

Predictive Markers for Surgical Indication in Sigmoid Volvulus with Grade II Ischemia

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Rezumat

Markeri predictivi pentru indicația chirurgicală în volvulusul de sigmoid cu ischemie Grad II

Introducere: Ischemia de grad II în cadrul volvulusului sigmoidian ridică dificultăți în luarea deciziei chirurgicale. Acest studiu compară rezultatele între pacienții care au suferit rezecție sigmoidiană în timpul primului episod față de cei operați în momentul apariției recurenței.

Metode: A fost realizată o analiză retrospectivă a 63 de pacienți cu ischemie de grad II confirmată intraoperator, tratați între anii 2018-2024. Toți pacienții au beneficiat inițial de devolvulare și decompresie endoscopică, urmată de rezecție sigmoidiană – fie în timpul primului episod (Grup I, n=41), fie în momentul apariției recurenței (Grup II, n=22). Au fost comparate variabile demografice, biochimice și chirurgicale.

Rezultate: Markerii biochimici – inclusiv leucocitele, PCR-ul, D-dimerii, lactatul seric și creatinina – au fost semnificativ mai crescuți în cazurile recurente ($p<0.001$), iar pH-ul sanguin a fost mai scăzut (7.23 vs. 7.29, $p<0.001$). Durata intervenției și pierderile sanguine intraoperatorii au fost mai mari în grupul recurent, iar anastomoza primară a fost realizată doar la pacienții aflați la primul episod ($p=0.025$). Complicațiile postoperatorii au fost mai frecvente în cazurile recurente (31.8% vs. 12.2%, $p=0.064$), iar durata internării a fost semnificativ mai lungă (8.64 vs. 6.32 zile, $p<0.001$).

Concluzii: Temporizarea intervenției chirurgicale până la recurență se asociază cu inflamație accentuată, dezechilibre metabolice și risc chirurgical crescut. Intervenția precoce, în timpul primului episod, oferă rezultate clinice și postoperatorii mai bune.

Cuvinte cheie: volvulus sigmoidian, ischemie, decompresie endoscopică, chirurgie precoce, markeri inflamatori

Abstract

Background: Grade II ischemia in sigmoid volvulus presents challenges in surgical decision-making. This study compares outcomes between patients undergoing sigmoid resection during the first episode versus at recurrence.

Methods: A retrospective analysis of 63 patients with intraoperatively confirmed Grade II ischemia treated between 2018-2024 was performed. All underwent initial endoscopic decompression followed by surgical resection - either during the first episode (Group I, n=41) or at recurrence (Group II, n=22). Demographic, biochemical, and surgical outcomes were compared.

Results: Biochemical markers - including white blood cell count, CRP, D-dimer, serum lactate, and creatinine - were significantly elevated in recurrent cases (all $p < 0.001$). Lower blood pH values were observed in recurrent cases (7.23 vs. 7.29, $p < 0.001$) consistent with systemic acidosis. Operative time and intraoperative blood loss were higher in the recurrent group, and primary anastomosis was performed only in the first-episode group. Postoperative complications were more common in recurrent cases (31.8% vs. 12.2%, $p = 0.064$), and length of stay was longer (8.64 vs. 6.32 days, $p < 0.001$).

Conclusions: Delayed surgery at recurrence is associated with worsened inflammation, metabolic derangement, and higher surgical risk. Early surgery during the first episode offers better clinical outcomes.

Keywords: sigmoid volvulus, ischemia, endoscopic decompression, early surgery, inflammatory markers

Introduction

Sigmoid volvulus (SV) is a major surgical emergency defined by axial twisting of the sigmoid colon along its mesenteric axis, resulting in various degrees of bowel obstruction and ischemia (1,2). In Western countries, it makes up 3-5% of all cases of large bowel obstruction; but, in areas like Eastern Europe, Asia, and portions of Africa, where dolichocolon and chronic constipation are more common, its frequency increases significantly (3,4).

A major factor in SV morbidity and mortality is bowel ischemia, which can range from mucosal hypoperfusion (Grade I) to transmural necrosis (Grade III) (5). When it comes to the timing and necessity of surgical intervention, grade II ischemia - which represents reversible transmural injury without gangrene - presents a clinical challenge (6). Conservative endoscopic decompression is frequently used in the acute setting, but recurrence is common, and postponing surgery may be linked to a worsened clinical profile and higher rates of complications (7).

According to recent research, a number of clinical, laboratory, and intraoperative factors could be used as predictors of SV outcomes and as markers of ischemia development (8). Elevated inflammatory markers (CRP, leukocytosis), metabolic acidosis (low pH, high lactate), and coagulation alterations (D-dimer elevation) have been individually associated with bowel ischemia severity and poorer prognosis. (9) Despite this, there is a lack of consensus on standardized

predictors that can inform the optimal timing of surgical intervention in patients with Grade II ischemia who initially respond to non-operative management (10).

In Romania, the incidence of SV requiring surgical intervention has increased in recent decades, particularly in elderly patients with multiple comorbidities and limited access to specialized surgical care (11). Better characterization of prognostic markers that could direct early surgery and enhance outcomes is urgently needed, as there are few national studies evaluating the effects of postponed surgical intervention in SV with moderate ischemia.

Given the absence of consensus on reliable indicators for timely surgical intervention in cases of Grade II ischemia, this study aimed to identify clinical, biochemical, and intraoperative factors that could help distinguish patients who may benefit from early surgical resection. By comparing outcomes between those undergoing surgery during the initial episode versus at recurrence, we sought to better define predictors of disease progression and surgical necessity.

Material and Methods

Study Design and Population

This retrospective observational study was conducted at the Emergency Surgery Department of the Constanța County Clinical Emergency Hospital, Romania, over a six-year period between December 2018-2024. The study included patients

who presented to the Emergency Department and were diagnosed with sigmoid volvulus associated with Grade II bowel ischemia (*Fig. 1*). The degree of ischemia was determined intraoperatively, based on serosal color changes, bowel wall thinning, loss of peristalsis, and capillary refill assessment, without evidence of transmural necrosis or gangrene. All patients initially underwent endoscopic devolvulation and decompression during the acute episode. Surgical resection of the sigmoid colon was subsequently performed either during the first presentation or after a recurrent episode.

The inclusion criteria were as follows: 1) confirmed diagnosis of sigmoid volvulus with intraoperatively verified Grade II intestinal ischemia; 2) underwent endoscopic decompression as an initial therapeutic measure; 3) subsequently underwent definitive surgical resection. The exclusion criteria were as follows: 1) patients with Grade I or Grade III bowel ischemia after sigmoid volvulus; 2) patients presenting with hemodynamic or respiratory instability; 3) incomplete clinical records or missing laboratory/intraoperative data; 3) patients who did not undergo endoscopic decompression prior to surgery. A schematic representation of patient selection and allocation is provided in *Fig. 1*.

Surgical Intervention

All included patients underwent elective or semi-urgent sigmoid resection with curative intent, following initial endoscopic decompression. The timing of surgery divided patients into two groups: Group I: First episode – 41 patients who underwent surgery during the first episode of volvulus; Group II: Second episode – 22 patients who underwent surgical resection at the time of a recurrent episode. The surgical approach (open or laparoscopic) and the type of anastomosis or stoma creation were at the discretion of the attending surgeon, based on intraoperative findings and patient condition.

Data Collection

Clinical records were reviewed to extract data on demographics (age, gender), clinical presentation (abdominal pain, bloating, absence of intestinal transit), comorbid conditions (e.g., diabetes, obesity, cardiac disease, previous surgery), behavioral risk factors (smoking, alcohol), intraoperative findings, and immediate postoperative course. Smoking was defined as consumption of at least 10 cigarettes per

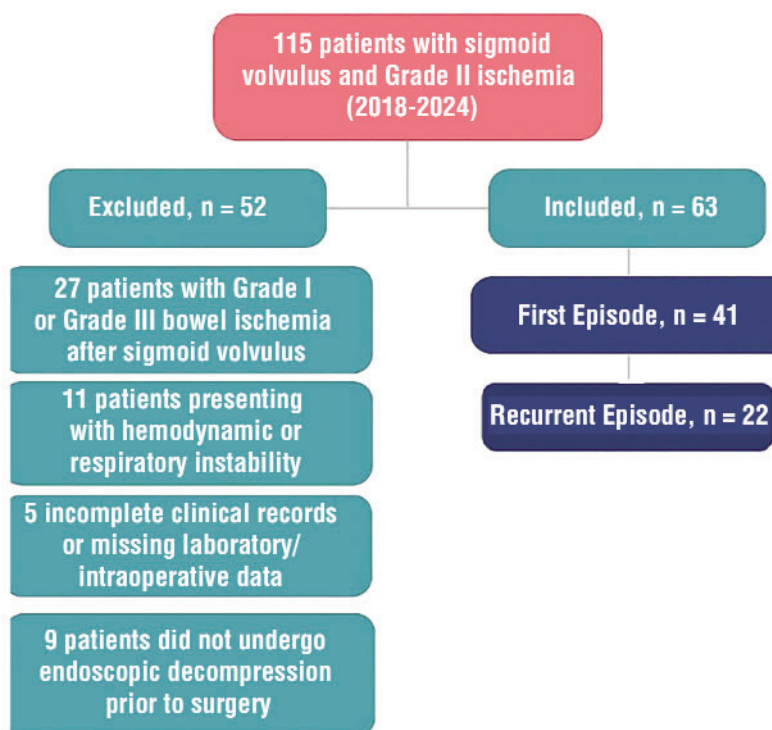


Figure 1. Flow chart illustrating patient selection and distribution in the study.

day. Alcohol consumption was defined as ≥ 1 drink per day for women or ≥ 2 drinks per day for men, in line with international criteria. Comorbidity burden was assessed using the Age-Adjusted Charlson Comorbidity Index (ACCI). Laboratory parameters (white blood cell count, CRP, serum lactate, electrolytes, creatinine, CK, D-dimer, blood pH), imaging and endoscopic findings were also recorded alongside with intraoperative variables (surgical approach, operative time, blood loss, anastomosis or stoma) and postoperative outcomes. Postoperative follow-up was performed through clinical visits or by telephone.

Study Endpoints

The primary endpoint was to analyze postoperative outcomes and to evaluate potential markers that may help identify the optimal timing for surgical intervention in patients with sigmoid volvulus and Grade II ischemia.

The secondary endpoint was to determine the existence of statistical differences regarding the clinical and demographic characteristics between the study groups.

Ethical Approval

In compliance with the Declaration of Helsinki on human testing, the study was authorized by the Local Ethics Commission for the Approval of Clinical and Research Developmental Studies. All patients gave their informed consent when they were enrolled (approval no. 51/21.11.2018).

Statistical Analysis

SPSS version 28 was utilized for statistical analysis. Categorical variables are summarized as frequencies and percentages, while continuous variables are expressed as mean $\pm$ standard deviation or median, depending on data distribution. Continuous variables were compared using the independent samples t-test for normally distributed data, and the Mann-Whitney U test when distributional assumptions were not met. Categorical variables were analyzed using the Chi-square or Fisher's exact test, depending on cell frequency. A statistically significant difference was defined as $P < 0.05$.

Results

A total of 63 patients with sigmoid volvulus and

intraoperatively confirmed Grade II bowel ischemia were included in the study. Among these, 41 patients (65.1%) underwent surgery during their first episode, while 22 patients (34.9%) required surgical intervention during a recurrent episode. The mean age was significantly higher in the recurrent group (55.09 ± 12.56 years) compared to those operated on at first presentation (48.71 ± 11.45 years; $p = 0.047$). Male sex predominated in both groups, with no statistically significant difference ($p = 0.447$). Notably, habitual alcohol use was significantly more frequent in recurrent cases (18.2% vs. 2.4%; $p = 0.031$), and diabetes mellitus was also significantly more prevalent among recurrent patients (27.3% vs. 4.9%; $p = 0.018$). The ACCI was higher in the recurrent group, though this did not reach statistical significance ($p = 0.065$) (Table 1).

Clinically, abdominal pain and absence of intestinal transit were universal findings in both groups. Bloating was more frequently reported in recurrent cases (95.5% vs. 80.5%), though not statistically significant ($p = 0.080$). From an etiologic perspective, chronic constipation, dolichosigmoid, megacolon, and prior laparotomy were common in both groups. However, no individual etiology reached statistical significance when comparing the two cohorts (Table 2).

CT imaging was performed in all cases prior to endoscopic decompression, and classic signs of sigmoid volvulus - such as the "coffee bean" appearance and twisted mesenteric vessels - were commonly observed (Fig. 2). In several patients, signs suggestive of Grade II ischemia (e.g., bowel wall hypoenhancement, pericolic fat stranding) were also noted.

In terms of biological values, patients with recurrent SV had significantly elevated markers of inflammation and ischemia. White blood cell counts were markedly higher in the recurrent group (14.64 ± 1.50 vs. 11.52 ± 1.53 / μ L; $p < 0.001$), as were CRP levels (8.85 ± 2.89 vs. 6.09 ± 2.54 mg/dL; $p < 0.001$). Serum potassium and creatinine were also significantly elevated in recurrent cases ($p = 0.002$ and $p = 0.001$, respectively). Importantly, D-dimer levels were substantially higher in recurrent patients (5.78 ± 1.11 vs. 2.92 ± 0.55 μ g/mL; $p < 0.001$), as were serum lactate values (2.78 ± 0.31 vs. 2.64 ± 0.32 mmol/L; $p = 0.001$), and lower pH values were noted ($p < 0.001$), indicating more advanced systemic acidosis. While creatine kinase (CK) was numerically higher in the recurrent group, the difference did not reach statistical significance ($p = 0.074$) (Table 2).

Table 1. Baseline demographics and comorbidities of the patients.

Variable	SV cases (n=63)		p-value
	I st Episod (n=41)	II nd Episode (n=22)	
Age, years ^a	48.71±11.45	55.09±12.56	0.047
< 50 years, n (%)	25 (61)	7 (31.8)	
50-59 years, n (%)	7 (17.1)	6 (27.3)	
60-69 years, n (%)	9 (22)	8 (36.4)	
70-79 years	0	1 (4.5)	
≥ 80 years	0	0	
Sex, n (%)			0.447
Male	28 (68.3)	17 (77.3)	
Female	13 (31.7)	5 (22.7)	
Smoker, n (%)	10 (24.4)	8 (36.4)	0.321
Habitual alcohol use, n (%)	1 (2.4)	4 (18.2)	0.031
BMI, kg/m ^{2a}	25.68±3.85	25.79±3.95	0.054
Underweight, n (%)	2 (4.9)	0	
Normal weight, n (%)	14 (34.1)	10 (45.5)	
Overweight, n (%)	19 (46.3)	9 (40.9)	
Obesity, n (%)	6 (14.6)	3 (13.6)	
Diabetes Mellitus, n (%)	2 (4.9)	6 (27.3)	0.018
Hypertension, n (%)	2 (4.9)	3 (13.6)	0.233
ACCI ^b	0.88±0.09	1.55±0.9	0.065
0-1, n (%)	29 (70.7)	9 (40.9)	
2-3, n (%)	12 (29.3)	13 (59.1)	
≥ 4, n (%)	0	0	

^aMean ± standard deviation. BMI, body mass index; ACCI, age-adjusted Charlson comorbidity index. Values in italics indicate statistical significance (p < 0.050).

Table 2. Evaluation of clinical, etiological and biological markers of the patients in the study

Variable	SV cases (n=63)		p-value
	I st Episod (n=41)	II nd Episode (n=22)	
Symptoms, n (%)			
Abdominal pain	41 (100)	22 (100)	ns
Bloating	33 (80.5)	21 (95.5)	0.080
Intestinal transit (-)	41 (100)	22 (100)	ns
Etiology, n (%)			
Chronic constipation	13 (31.7)	4 (18.2)	0.239
Dolicho-sigmoid	8 (19.5)	2 (9.1)	0.262
Megacolon	8 (19.5)	2 (9.1)	0.262
Neuropsychiatric issues	5 (12.2)	2 (9.1)	0.705
History of laparotomy	6 (14.6)	4 (18.2)	0.716
Abnormal mesenteric fixation	6 (14.6)	3 (13.6)	0.914
Other	0	5 (22.7)	ns
White Blood Cell (μL) ^a	11.52±1.53	14.64±1.50	<0.001
Na, Natrium (mEq/L) ^a	137.88±8.06	137.50±6.09	0.851
K ⁺ , Potassium (mmol/L) ^a	4.67±0.43	5.04±0.35	0.002
Cl ⁻ , Chloride (mEq/L) ^a	104.02±6.08	102.68±5.44	0.386
HCO ₃ ⁻ , Bicarbonate (mEq/L) ^a	18.71±1.71	19.05±2.51	0.525
C-reactive protein (mg/dL) ^a	6.09±2.54	8.85±2.89	<0.001
Creatinine (mg/dL) ^a	1.21±0.21	1.46±0.35	0.001
Lactate (mmol/L) ^a	2.64±0.32	2.78±0.31	0.001
pH ^a	7.29±0.03	7.23±0.21	<0.001
D-dimer (μg/mL) ^a	2.92±0.55	5.78±1.11	<0.001
CK, Creatine Kinase (U/L) ^a	229.95±44.84	253.09±54.01	0.074

^aMean ± standard deviation. Values in italics indicate statistical significance (p < 0.050). ns: not significant

Surgical resection was performed in all cases, with the majority undergoing open surgery in both groups. There was no significant difference in sur-

gical approach (p = 0.298), though laparoscopic access was less frequent in the recurrent group (4.5% vs. 12.2%). Estimated intraoperative blood

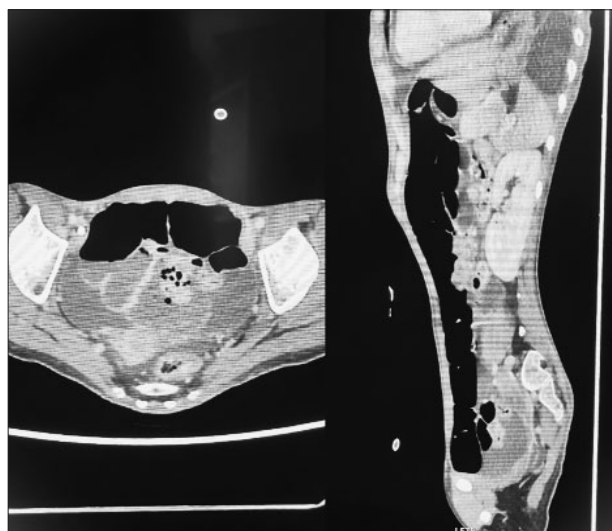


Figure 2. Abdominal CT scan showing typical features of sigmoid volvulus

loss was significantly higher in recurrent cases (154.55 ± 40.56 vs. 127.80 ± 36.77 mL; $p = 0.011$), as was operative time (212.05 ± 26.75 vs. 209.76 ± 20.18 min; $p = 0.002$). Restoration of digestive continuity differed notably: while primary colorectal anastomosis was performed in 12.2% of first-episode cases, none of the recurrent patients underwent this procedure ($p = 0.025$) (Table 3).

Postoperative complications occurred more frequently in the recurrent group (31.8% vs. 12.2%), bordering on statistical significance ($p = 0.064$). According to the Clavien-Dindo classification, the recurrent group had more Grade I–II complications and one case of Grade IIIB requiring reoperation. Postoperative hospital stay was significantly longer in patients with recurrent volvulus (8.64 ± 1.76 vs. 6.32 ± 1.12 days; $p < 0.001$). No cases of 30-day mortality or readmission were reported in either group.

Variable	SV cases (n=63)		p-value
	I st Episod (n=41)	II nd Episode (n=22)	
Type of surgery, n (%)			
Open	36 (87.8)	21 (95.5)	0.298
Laparoscopic	5 (12.2)	1 (4.5)	0.309
Estimate blood loss (ml) ^a	127.80 ± 36.77	154.55 ± 40.56	0.011
Operation time (min) ^a	209.76 ± 20.18	212.05 ± 26.75	0.002
Digestive continuity, n (%)			0.025
End colostomy	25 (61)	19 (86.4)	
Diverted colorectal anastomosis	11 (26.8)	3 (13.6)	
Primary colorectal anastomosis	5 (12.2)	0	
Any postoperative complication, n (%)	5 (12.2)	7 (31.8)	0.064
Clavien-Dindo classification, n (%)			0.080
Grade I	2 (4.9)	4 (18.2)	
Grade II	3 (7.3)	2 (9.1)	
Grade IIIA	0	0	
Grade IIIB	0	1 (4.5)	
≥ Grade IVA	0	0 (0)	
Reoperation, n (%)	0	1 (4.5)	0.144
Anastomotic leakage, n (%)	0	1 (4.5)	0.144
Infectious complications, n (%)			
Surgical site infection, n (%)	1 (2.4)	2 (9.1)	0.344
Intra-abdominal abscess, n (%)	1 (2.4)	0 (0)	ns
Septicemia, n (%)	0	0	ns
Systemic complications, n (%)			
Urinary complications	0	1 (4.5)	0.144
Pulmonary complications	1 (2.4)	1 (4.5)	0.384
Cardiac complications	0 (0)	1 (4.5)	0.144
Mechanical failure of wound healing, n (%)	0	1 (4.5)	0.144
Ileus, n (%)	2 (4.9)	0	ns
Postoperative hospital stay ^a	6.32 ± 1.12	8.64 ± 1.76	<0.001
30-day mortality, n (%)	0	0	ns
Readmission	0	0	ns

^aMean $\pm$ standard deviation; ns, not significant; Values in italics indicate statistical significance ($p < 0.050$).

Table 3. Perioperative characteristics and complications of patients in the study

Discussions

This study provides a comparative analysis of clinical, biological, and surgical indicators associated with the need for surgical intervention in patients with sigmoid volvulus and Grade II ischemia. By evaluating outcomes based on the timing of surgery (first vs. second episode), we identified several predictors with statistical significance and clinical relevance. Advanced age, more prevalent in the recurrent group, has been consistently linked with delayed decision-making and poorer surgical outcomes. Schabl et al. reported that elderly patients with SV often present with delayed ischemic changes and more complex postoperative courses (12).

Comorbidities, such as diabetes and habitual alcohol use, were significantly more frequent in the recurrent group in our cohort. This reflects systemic microvascular dysfunction and immune compromise, which may accelerate ischemic damage (13-15). These findings align with those of Perrot et al., who reported that comorbidities such as diabetes are associated with higher rates of complications and recurrence in colonic volvulus (2).

From a biomarker perspective, elevated white blood cell count, CRP, creatinine, D-dimer, and lactate, along with reduced blood pH, were significantly associated with recurrent cases. These markers reflect systemic inflammation, metabolic acidosis, and impaired perfusion (16-18). Moreover, our findings reinforce the prognostic relevance of serum lactate and D-dimer - parameters increasingly recognized for their diagnostic utility in intestinal ischemia. Atamanalp et al. previously emphasized the association between elevated D-dimer and the severity of sigmoid ischemia, suggesting its potential role in guiding early surgical decisions (6,7,19). The significantly lower blood pH and elevated creatinine in the recurrent group also suggest systemic involvement and worsening perfusion, consistent with the results reported by Baiu and Shelton (10).

Surgically, although the approach (open vs. laparoscopic) did not differ significantly, laparoscopic surgery was less frequently utilized in the recurrent group—likely due to increased intra-abdominal adhesions and poorer patient status. These limitations have been described also in the WSES guidelines, which suggest that delayed intervention often reduces the feasibility of minimally invasive techniques (1,19). Importantly, the absence of primary anastomosis in the recurrent group and the higher rates of colostomy

reflect more complex intraoperative conditions, echoing findings from Kasten et al. and Awedew et al., who highlighted that late surgical intervention is often associated with higher morbidity and a shift toward damage control strategies such as Hartmann's procedure (4,5,20).

Postoperative complication rates, although not statistically significant, were almost three times higher in the recurrent group, and the length of hospital stay was significantly prolonged. These findings corroborate those of the literature which noted that delayed surgical intervention in SV leads to increased morbidity and extended recovery (21-23). While our study reported no 30-day mortality, the increased rate of Grade I-II complications and one case of Grade IIIB complication requiring reoperation in the recurrent group illustrates the potential risks associated with deferring surgery after initial decompression.

Interestingly, our study did not identify any statistically significant difference in the etiologic factors (e.g., dolichosigmoid, chronic constipation), suggesting that patient physiology and biochemical imbalance—rather than structural predisposition alone—may play a greater role in determining the timing and severity of recurrence.

Limitations of this study include its retrospective single-center design and the relatively small sample size, which may limit the generalizability of results. However, the homogeneity of the surgical protocol and rigorous intraoperative grading of ischemia add strength to our comparative analysis.

Conclusions

In summary, our data suggest that earlier surgical intervention during the first episode of sigmoid volvulus with Grade II ischemia is associated with fewer complications, reduced biochemical imbalance, and better postoperative recovery. Elevated D-dimer, CRP, lactate, and leukocyte levels may serve as predictive markers for worsening ischemia and should be integrated into decision-making algorithms to avoid the adverse outcomes associated with delayed surgery.

Author's Contributions

Conceptualization: Leopa Nicoleta, Dimitrie Busu, Mihaela Pundiche, Vasile Sarbu; methodology: Nicoleta Leopa, Dimitrie Busu, Razvan Catalin Popescu, Mihaela Pundiche, Vasile Sarbu; software: Nicoleta Leopa, Ioana Popescu; validation: Nicoleta Leopa, Dimitrie Busu, Razvan Catalin Popescu,

Mihaela Pundiche, Daniel Ovidiu Costea; formal analysis, Nicoleta Leopa, Ioana Popescu; investigation: Razvan Catalin Popescu, Dimitrie Busu, Nicoleta Leopa, Mihaela Pundiche, Daniel Ovidiu Costea; Andrei Dumitru, Cristina Tocia, Viorel Ispas, Sorina Ispas, resources: Nicoleta Leopa, Razvan Catalin Popescu, Mihaela Pundiche, Dimitrie Busu, Daniel Ovidiu Costea; Andrei Dumitru, Cristina Tocia, Viorel Ispas, data curation: Nicoleta Leopa, Ioana Popescu; writing - original draft preparation, Dimitrie Busu, Mihaela Pundiche, Nicoleta Leopa; writing - review and editing: Dimitrie Busu, Mihaela Pundiche, Nicoleta Leopa; visualization: Dimitrie Busu, Nicoleta Leopa, Razvan Catalin Popescu, Mihaela Pundiche, Daniel Ovidiu Costea, Vasile Sarbu, Andrei Dumitru, Cristina Tocia, Viorel Ispas, Sorina Ispas ; supervision: Dimitrie Busu, Nicoleta Leopa, Mihaela Pundiche, Razvan Catalin Popescu, Andrei Dumitru, Cristina Tocia, Viorel Ispas, Sorina Ispas ; administration: Dimitrie Busu, Nicoleta Leopa, Razvan Catalin Popescu, Mihaela Pundiche, Vasile Sarbu. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest: None to declare.

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