was to evaluate the relationship between CLASSIC and the grade of postoperative complications (PostC) in gastrointestinal oncological surgery.

Methods: Demographics, preoperative laboratory parameters, grades of iAEs, grades of PostC, and intraoperative pH and lactate levels were evaluated in patients who underwent gastric and colorectal surgery.

Results: A total of 95 patients were included in this study. Mean age was 60±14, 57 male vs 38 females. There was no significant relationship between the grade of iAEs and PostC in terms of demographics and the presence of intraoperative acidosis. Preoperative albumin level was inversely proportional to the grade of iAEs. There was no relationship between the grade of iAEs and the grade of PostC (p=0.563). The actual rates of high-grade PostC in patients with low-grade iAEs and high-grade iAEs were 10% and 18%, respectively. Additionally, the length of stay was higher in patients with high-grade iAEs (p=0.018).

Conclusion: CLASSIC may be a predictive of the grade of PostC in patients who undergo gastrointestinal surgery. High-grade iAEs is a valuable predictor of increased hospital stay.

Keywords: Colon cancer, complication, gastric cancer, gastrointestinal cancer, intraoperative, postoperative

Introduction

Intraoperative complications are one of the most confusing issues in the surgical literature. Several sources of evidence have previously been reported regarding the effects of intraoperative adverse events (iAEs) on the postoperative course of a surgical patient (1-4). However, a common language related to the severity of iAEs has not been provided up to recent years. This gap have was most evident in donor operations with living donor-related liver transplantation in which donors are equally healthy in the preoperative period (5). Kaafarani et al. (6) and Rosenthal et al. (7) reported two different classification systems for iAEs. The system proposed by Kaafarani et al. (6) generally includes undesirable injuries in general surgical operations. The accepted definition of iAE by Kaafarani et al. (6) was "an inadvertent injury that occurred during the operation" (8). It was validated during the construction of the system and the correlation of the severity of PostC with high grades of iAEs was put forward.

Rosenthal et al. (7) proposed a system named the "Classification of Intraoperative Complications (CLASSIC)" to define the grades for iAEs for all types of surgical operations. In contrast to Kaafarani et al. (6) classification, the CLASSIC system graded all types of complications, including anaesthesia-related complications. However, this had not been validated until our recently published study in which we included patients who had undergone hepatopancreatobiliary surgery (9).

In this study, we examined the validity of the CLASSIC system in patients who underwent gastric and colorectal resections. For this purpose, the relationship between the grade of iAEs according to the CLASSIC system (7) and the grade of postoperative complications (PostC) according to the Accordion Severity Classification of Postoperative Complications (ASCPC) (10) were evaluated.

Methods

Patients undergoing gastric or colorectal resection between December 2015-2018 were included in the study protocol. The demographics, biochemical characteristics, preoperative features, iAEs, intraoperative parameters and postoperative course of the patients were considered. Unexpected adverse events during surgery were also evaluated and included in the grading of iAEs, such as injury of untargeted organs or vessels; additional organ resection (e.g., cholecystectomy, splenectomy); technical problems (e.g., malfunction of equipment), anaesthesia-related adverse events, arrhythmia, oliguria or anuria. Moreover, atelectasis,

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wound infection, anastomotic leak, intra-abdominal fluid collection, bleeding, other respiratory complications, delayed gastric emptying, mechanical intestinal obstruction, organ failures, and readmission in the first 30 days after surgery were recorded.

The CLASSIC was used to grade iAEs, which is proposed by Rosenthal et al. (7). Five grades, from 0 to 4, are included in the system. Intraoperative complications were divided into two groups to prevent a confusing statistical analysis and to provide easily understandable results. According to the CLASSIC system, grade 0 is defined as the patients with ideal intraoperative course; grade 1 is defined as a minor deviation from the ideal intraoperative course without the need for additional treatment or intervention; grade 2 is defined as a major deviation from the ideal intraoperative course; grade 3 is defined as the need for additional treatment or intervention; grade 4 is defined as intraoperative death. Grade 0 and grade 1 iAEs were collected in the first group (low grade iAEs). Grade 2, grade 3, and grade 4 iAEs were collected in the second group (high-grade iAEs).

PostC were graded according to the ASCPC proposed by Strasberg et al. (10) PostC were also divided into two groups. The first group includes "low-grade PostC" (patients with no, mild, or moderate complications). The second group includes "high-grade PostC" (patients with severe complications or mortality). All of the preoperative, intraoperative parameters, and the grades of PostC were compared between the groups.

Ethics Committee approval was obtained from University of Health Sciences Turkey, Istanbul Training and Research Hospital for the study (approval number: 2529, date: 02.10.2020). Written consent was obtained from the patients in our study.

Statistical Analysis

Statistical analysis was performed using SPSS 20.0 (SPSS Inc., IBM Corporation, Armonk, NY, USA) software. The distribution of variables was measured with the Kolmogorov-Smirnov test. Normally-distributed continuous variables were analyzed with Student's t-test and expressed as mean ± standard deviation. Variables not normally distributed were analyzed with Mann-Whitney U test and expressed as median and minimum-maximum range. The chi-square test and Fisher's exact test were used in the analysis of categorical variable.

Results

Descriptive statistics of demographic and clinical measurements of a total of 95 patients who underwent gastric or colorectal resection due for malignant diseases were evaluated (Table 1).

In 14 patients, minor iAEs (grade 1) observed during surgery, such as controllable hypotension, transient arrhythmia, and simple, controllable bleeding from laceration on the splenic and pancreatic capsule. In 26 patients with high-grade (grade 2 or 3) iAEs, injury of the adjacent organ(s) were seen, such as ureteral injury requiring primary anastomosis with double-J catheter insertion in two cases, bladder injury requiring primary suturing in three cases, and injury of the gallbladder requiring cholecystectomy in one case. Additionally, vascular injury was seen in the same group of patients, including injury to the splenic artery, aberrant left hepatic artery, and sacral venous plexus. The other adverse events that complicated the operative process were technical failures such as inappropriate formation of esophagojejunostomy due to malfunction of a circular stapler, or anaesthesia-related adverse events including severe hypo- or hypertension or resistant arrhythmia.

Table 1. Descriptive statistics of demographic and clinical measurements of the patients (n=95)

Age (mean ± SD) (years)	60.49±14.54
Gender (n, %) (male)	57 (60.00%)
Colorectal resections	65 (68.42%)
Gastric resections	30 (33.68%)
Intraoperative complications* (n, %)	
Grade 0	55 (57.89%)
Grade 1	14 (14.73%)
Grade 2	25 (26.31%)
Grade 3	1 (1.05%)
Grade 4	0 (0.00%)
Postoperative complications (n, %)**	
No complication	27 (28.42%)
Grade 1	24 (25.26%)
Grade 2	26 (27.36%)
Grade 3	7 (7.36%)
Grade 4	4 (4.21%)
Grade 5	6 (6.31%)
Grade 6	1 (1.05%)

*: According to the CLASSIC (7), **: According to Accordion Severity Classification of Postoperative Complications (10), SD: Standard deviation

PostC of any grade was seen in 68 patients (71%). Operation-related postoperative mortality was observed in a 73-year-old female patient who underwent low anterior resection for rectal malignancy. Postoperative enterocutaneous fistula-related abdominal sepsis caused death. High-grade (grades 4-6) PostC was seen in 26 patients (27%).

Outcomes of the patients are summarized in Table 2. Preoperative albumin level (p=0.047) and postoperative hospital stay (p=0.018), were significantly lower at low-grade iAEs than at high-grade iAEs. High-grade PostC rates were 10% in patients with low-grade iAEs and 18% in patients with high-grade iAEs. There was no significant difference between the groups (p=0.563).

Discussion

The classification of PostC first proposed by Clavien et al. (11) and its modifications (10,12,13) is widely accepted in the surgical literature. The need for a classification system for iAEs has been mentioned in previous studies, especially regarding donor surgery in living-donor liver transplantation (5,14). Hence, the first reported classification for iAEs was related to donor hepatectomy in 2005 (15). However, it was not limited to intraoperative complications and was complicated for clinical use. Therefore, it has not been widely accepted in the literature. In the last two years, Kaafarani et al. (6) and Rosenthal et al. (7) proposed two different classification systems to define and classify iAEs to provide reliable intraoperative patient care. Defining the predictive value of the

Table 2. Comparison of the patients according to the grade of iAEs

	Low-grade iAEs (n=69)	High-grade iAEs (n=26)	p
Demography			
Age (years)	61.28±14.73	59.41±12.29	0.748[a]
Gender (male) (n, %)	34 (49.27%)	3 (11.53%)	0.817[b]
Preoperative findings			
ASA score (n)	-	-	0.225[b]
1	24 (34.78%)	7 (26.92%)	-
2	35 (50.72%)	12 (46.15%)	-
3	10 (14.49%)	7 (26.92%)	-
Malignant lesion	41 (78.84%)	6 (100.00%)	0.583[b]
Hemoglobin (g/dL)	11.75±1.72	11.69±2.31	0.842[a]
Creatinine (mg/dL)	0.97±0.36	0.73±0.26	0.106[a]
Albumin (g/dL)	3.78±0.54	3.52±0.74	**0.047**[a]
AST (U/L)	18 (9-34)	22 (11-43)	0.181[c]
ALT (U/L)	17 (3-160)	16 (5-46)	0.904[c]
LDH (mg/dL)	222.76±60.23	232.68±98.39	0.554[a]
INR	1.04±0.13	1.13±0.21	0.167[a]
Intraoperative findings			
Operation time (minute)	155 (80-345)	165 (75-320)	0.175[c]
Transfusions (U)	0 (0-2)	0 (0-2)	0.161[c]
pH	7.32±0.30	7.39±0.12	0.273[a]
Lactate (mmol/L)	1.19 (0.39-7.00)	1.35 (0.92-4.16)	0.381[c]
Ca^{++}	1.04±0.16	1.00±0.13	0.291[a]
Postoperative findings			
PostC grade* (n)	-	-	0.563[d]
High-grade PostC	7 (10.14%)	4 (15.38%)	-
Low-grade PostC	62 (89.85%)	22 (84.61%)	-
Hospital stay (d)	7 (5-27)	9 (6–38)	**0.018**[c]
Intraoperative mortality (n)	0 (0.00%)	0 (0.00%)	-
Postoperative mortality (n, %)	1 (1.44%)	0 (0.00%)	0.998[d]

*: According to Accordion Severity Classification of Postoperative Complications (6), [a]: Student's t-test, [b]: chi-square test, [c]: Mann-Whitney U test, [d]: Fisher's exact test, ALT: Alanine aminotransferase, ASA: American Society of Anesthesiologists, AST: Aspartate aminotransferase, INR: International normalization ratio, iAEs: Intraoperative adverse events, PostC: Postoperative complications

grade of iAEs for postoperative course was not listed in the aims. The proposed classification by Kaafarani et al. (6), however, was validated for general surgery patients in the same study, which made it superior to the work of Rosenthal et al. (7). Nevertheless, it was generally related to injuries of non-targeted organ(s) in the planned operation and excluded the anaesthesia-related complications that were the shortcomings in Kaafarani et al. (6) classification. Conversely, in the CLASSIC system, the grades are described with more general phrases, and the system was proposed for all types of surgical operations and included anaesthesia-related complications, which make it potentially more useful. However, the main limitation of the Rosenthal et al. (7) study was the lack of validation of the system, which was the main goal of our study for gastric and colorectal operations.

The question of which group of patients should be selected to measure the validity of a proposed classification system for iAEs is critical, as to study a selected or mixed group of patients would directly affect the results. It is our contention that if the number of patients is limited, a special group of surgical operations with similar features should be selected to provide reliable conclusions. For this purpose, we first studied the patients who underwent hepatopancreaticobiliary surgery (9). We found a positive relationship between the grade of iAEs and the severity of PostC in this special group of patients (9). In this study, we determined the validity of the CLASSIC system in another group of surgical operations, gastric and colorectal resections, using a similar methodology.

The CLASSIC system is limited to iAEs. However, the presence of iAEs and the preoperative condition of the patient has predictive value for early postoperative morbidity and mortality in both gastric and colorectal resections (16-18). Therefore, patient-dependent factors and the biochemical parameters related to basic organ functions were recorded to be able to include the effect of these factors. Preoperative features and basic laboratory findings were similar in patients with both low-grade and high-grade iAEs. A unique exception was the preoperative albumin level, which was significantly lower in patients with high-grade iAEs (p=0.047). Although the difference was statistically significant, actual values of preoperative mean albumin levels were 3.7±0.5 and 3.5±0.7 in patients with low and high-grade iAEs, respectively.

There have been no reported data about the validation of the CLASSIC system in this group of patients. Therefore, it is impossible to compare the present results with those of previous studies. The grades of iAEs in gastric and colorectal surgery patients were not significantly correlated with the grades PostC. In contrast, a significant relationship was found between the grades of iAEs and PostC in patients who underwent hepatopancreatobiliary surgery in our recently published study conducted (9). However, although the difference between the groups was not statistically significant, the actual rates of high-grade PostC were 10% and 18% in patients with low grade and high-grade iAEs, respectively. Note that this result could be the product of the insufficiency in the number of cases. Additionally, the other considerable result of this study is the significantly longer hospital stay in patients with high-grade iAEs. Therefore, the proposed classification system, CLASSIC, has some degree of a relationship with the postoperative course in patients who underwent gastric and colorectal resections when, the hospital stay and the actual rates of the grades of PostC were considered.

Intraoperative acidosis and blood lactate level are new parameters being used as surrogates for the adverse events occurring during surgery and to predict the postoperative course in major abdominal operations (1,2). The main argument for these studies was the potential relationship between iAEs and metabolic state of the patient during surgery. However, there was no considerable difference in pH and lactate level between the two groups in the current study, which means that CLASSIC does not reflect the perioperative metabolic state of the patient. Acidosis is a useful marker for tissue hypoperfusion that can be due to excessive blood loss, major transfusions, long operation time, hypothermia, or inappropriate fluid administiration during surgery (19). However, the metabolic state of the patients cannot reflect the technical

(e.g., reconstruction of an unreliable anastomosis) or mechanical (e.g., injury of adjacent organs or resection of untargeted organs) adverse events that can also disturb the postoperative healing process (20). Two important parameters were also ignored in the CLASSIC system: 1) History of previous abdominal surgery and depending adhesions, and 2) recognition time of an intraoperative inadvertent injury, which were expressly considered by the team who proposed Kaafarani et al. (6) classification system (8). We believe that the CLASSIC system would be a more reliable predictor of postoperative course, if it was to be modified to combine these pe rspectives.

Study Limitations

There are some limitations related to this study. The first and the most important point is the relatively small number of patients; the effects of this limitation were previously discussed in this article. However, there have been no published data regarding the validation of the CLASSIC system in this group of patients. We believe that this is an important contribution to our previous study regarding the validity of the CLASSIC system (9). This study is also limited to the area of gastric and colorectal resections. Although the CLASSIC system was proposed for all types of surgical interventions, the nature of diseases and surgical manipulations should be considered during the evaluation of the clinical value of this system. For this purpose, we divided the operations according to the target organs and diseases. Finally, the retrospective nature of the study was another limitation.

Conclusion

The grade of iAEs according to the CLASSIC system (7) could be related to the grade of PostC according to ASCPC (10) in patients who underwent gastric and colorectal resections. Importantly, our findings indicate that high-grade iAEs can be a valuable indicator for a longer hospital stay in the same group of patients.

Ethics Committee Approval: Ethics Committee approval was obtained from University of Health Sciences Turkey, Istanbul Training and Research Hospital for the study (approval number: 2529, date: 02.10.2020).

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References

1. Kinaci E, Sevinc MM, Ozakay A, Bayrak S, Cakar E, Sari S. Intraoperative acidosis is a new predictor for postoperative pancreatic fistula after pancreaticoduodenectomy. Hepatobiliary Pancreat Dis Int 2016; 15: 302-9.
2. Vibert E, Boleslawski E, Cosse C, Adam R, Castaing D, Cherqui D, et al. Arterial Lactate Concentration at the End of an Elective Hepatectomy Is an Early Predictor of the Postoperative Course and a Potential Surrogate of Intraoperative Events. Ann Surg 2015; 262: 787-93.
3. Nienhuijs SW, Kaymak U, Korsten E, Buise MP. Influence of intraoperative hypotension on leaks after sleeve gastrectomy. Surg Obes Relat Dis 2015; 15: 813-8.
4. Kim SH, Son SY, Park YS, Ahn SH, Park DJ, Kim HH. Risc factors for anastomotic leakage: A retrospective cohort study in a single gastric surgical unit. J Gastric Cancer 2015; 15: 167-75.
5. Azoulay D, Bhangui P, Andreani P, Salloum C, Karam V, Hoti E, et al. Short- and long-term donor morbidity in right lobe living donor liver transplantation: 91 consecutive cases in a European Center. Am J Transplant 2011; 11: 101-10.
6. Kaafarani HM, Mavros MN, Hwabejire J, Fagenholz P, Yeh DD, Demoya M, et al. Derivation and validation of novel severity classification for intraoperative adverse events. J Am Coll Surg 2014; 218: 1120-8.
7. Rosenthal R, Hoffmann H, Clavien PA, Bucher HC, Dell-Kuster S. Definition and classification of intraoperative complications (CLASSIC): Delphi study and pilot evaluation. World J Surg 2015; 39: 1663-71.
8. Ramley EP, Bohnen JD, Farhat MR, Razmdjou S, Mavros MN, Yeh DD, et al. The nature, patterns, clinical outcomes, and financial impact of intraoperative adverse events in emergency surgery. Am J Surg 2016; 212: 16-23.
9. Kinaci E, Sevinc MM, Bayrak S, Erdoğan E, Ozakay A, Sari S. Is the classification of intraoperative complications (CLASSIC) related to postoperative course? Int J Surg 2016; 29: 171-5.
10. Strasberg SM, Linehan DC, Hawkins WG. The accordion severity grading system of surgical complications. Ann Surg 2009; 250: 177-86.
11. Clavien PA, Sanabria JR, Strasberg S. Proposed classification of complications of surgery with examples of utility in cholesistectomy. Surgery 1992; 111: 518-26.
12. Clavien PA, Camargo CA Jr, Croxforth R, Langer B, Levy GA, Greig PD. Definition and classification of negative outcomes in solid organ transplantation. Application in liver transplantation. Ann Surg 1994; 220: 109-20.
13. Dindo D, Demartines N, Clavien PA. Classification of surgical complications. A new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004; 240: 205-13.
14. Hashikura Y, Ichida T, Umeshita K, Kawasaki S, Mizokami M, Mochida S, et al. Donor complications associated with living donor liver transplantation in Japan. Transplantation 2009; 88: 110-4.
15. Shackleton CR, Vierling JM, Nissen N, Martin P, Poordad F, Tran T, et al. Morbidity in live liver donors: standards-based adverse event reporting further refined. Arch Surg 2005; 140: 888-95.
16. Aminian A, Brethauer SA, Sharafkhah M, Schauer PR. Development of a sleeve gastrectomy risk calculator. Surg Obes Relat Dis 2015; 11: 758-64.
17. Longo WE, Virgo KS, Johnson FE, Oprian CA, Vernava AM, Wade TP, et al. Risk factors for morbidity and mortality after colectomy for colon cancer. Dis Colon Rectum 2000; 43: 83-91.
18. Jestin P, Påhlman L, Gunnarsson U. Risk factors for anastomotic leakage after rectal cancer surgery: a case-control study. Colorectal Dis 2008; 10: 715-21.
19. Waters JH, Miller LR, Clack S, Kim JV. Cause of metabolic acidosis in prolonged surgery. Crit Care Med 1999; 27: 2142-6.
20. Mavros MN, Velmahos GC, Larentzakis A, Yeh DD, Fagenholz P, de Moya M, et al. Opening Pandora's box: understanding the nature, patterns, and 30-day outcomes of intraoperative adverse events. Am J Surg 2014; 208: 626-31.