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SURGICAL DISEASES OF THE SPLEEN

**ABSTRACT
of a dissertation for awarding a scientific degree
"DOCTOR"**

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The materials related to the defense are available at the Research Department of the Medical University – Varna and are published on the official website of the Medical University “Prof. Dr. Paraskev Stoyanov” – Varna.

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ABBREVIATIONS

AG - Angiography
AE - Angioembolization
AHA - Autoimmune hemolytic anemia
PTE - Pulmonary thromboembolism
IPT - Inflammatory pseudotumors
VTE - Venous thromboembolism
DVT - Deep vein thrombosis
ITP - Ideopathic thrombocytopenic purpura
HCL - Hairy cell leukemia
CT - Computed tomography
LCA - Littoral cell angioma
MRI - Magnetic resonance imaging
HE - Hereditary elliptocytosis
NOT - Non-prompt treatment
HS - Hereditary spherocytosis
NHL - Non-Hodgkin's lymphoma
AML - Acute myeloid leukemia
PE - Positron emission tomography
PK - Pyruvate kinase
CBC - Complete blood count
US - Ultrasound
CML - Chronic myeloid leukemia
CMML - Chronic myelomonocytic leukemia
AAST - American Association for the Surgery of Trauma
CEUS - Contrast Enhanced Ultrasound
EBV - Epstein-Barr virus
FAST - Focused Assessment with Sonography in Trauma
G6PD - Glucose-6-phosphate dehydrogenase
HHV-8 - Human Herpesvirus 8
OPSI - Overwhelming Post-Splenectomy Infection
WSES - World Society of Emergency Surgery

INTRODUCTION

The spleen is an often overlooked organ that plays a key role in the body's immunological, hematological, hemodynamic, and hormonal functions. "Hidden" deep in the upper left abdominal quadrant, it is less likely to be affected by disease compared to other parenchymal organs in the abdominal cavity. Throughout medical history, it has been the subject of facts, legends, and myths, perceived as extraordinary and mysterious, performing more functions than any other organ.

With the advancement of medicine, the spectrum of diseases associated with splenic disorders, including infectious, neoplastic, and immunological conditions, has significantly expanded. At the beginning of the 20th century, the term "leukocythemia" was used to describe malignant hematological diseases, which were subsequently classified as leukemias and lymphomas.

In the 1960s, there was a significant change in the indications for splenectomy, especially in cases of traumatic injuries and benign diseases.

By the end of the 1980s, a conservative approach to the treatment of splenic diseases, with organ-preserving strategies supported by evidence of the spleen's important immunological role, had been established.

At the end of the 20th century, laparoscopic splenectomy became the preferred method due to its minimally invasive nature and faster recovery.

The future is expected to bring new therapeutic alternatives that reduce the need for splenectomy, as well as a deeper understanding of the biological function of this organ.

AIM

The aim of this dissertation is to study, analyze, and apply modern diagnostic and therapeutic strategies in the management of patients with splenic diseases, with the goal of optimizing outcomes and reducing complications and mortality in this patient population.

SCIENTIFIC OBJECTIVES

1. Retrospective analysis and diagnostic distribution of patients with splenic diseases hospitalized in the Second Department of Surgery between 2008 and 2023.
2. Refinement of the indications for surgical treatment in patients with splenic diseases.
3. Analysis of the surgical methods applied in patients with splenic diseases.
4. Analysis of postoperative complications, laboratory parameters, and patient survival.
5. Assessment of the impact of risk factors, preoperative general condition, complications, and comorbidities on outcomes, length of hospital stay, and the need for intensive care.
6. Development of a diagnostic and therapeutic algorithm for patients with splenic diseases.

MATERIAL

We conducted a retrospective analysis of 117 patients with splenic diseases who were hospitalized and operated on between 2008 and 2023 in the Second Department of Surgery at the University Hospital "St. Marina", Varna. The diagnosis was established based on anamnestic data, clinical findings, laboratory results, imaging studies, intraoperative findings, as well as histological and microbiological examinations. For this purpose, data from patients' medical records archived in the hospital database, as well as operative logs from the Second Department of Surgery, were utilized.

Demographic characteristics of patients

For the described period and pathology, 61 men and 56 women were operated on, in a percentage ratio of 52.10% to 47.90%, aged 16 to 83 years. (Diagrams 1 and 2)

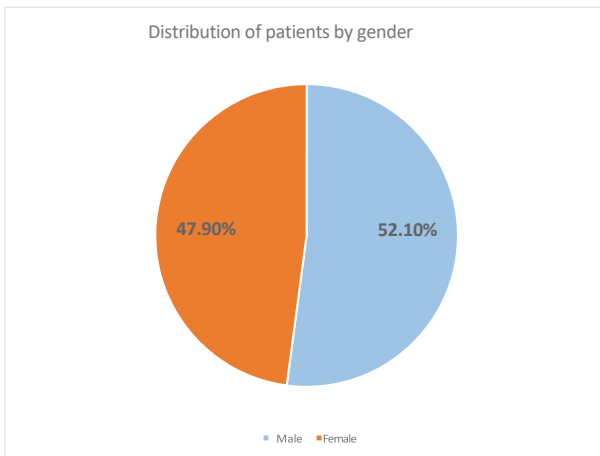


Diagram 1

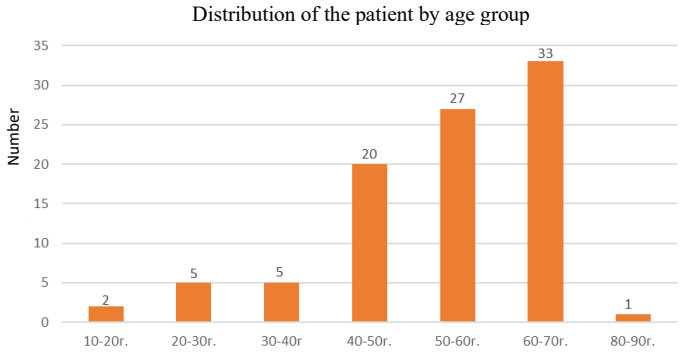


Diagram 2

Patients between the ages of 10–30 are approximately evenly distributed by sex. In the 30–40 age group, all patients are women. For the rest of the age ranges, the ratio between men and women is relatively balanced, with a slight predominance of men in the 50–60 age group (Diagram 3)

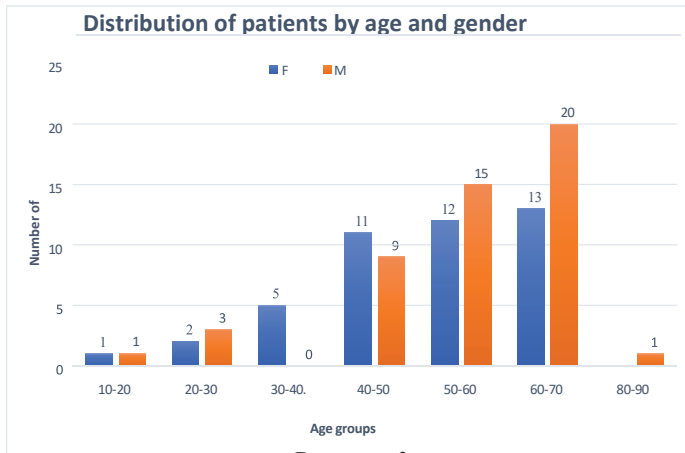


Diagram 3

Table 1 presents the distribution of patients by age and gender, grouped according to the primary diagnosis necessitating hospitalization at the Second Department of Surgery, University Hospital “St. Marina” – Varna, and subsequent surgical treatment.

Tabl. 1. Distribution of the patients by age and gender

Disease	Male			Female			Total
	<30	30-50	50-80.	<30	30-50	50-83	
Malignant hematological diseases	2	3	22	1	9	16	53
Benign hematological diseases	1	2	3		3	5	14
Splenic rupture			9		1	1	11
Splenic abscess		1	4	2	1	4	11
Echinococcosis of the spleen	1				1	2	4
Simple cyst of the spleen			1	2			3
Splenic sarcoidosis					1	1	2
Splenic amyloidosis			1				1
Infarct of the spleen		1	1				2
Diseases of Adjacent Structures and Organs			5		1	5	11
Other		2	2		1		5

The largest proportion of patients consisted of those with malignant hematological diseases (n = 53), followed by patients with benign hematological diseases, patients with splenic rupture, patients with splenic abscess, as well as patients with diseases of other organs (stomach, pancreas, colon) necessitating splenectomy.

METHODS

To achieve the aim and accomplish the set objectives, various methods were employed, which were classified as follows:

1. Diagnostic methods

1.1. Anamnesis and physical examination

Anamnesis

Patients with various diseases of the spleen were consulted in a planned and urgent manner, and the leading complaints were:

- heaviness and pain in the left hypochondrium;
- nausea and easy satiety;
- febrile episodes, chills;
- lack of appetite, general weakness, asthenodynamia;
- traumatism;
- concomitant diseases.

Physical examination

- palpable enlarged spleen under the left costal arch;
- palpation abdominal soreness, with or without signs of peritoneal irritation;
- increased body temperature;
- pale and sweaty skin;
- enlarged peripheral lymph nodes;
- difficulty breathing and dull percussion tone in the left chest half;
- Shock index greater than 1 (in patients with spleen trauma).

1.2. Laboratory results

The following laboratory parameters were examined: complete blood count, serum urea, serum creatinine, blood sugar, standard urine – sediment, ionogram, coagulation status of all studied patients during their hospitalization. In addition to them, some additional studies such as total protein, albumin, CRP, acid-base balance have been taken into account.

1.3. Microbiological results

The materials are inoculated on selective and differentiating culture media upon entry into the laboratory. After an incubation period of 24 hours, the microorganism is identified by manual biochemical and automated methods (BD Crystal, BD Phoenix). After identification, an antibiogram of the etiological microorganism is prepared. Antibiograms are made using the Kirby–Bauer manual method of Mueller–Hinton agar or by determining a minimum inhibitory concentration of BD Phoenix. Interpretation of antibiotic susceptibility results (sensitive, intermediate, resistant) is done using the latest version of EUCAST.

2. Imaging methods

2.1. Ultrasound

Ultrasound is the main and first method of choice in case of suspected diseases of the spleen. (Fig. 1) Its wide application is due to its accessibility and speed of research. We performed abdominal ultrasound diagnostics in all patients with trauma, abdominal pain, palpable spleen under the costal arch, suspected rupture or tumor formation of the spleen, etc. The study assessed the size of the spleen, the presence of fluid in the Morrison, Douglas, paracolic and splenorenal spaces.



Fig. 1. Ultrasound - spleen abscess

2.2 X-ray

Chest X-ray and abdominal overview X-ray do not have particular diagnostic value in diseases of the spleen. They were used to rule out or confirm diseases of other systems and organs. (Figs. 2 and 3)



Fig. 2. X-ray of the lungs and abdomen



Fig. 3. X-ray of the lungs and abdomen

2.3 Computed tomography

We applied CT scan with contrast preoperatively, with a view to a more complete and accurate diagnosis. (Figs. 4 and 5) The contrast agents that we applied intravenously are Yomeron 350 and Omnipack 350. The arterial, venous and late venous phases were evaluated consecutively. In patients admitted in an emergency, CT scan was performed in hemodynamically stable patients in order to more accurately assess the anatomical structures and pathology.

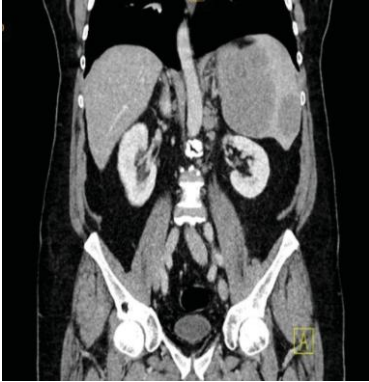


Fig. 4. CT abdomen – subcapsular hematoma on the tear



Fig. 5. CT scan of the abdomen – rupture of the spleen

2.4 MRI

MRI is rarely used in the diagnosis of pathologies of the spleen due to its high cost and long duration of the study. In the present study, we used MRI only to diagnose patients with insufficient diagnostic value of ultrasound examination and contraindications to X-ray and/or contrast examinations and unclear conditions. (Fig.6 and 7) In case of contraindications (relative or absolute) for the administration of intravenous contrast agent, the native MRI has a higher diagnostic value than the CT scan.



Fig. 6. MRI abdomen - Splenomegaly

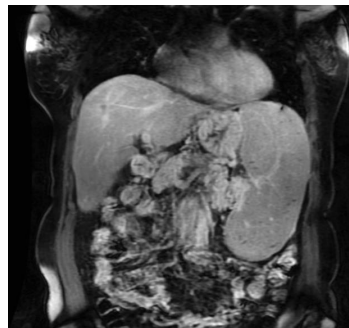


Fig. 7. MRI abdomen - Splenomegaly

3. Assessment of Patients According to ASA Classification

All hospitalized patients were consulted by an anesthesiologist and classified under the ASA system. (Diagram 4) It is a system for classifying physical condition and, based on this, assessing the fitness of patients before surgery. It was introduced in the period 1940–1941 by Meyer Saklad, Emery A. Rovenstine, Ivan Taylor. They described a six-point scale ranging from a healthy person (Class I) to one with an extreme systemic disorder that is an immediate threat to life (Class IV).

ASA I. Healthy Person

ASA II. Mild systemic disease

ASA III. Severe systemic disease

ASA IV. Severe systemic disease that is a constant threat to life.

ASA V. Dying person who is not expected to survive without surgery.

ASA VI. A patient with proven brain death whose organs can be used for donor purposes.

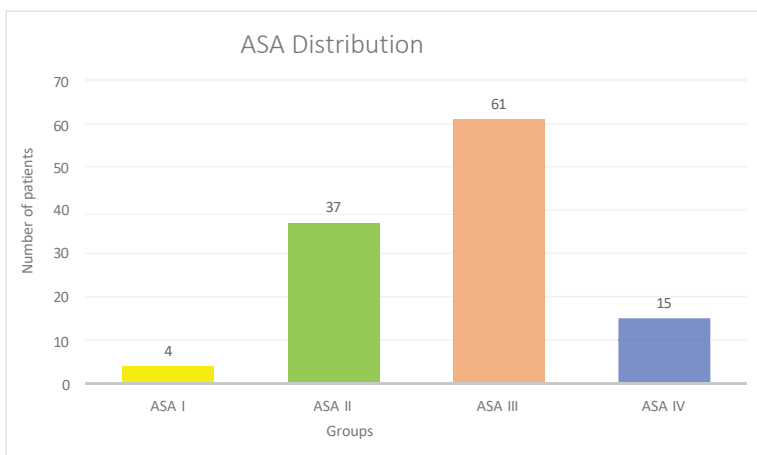


Diagram 4

4. Surgical methods

Surgical treatment is a primary method in a large proportion of splenic diseases, particularly in the presence of complications, hematological indications, or traumatic injuries. Despite the development and widespread adoption of minimally invasive techniques in recent decades, conventional splenectomy has retained its role as a reliable and effective surgical method, especially in patients with marked splenomegaly, hemodynamic instability,

associated complications, or contraindications to a laparoscopic approach.

During the period 2008–2023, the main operative method applied at the Second Department of Surgery was conventional splenectomy. The choice of surgical technique and approach was determined by the patient's clinical condition, the nature of the underlying disease, the presence of comorbidities, intraoperative findings, as well as the experience of the surgical team.

Indications for surgical intervention included patients with clinical, laboratory, and imaging findings consistent with surgically significant splenic diseases, including hypersplenism, traumatic injuries, cystic and tumorous formations, as well as certain hematological diseases indicated for splenectomy. The preferred surgical approach was midline laparotomy, which provides good visualization of the abdominal cavity and allows adequate access to the spleen, its vascular pedicle, and adjacent anatomical structures. An advantage of this approach is the possibility for rapid exploration and extension of the operative field when necessary, as well as improved control in cases of intraoperative bleeding.

5. Pathological and Histological Methods

The pathomorphological assessment included macroscopic pathological-anatomical examination and standard histological treatment of the resected material. Macroscopic findings were documented photographically, presenting macroscopic images of various diseases of the spleen (Figs. 8-13).



Fig. 8. Macroscopic view of the spleen with abscess – limited cavitation filled with purulent contents.

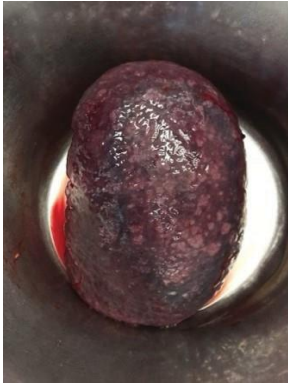


Fig. 9. Macroscopic view of the spleen in sarcoidosis – an enlarged organ with multiple nodular formations.

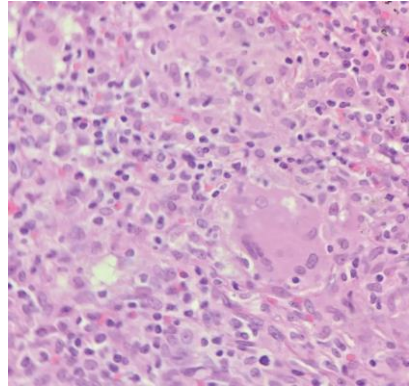


Fig. 10. Microscopic View - granulomas in sarcoidosis without the presence of necrosis.



Fig. 11. Macroscopic view of spleen rupture – rupture of the capsule with underlying parenchymal defect.



Fig. 12. *Macroscopic View - splenomegaly in NHL. Spleen measuring 27/16 cm. 1709 g.*



Fig. 13. *Macroscopic view - spleniculum in a patient with NHL. Dimensions 6/5 cm.*

6. Statistic methods

For the purposes of this study, we have applied the following statistical methods:

6.1. Statistical grouping of data

The identification of the subject of statistical study in each study serves as a basis on the basis of which a theoretical model is developed and an empirical model is designed. In order to build the empirical model, it is necessary at the next stage to record the information about the individual statistical units, taking into account 50 factors – time and place of observation, period of registration, observation bodies. As the third main stage of the overall statistical study, the statistical grouping of data is considered. Being part of the process of statistical study, the grouping of data by content is an independent method of analysis that provides an opportunity to penetrate into the structure of the phenomenon studied and to reveal connections, dependencies and influences. As a result of a correctly conducted grouping of data, empirical distributions of one-dimensional, two-dimensional or multidimensional nature are obtained.

7. Descriptive analysis

Descriptive (descriptive methods) have a direct connection with the distribution of statistical units according to the meanings of their features, revealing their character and internal structure. In order to correctly apply descriptive methods, it is necessary that the observation units are comparable and specific in time and place. Through descriptive methods, central trends, the degree of difference between the individual units of observation (patients) and the degree of deviation of the empirical distributions of the observed units from reference distributions are established. For each individual group of characteristics, different methods are applied. Average values (mode, median) are used to establish central trends, to establish differences between units (variance, standard deviation), to establish deviations from reference distributions (coefficient of asymmetry, coefficient of excess). The graphical representation of the empirical distribution is an essential part of the descriptive statistical methodology. The following graphic representations are attached: histogram, structural diagram, bar chart.

The data processing is carried out using a software product SPSS Version 26.0.

7.1. Corelation analysis

Correlation analysis is a statistical method that measures the strength and direction of the correlation between two or more phenomena. When developing a correlation model, it is essential to correctly define the independent variable X (factor) and the dependent variable Y (consequence). The main measure of the narrowness of the relationship is the correlation coefficient r . Its value is interpreted according to the one presented in Table 2.

When the correlation coefficient r is positive, it can be argued that the relationship between the phenomena is right. With a negative sign of the correlation coefficient r , it is said that the relationship is reversed. For the correct conduct of correlation analysis, it is necessary to observe the following stages:

1. Determine the independent variables (factors) X and the dependent variable Y (consequence).
2. An appropriate correlation coefficient should be selected according to the statistical scale to which the studied variables belong.

3. To assess the narrowness of the correlation relationship.
4. To assess the statistical significance of the obtained coefficient.
5. Interpret the results obtained.

Table. 2. *Correlation and correlation coefficient values.*

Correlation coefficient value	Tightness (strength) of the relationship
0.0	Missing connection
0.0 – 0.1	Very weak connection
0.1 – 0.3	Weak connection
0.3 – 0.5	Moderate relationship
0.5 – 0.7	Significant connection
0.7 – 0.9	Strong Bond
0.9 – 1.0	Very strong connection
1.0	Functional connection

It is essential to assess whether the resulting correlation coefficient is statistically significant. In the conditions of using modern statistical and econometric software products, science allows to make a decision in an alternative way (without calculating an empirical quantity). The solution is limited to a comparison of an adopted reference level of significance (risk of error α) and a calculated limit level of significance (Significance).

This method has been applied in this study to check the statistical significance of the correlation coefficient r . If the significance level (Sig) calculated on the basis of sample data is less than the norm significance level (α), the resulting correlation coefficient is assumed to be statistically significant and reliable. If the calculated significance level (Sig) is greater than the norm significance level (α), the resulting correlation coefficient is not statistically significant.

In the dissertation, the parametric correlation coefficient of Brave, the nonparametric correlation coefficient of contingent and the specific in the special case of the relationship between the interval and nominally scaled characteristic nonparametric coefficient Eta are applied.

Results

Observation parameters:

1. Sociodemographic characteristics of the patients
2. Length of hospital stay
3. Diagnostic distribution of patients
4. Results of the initial examination
5. Laboratory values of hemoglobin, leukocytes, and platelets at admission and discharge
6. Imaging modalities used
7. Preoperative staging of patients according to ASA
8. Results of microbiological examination
9. Comorbidities and past medical history
10. Need for intensive care
11. Mortality
12. Survival
13. Data on hemoperitoneum
14. Results of the correlation analysis of the observed parameters

1. Sociodemographic characteristics of the patients

The distribution of operated patients with diseases of the spleen by sex is presented in Table. 3 and Diagram 5.

Табл. 3. Distribution by gender

Gender	Number	Percentage	Validation Rate	Total percentage
Male	61	52,1	52,1	52,1
Female	56	47,9	47,9	100,0
Total	117	100,0	100,0	

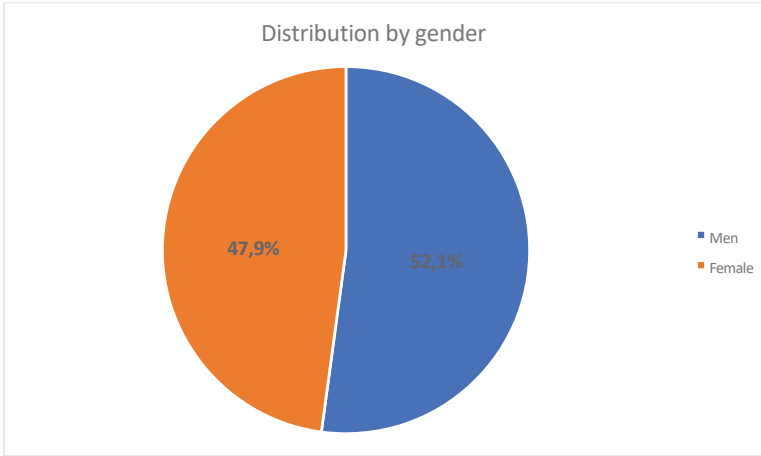


Diagram 5

From the presented data, it becomes clear that the sexual structure is balanced, with a slight prevalence of males.

The age distribution of patients is presented in Table. 4 and diagram 6.

Tabl. 4 Age distribution

Number of patients	117	Standard Asymmetry Error	,224
Average	57,04	Excess	,442
Median	59,00	Standard error of excess	,444
Mode	48 ^a	Minimum	16
Standard deviation	14,502	Maximum	83
Asymmetry	-,821		

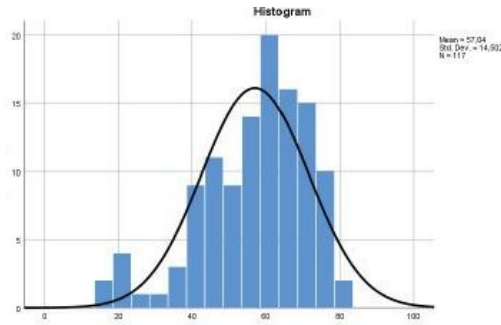


Diagram 6

The study involved 117 patients with an average age of 57 years. The most common age is 48 years, and the variation around the average is approximately 15 years. The age distribution shows moderate asymmetry with a pull to the right and a distinct top of the curve. The youngest patient is 16 years old, and the oldest is 83 years old.

2. Length of hospital stay

The distribution of patients according to the duration of the hospital stay is presented in Table. 5 and Diagram 7.

Tabl. 5. Duration of hospital stay

Number of patients	117	Standard Asymmetry Error	,224
Average	12,32	Excess	13,331
Median	10,00	Standard error of excess	,444
Mode	7	Minimum	2
Standard deviation	7,112	Maximum	56
Asymmetry	3,078		

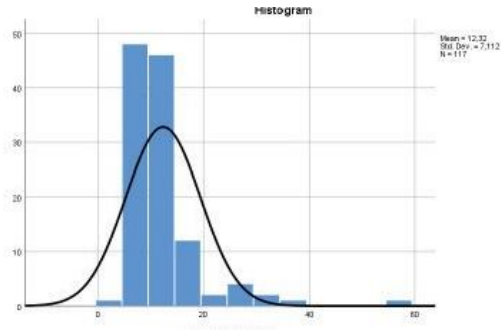


Diagram 7

The average hospital stay is 12 days, with the most common value being 7 days. The differences between patients are approximately 7 days. The distribution shows pronounced asymmetry with a pull to the left and a distinct top of the curve. The shortest stay is 2 days and the longest is 56 days.

3. Diagnostic distribution of patients

Depending on the etiology of the disease, patients were divided into the following diagnostic groups, presented in Table. 6 and Diagram 8:

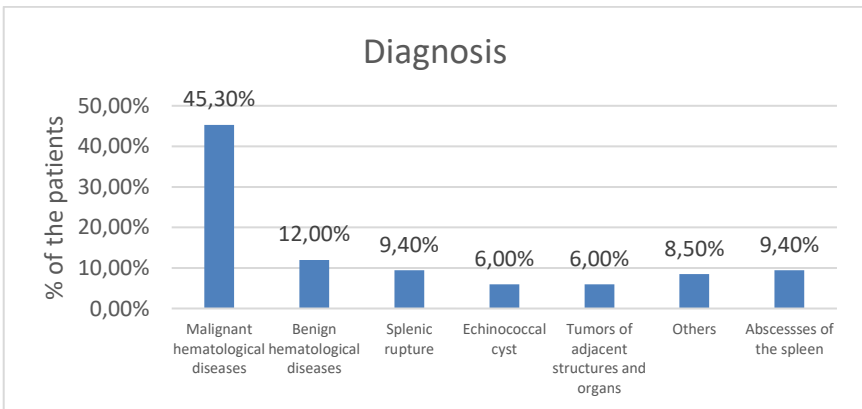


Diagram 8

Tabl. 6. Diagnostic distribution of patients

Diagnostic groups	Number	Percentage	Validation rate	Total percentage
Malignant hematological diseases	53	45,3	45,3	45,3
Benign hematological diseases	14	12,0	12,0	12
Spleen ruptures	11	9,4	9,4	9,7
Echinococcal cysts	7	6,0	6,0	6
Abscesses of the spleen	11	9,4	9,4	9,7
Tumors of adjacent structures and organs	11	9,4	9,4	9,7
Others	10	8,5	8,5	8,5
All	117	100,0	100,0	

Patients are divided into diagnostic groups according to the etiology of the disease. The largest share is occupied by malignant hematological diseases – 53 patients (45.3%). This is followed by the groups of benign hematological diseases – 14 patients (12.0%), and several groups with the same relative share – spleen ruptures, spleen abscesses and tumors of neighboring structures and organs, each with 11 patients (9.4%). Echinococcal cysts are represented by 7 cases (6.0%), and the category "Other" includes 10 patients (8.5%). The "Other" category, due to isolated cases, includes patients with unexplained hypersplenism, sarcoidosis, amyloidosis, heart attack and simple spleen cysts.

In general, almost half of patients suffer from malignant hematological diseases, while the rest of the diagnoses are distributed relatively evenly among smaller groups. This shows a pronounced dominance of oncohematological diseases in the cohort under consideration

4. Results of initial examination

Blood pressure value – systole is presented in Table. 7 and Diagram 9

Tabl. 7. Blood pressure value – systole

Number of patients	117	Standard Asymmetry Error	,224
Average	117,85	Excess	2,889
Median	120,00	Standard error of excess	,444
Mode	120	Minimum	50
Standard deviation	16,547	Maximum	160
Asymmetry	-1,011		

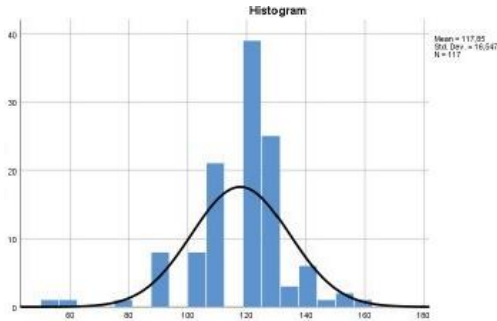


Diagram 9

The average value of the upper limit of blood pressure is 118 mmHg, with the most common being 120 mmHg. The differences between patients are on average about 17 units. The distribution shows moderate asymmetry with a pull to the right and a distinct top of the curve. The lowest value is 50 mmHg and the highest is 160 mmHg.

Blood pressure value – diastole is represented in Table. 8 and diagram 10.

Tabl. 8. Blood pressure value - diastole.

Number of patients	117	Standard Asymmetry Error	,224
Average	72,78	Excess	2,584
Median	75,00	Standard error of excess	,444
Moda	80	Minimum	30
Standard deviation	9,985	Maximum	90
Asymmetry	-1,294		

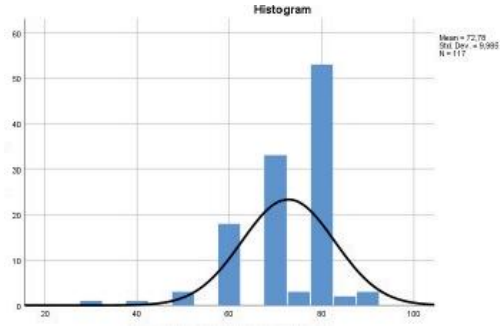


Diagram 10

The average value of the lower limit of blood pressure is 73 mmHg, and the most common value is 80 mmHg. The differences between patients are on average about 10 units. The distribution shows moderate asymmetry with a pull to the right and a distinct top of the curve. The lowest value is 30 mmHg and the highest is 90 mmHg.

Distribution of patients according to heart rate and presented in Table. 9 and diagram 11.

Tabl. 9. *Distribution of patients according to heart rate.*

Number of patients	117	Standard Asymmetry Error	,224
Average	81,50	Excess	7,178
Median	80,00	Standard error of excess	,444
Mode	80	Minimum	60
Standard deviation	12,351	Maximum	144
Asymmetry	2,162		

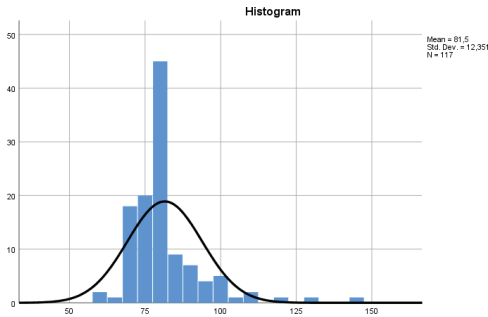


Diagram 11

The average heart rate is around 82 beats per minute, with the most common value being 80 beats per minute. The differences between patients are approximately 12 beats per minute. The distribution shows moderate asymmetry with a pull to the left and a distinct top of the curve. The lowest value is 60 and the highest is 144 beats per minute.

The data on fever during the examination are presented in Table. 10 and diagram 12.

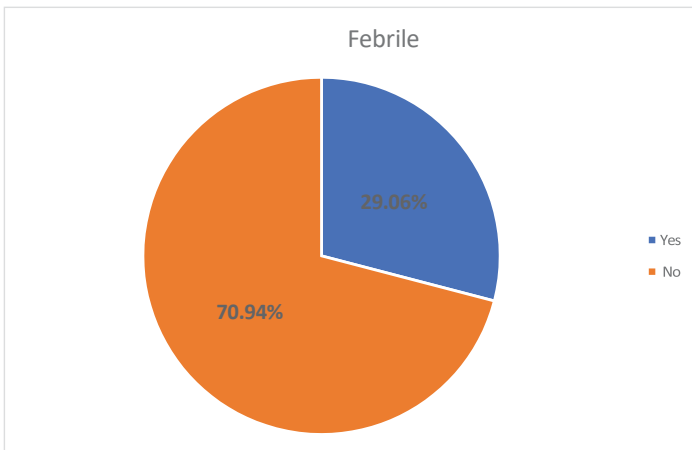


Diagram 12

Tabl. 10. Data on fever during the examination

Febrile	Number	Percentage	Validation Rate	Total percentage
No	83	70,9	70,9	70,9
Yes	34	29,1	29,1	100,0
Total	117	100,0	100,0	

In nearly 40% of cases, fever was detected during the clinical examination of patients. In almost all cases, there is anamnestic evidence of episodes of fever from the onset of complaints.

5. Laboratory values of hemoglobin, leukocytes and platelets at admission and discharge

The mean hemoglobin value preoperatively was 114.34 g/l, and postoperatively – 98.01 g/l, indicating a decrease after surgery. The dispersion of results was moderate – the standard deviation was 18,785 g/l for preoperative hemoglobin and 21,380 g/l for postoperative hemoglobin. The distribution of values is slightly asymmetric to the right – the asymmetry coefficient is -0.480 for the preoperative values and -0.245 for the postoperative values. This means that most patients have values that are concentrated around the mean, but with some pull to the higher values. The lowest measured values of haemoglobin are 40 g/l (preoperative) and 45 g/l (postoperative), and the highest values are 155 g/l and 144 g/l respectively.

The average value of leukocytes preoperatively is 10.09 x10⁹/l, and postoperative – 19.08 x10⁹/l, which indicates a significant increase after surgery. The dispersion is high – the standard deviation is 11.89 x10⁹/l for preoperative values and 26.06 x10⁹/l for postoperative values, reflecting large differences between patients. The distribution is strongly asymmetric on the left – the asymmetry coefficient is 4.012 for the preoperative values and 5.562 for the postoperative values, which indicates the presence of extremely high individual values in a small part of the patients. The minimum value of leukocytes preoperatively is 1.10 x10⁹/l, and the maximum is 88 x10⁹/l; Postoperatively, the lowest is 2.20 x10⁹/l, and the highest is 186 x10⁹/l.

The average platelet count preoperatively was 184.20 x10⁹/l, and postoperatively – 404.96 x10⁹/l, which shows more than twice

increase after surgery. The values differ significantly between patients – the standard deviation is 114.92 units for preoperative results and 270.64 x109/l for postoperative results. The distribution is asymmetrical to the left – the asymmetry coefficient is 1.075 preoperative and 2.744 postoperative, indicating the presence of a small number of patients with extremely high values. The minimum platelet count is 21 x109/l preoperative and 23 x 109/l postoperatively, and the maximum is 624 x 109/l and 2113 x 109/l, respectively.

6. Imaging modalities used

The imaging methods used are shown in Table. 11 and Diagram 13.

Tabl. 11. Imaging methods

Imaging studies	Number of tests performed	Grouped percentage	Rate of cases
US	98	41,5%	83,8%
X-ray	51	21,6%	43,6%
CT	84	35,6%	71,8%
MRI	3	1,3%	2,6%
Total	236	100,0%	201,8%

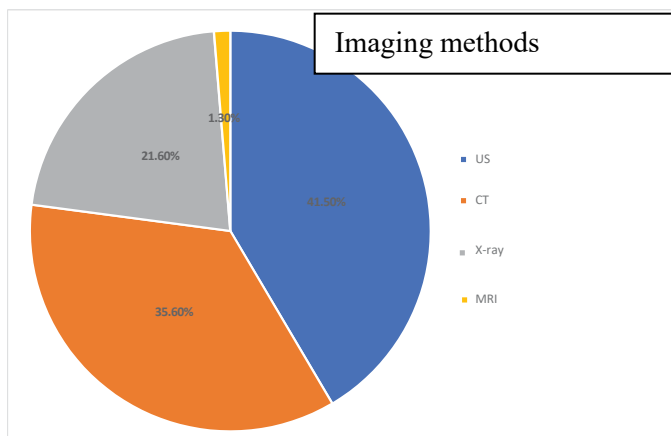


Diagram 13

A total of 236 imaging examinations were performed, as more than one method can be applied to one patient. Ultrasound of the abdomen remains the most commonly used method – performed in 98 patients. Computed tomography is the second most common method - in 84 patients. X-rays of the abdomen and chest were performed in 51 patients. Magnetic resonance imaging (MRI) was applied to 3 patients.

7. Preoperative staging of patients according to ASA

The largest percentage of cases are occupied by patients with ASA III (52.14%), followed by patients with ASA II (31.62%), ASA IV (12.82%) and ASA I (3.42%).

8. Microbiological results

On Table. 12 and Diagram 14 show the distribution of isolated microorganisms, as well as the cases in which sterile cultures have been found.

Tabl. 12. Results of the microbiological examination

	Microbiological result	Number	Percentage	Validation Rate	Total percentage
Valid	S. epidermidis	3	2,6	8,8	8,8
	S. enteritidis	1	,9	2,9	11,8
	Steril cultures	15	12,8	44,1	55,9
	M. tuberculosis	2	1,7	5,9	61,8
	S. aureus	3	2,6	8,8	70,6
	P. aeruginosa	2	1,7	5,9	76,5
	E. Coli	1	,9	2,9	79,4
	A. baumannii	1	,9	2,9	82,4
	E. cloacae	1	,9	2,9	85,3
	E. faecium	1	,9	2,9	88,2
	S. haemolyticus	1	,9	2,9	91,2
	C. albicans	1	,9	2,9	94,1
	E. faecalis	1	,9	2,9	97,1
	K. pneumoniae	1	,9	2,9	100,0
	Total	34	29,1	100,0	
Missing		83	70,9		
Total		117	100,0		

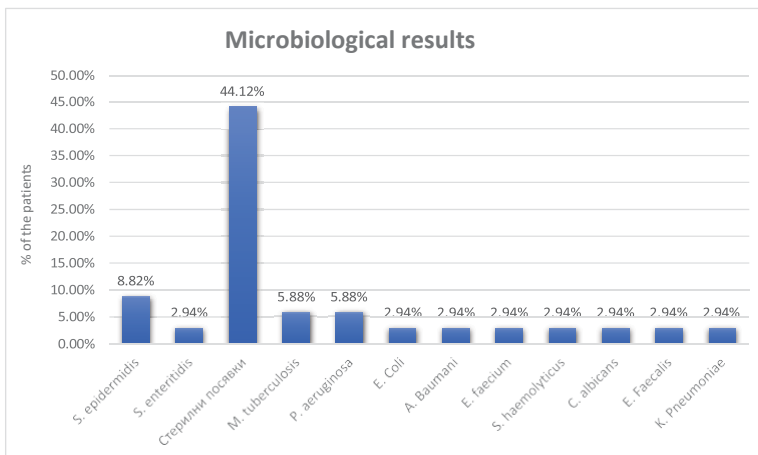


Diagram 14

9. Comorbidities and past medical examination

On Diagram 15 and Table. 13 data on the presence of concomitant metabolic diseases (diabetes mellitus, metabolic diseases, hypercholesterolemia) are presented:

Approximately 22% of patients have comorbidities of metabolic diseases. The largest percentage of cases have non-insulin-dependent type 2 diabetes.

Tabl. 13. Metabolic diseases

Metabolic diseases	Number	Percentage	Validation Rate	Total percentage
No	92	78,6	78,6	78,6
Yes	25	21,4	21,4	100,0
Total	117	100,0	100,0	

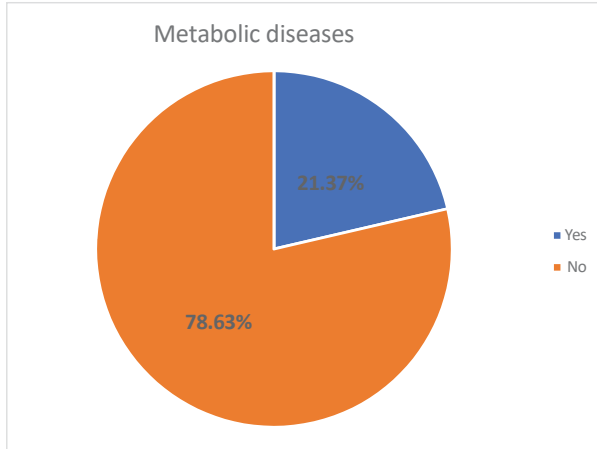


Diagram 15

On Table. 14 and Diagram 16 present data on the presence of concomitant cardiovascular diseases (hypertension, arrhythmia, heart failure, etc.).

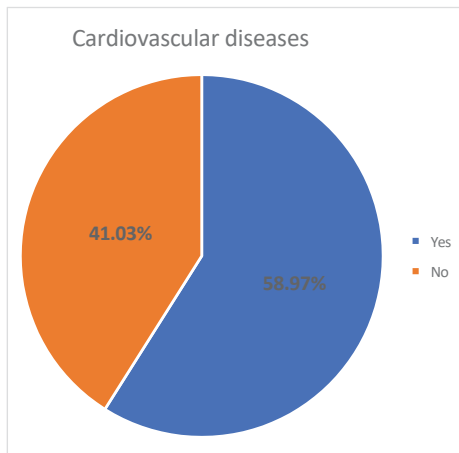


Diagram 16

Tabl. 14. Cardiovascular diseases

Cardiovascular diseases	Number	Percentage	Validation Rate	Total percentage
No	48	41,0	41,0	41,0
Yes	69	59,0	59,0	100,0
Total	117	100,0	100,0	

Approximately 60% of the patients surveyed reported concomitant cardiovascular disease. The largest percentage of cases have hypertension.

On Table. 15 and Diagram 17 present data on the presence of concomitant lung diseases (bronchial asthma, COPD, pneumonia, pleural effusions, etc.)

Tabl. 15. Pulmonary disease

Pulmonary diseases	Number	Percentage	Valid percentage	Total percentage
No	95	81,2	81,2	81,2
Yes	22	18,8	18,8	100,0
Total	117	100,0	100,0	

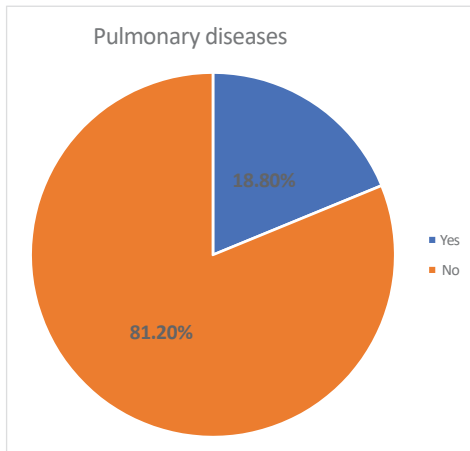


Diagram 17

Approximately 19% of patients have anamnestic and objective evidence of pulmonary disease.

10. Need for intensive care

On Table. 16 and Diagram 18 show the distribution of patients in need of additional treatment in an intensive care unit.

Tabl. 18. Need for intensive treatment

Need for intensive treatment	Number	Percentage	Validation Rate	Total percentage
No	61	52,1	52,1	52,1
Yes	56	47,9	47,9	100,0
Total	117	100,0	100,0	

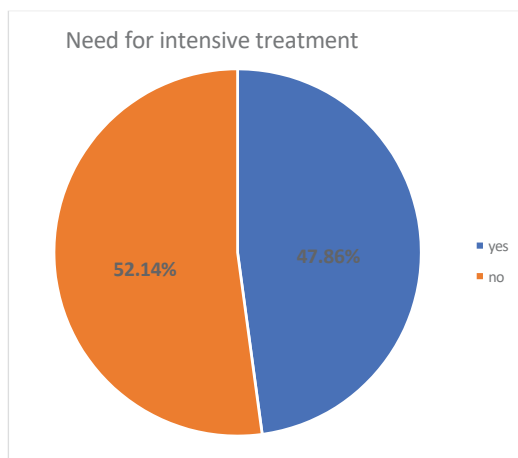


Diagram 18

In 47.86%(56) of cases, patients required intensive care.

11. Mortality

The distribution of the deceased during the hospital stay is presented in Table 17 and Diagram 19.

Tabl. 17. Deceased patients

Mortality	Number	Percentage	Validation Rate	Total percentage
No	109	93,2	93,2	93,2
Yes	8	6,8	6,8	100,0
Total	117	100,0	100,0	

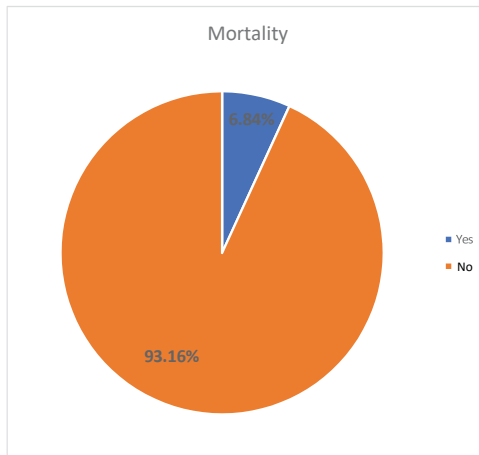


Diagram 19

In 6.84% (8) of patients, death occurred during the hospital stay.

12. Survival

Tables 18-21 and Diagrams 20-23 show the annual survival of patients postoperatively.

Tabl. 18. *Survival rate up to 1 year.*

Survival rate up to 1 year	Number	Percentage	Validation Rate	Total percentage
No	88	75,2	75,2	75,2
Yes	29	24,8	24,8	100,0
Total	117	100,0	100,0	

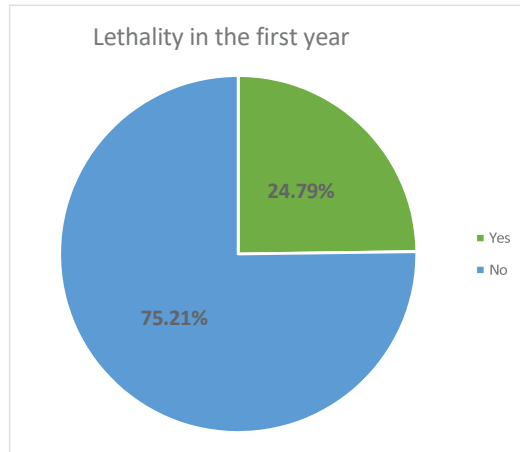


Diagram 20

In 24.8% (29) of cases, patients died in the first year after surgery.

Tabl. 19. *Survival rate up to 3 years.*

Survival rate up to 3 years	Number	Percentage	Validation Rate	Total percentage
No	99	84,6	84,6	84,6
Yes	18	15,4	15,4	100,0
Total	117	100,0	100,0	

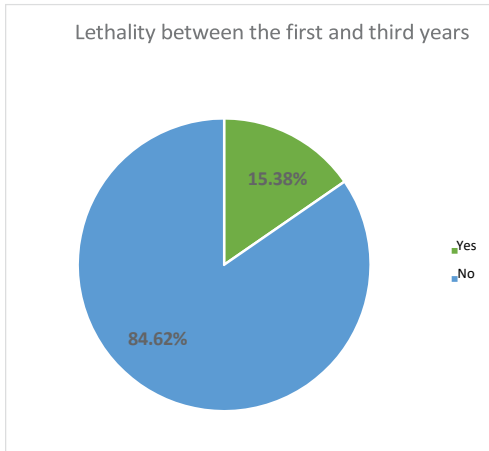


Diagram 21

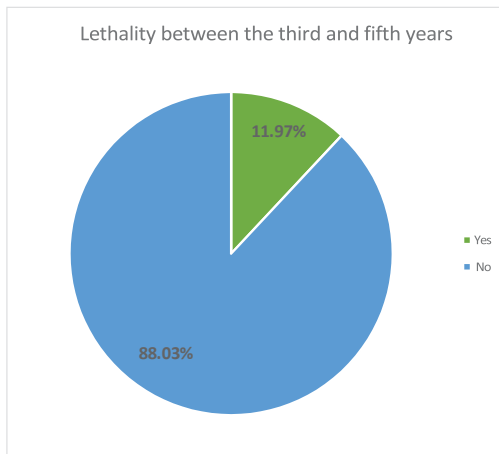


Diagram 22

In 15.38% (18) of cases, patients died between the first and third year after surgery.

Tabl. 20. Survival up to 5 years.

Survival rate up to 5 years	Number	Percentage	Validation Rate	Total percentage
No	103	88,0	88,0	88,0
Yes	14	12,0	12,0	100,0
Tota	117	100,0	100,0	

In 11.97% (14) of cases, patients died between the third and fifth year after surgery.

Tabl. 21. Survival rate over 5 years.

Survival rate over 5 years	Number	Percentage	Validation Rate	Total percentage
No	62	53,0	53,0	53,0
Yes	55	47,0	47,0	100,0
Total	117	100,0	100,0	

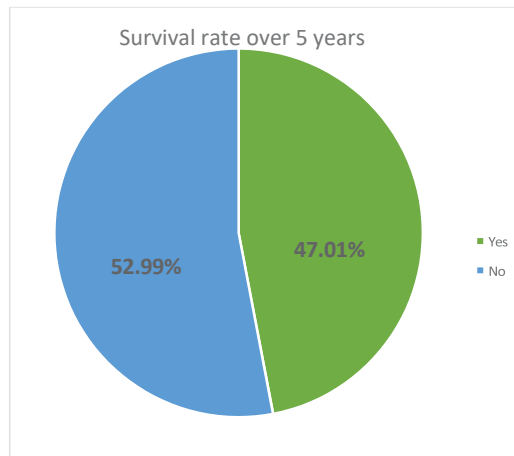


Diagram 23

47.01% (55) of patients have more than 5 years of postoperative survival.

13. Data of hemoperitoneum

On Table. 22 and Diagram 24 present the patients with hemoperitoneum data.

Tabl. 22. Data on hemoperitoneum

Hemoperitoneum	Number	Percentage	Validation Rate	Total percentage
No	101	86,3	86,3	86,3
Yes	16	13,7	13,7	100,0
Total	117	100,0	100,0	

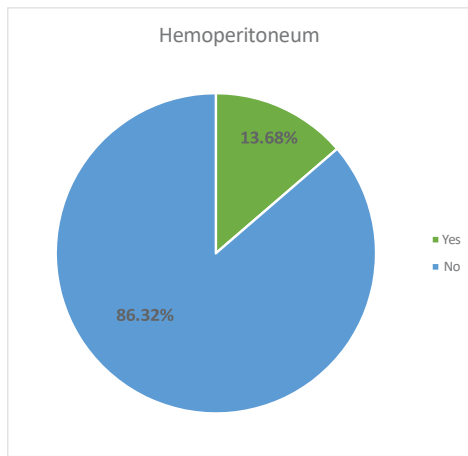


Diagram 24

In 13.68% (16) of cases, there are imaging and/or intraoperative data on hemoperitoneum.

14. Results of the correlation analysis of the observed parameters

A moderate positive correlation was established between the presence of hemoperitoneum and mortality.

A moderate positive correlation was also found between the presence of

hemoperitoneum and the postoperative need for intensive care. In 87.5% of operated patients with evidence of hemoperitoneum, subsequent intensive care was required.

A moderate positive correlation was observed between the presence of hemoperitoneum and the ASA classification. Patients with hemoperitoneum were classified as follows: 50% – ASA III, 43% – ASA IV, and 6.25% – ASA II.

A statistically significant association was established between diagnosis and the presence of hemoperitoneum.

A clear correlation was observed between hemoperitoneum and hemoglobin levels, particularly in the postoperative period.

Male patients more frequently required intensive care compared to female patients.

Male patients exhibited higher mortality within the first postoperative year compared to female patients.

Female patients more frequently demonstrated survival beyond 5 years postoperatively compared to male patients.

The highest proportion of patients requiring postoperative intensive care were classified as ASA III.

A weak positive correlation was found between mortality and ASA classification. Approximately 88% of deceased patients were classified as ASA III or ASA IV.

A moderate correlation was established between patient age and ASA classification.

A moderate correlation was observed between patient age and concomitant cardiovascular diseases.

A moderate correlation was found between age and the presence of concomitant pulmonary diseases.

A moderate to strong association was observed between the need for postoperative intensive care and arterial blood pressure and heart rate values.

A moderate association was observed between the presence of hemoperitoneum and arterial blood pressure and heart rate values.

A strong correlation was found between fever and hemoglobin levels, both preoperatively and postoperatively. A very strong correlation was established between leukocyte and platelet levels, both preoperatively and postoperatively.

A weak correlation was observed between concomitant metabolic diseases and survival up to 5 years.

A weak correlation was found between concomitant cardiovascular diseases and survival beyond 5 years.

A weak correlation was established between concomitant pulmonary diseases and survival beyond 5 years.

A weak correlation was observed between the postoperative need for intensive care and the presence of concomitant cardiovascular diseases.

A moderate correlation was found between the performance of abdominal and chest radiography and the postoperative need for intensive care. Nearly 69% of patients who underwent radiographic examination required intensive care.

It was established that all patients who died postoperatively had been treated in an intensive care unit.

Approximately 76% of patients who died within the first postoperative year had required intensive care during their hospital stay.

It was found that 67% of patients with survival beyond 5 years had not required postoperative intensive care.

Postoperative intensive care stay was strongly associated with leukocyte and platelet levels, and moderately associated with hemoglobin levels, both preoperatively and postoperatively.

Mortality showed a high to very high association with hemoglobin, leukocyte, and platelet levels, both preoperatively and postoperatively, indicating that these parameters are significant predictors of outcome following splenectomy.

A strong positive correlation was found between hemoglobin and leukocyte levels, both preoperatively and postoperatively. A moderate positive correlation was observed between platelet levels preoperatively and postoperatively.

Hemoglobin, leukocyte, and platelet levels showed a strong association with postoperative survival in patients undergoing splenectomy.

DISCUSSION

The spleen is a key organ of the lymphoreticuloendothelial system that integrates immunological, hematological, and hemodynamic functions and contributes significantly to the maintenance of systemic homeostasis. Historically perceived as a “mysterious” structure, in the modern clinical context it is regarded as a dynamic filter and immunological center in which antigens and cells of innate and adaptive immunity interact, while aging or damaged blood cells are removed from the circulation. The transition from early, often empirical surgical interventions to current organ-preserving strategies reflects a fundamental re-evaluation of the biological importance of the spleen. Clinical experience has shown that preserving the spleen whenever possible has a direct effect on reducing the risk of severe infections and thrombotic complications, particularly in children and in patients with concomitant immunosuppression.

In the context of the present study, the choice of conventional splenectomy is fully justified, given the retrospective nature of the study, the limited resources, and the lack of the necessary equipment and trained personnel for laparoscopic or interventional procedures. These factors should not be regarded as a methodological limitation, but rather as a realistic reflection of clinical practice in the specific institution and study period, which gives practical value to the results obtained.

The study group included 117 patients who underwent splenectomy, with a relatively balanced sex distribution: 61 men (52.1%) and 56 women (47.9%). The average age of the patients was 57 years, ranging from 16 to 83 years, indicating population heterogeneity and reflecting the fact that splenic diseases may occur in all age groups. The highest incidence was observed in the fifth and sixth decades of life, which is consistent with the trends described by Morgenstern et al. (1997), according to whom most patients undergoing splenectomy for hematological or neoplastic diseases are between 40 and 60 years of age. The sex distribution is also

consistent with the published data of Skandalakis et al. (2004), according to which male patients predominate in traumatic and infectious diseases, whereas female patients are more frequently affected in autoimmune and benign hematological disorders.

The diagnostic distribution in the present study shows that the largest proportion consisted of patients with malignant hematological diseases, accounting for 53 cases (45.3%), followed by benign hematological diseases with 14 cases (12.0%). Traumatic splenic lesions were identified in 11 patients (9.4%), the same proportion observed in patients with splenic abscesses and in those with tumors of neighboring structures and organs. Echinococcal cysts were found in 7 patients (6.0%), and the group classified as “other,” due to isolated cases, included patients with sarcoidosis, amyloidosis, splenic infarction, simple splenic cysts, and unexplained hypersplenism. This distribution clearly demonstrates the dominant role of hematological indications, which is in agreement with current trends also described by Coccolini et al. (2017), according to whom traumatic splenectomies have been decreasing in recent decades as a result of the increasing use of interventional treatment methods, while hematological and oncological indications have gradually assumed a leading role.

The overall proportion of splenectomy performed because of adjacent tumor processes in our series was 9.4%, which is slightly higher than the average reported in the literature, approximately 6 to 8 percent. This reflects the profile of patients treated in the clinic, where advanced cancers of the pancreas, stomach, and colon predominated, and in which splenectomy was performed as part of a more extensive resection.

Thus, the composition of the studied group may be considered representative of real clinical practice under the conditions of the surgical unit, where patients with malignant and infectious diseases predominate and the proportion of traumatic cases is limited because of the lack of a specialized trauma center. Nevertheless, the

distribution by diagnosis is comparable to data from most published studies and confirms the observed changes in splenectomy indications over recent decades.

The postoperative period in the study group was characterized by significant heterogeneity in clinical course, reflecting both the severity of the underlying diseases and the predominance of patients with high anesthetic risk. Nearly half of all patients, 56 out of 117 (47.9%), required intensive monitoring in the early postoperative period. This proportion exceeds that reported in most modern laparoscopic series, but is comparable to the results of conventional splenectomy, especially in patients with malignant hematological or infectious diseases. According to Brunicardi (2022), approximately 30 to 50 percent of patients undergoing splenectomy for oncohematological diseases require short-term intensive monitoring. The present study also found that patients classified as American Society of Anesthesiologists class three and four, who represent more than 60 percent of all patients, required postoperative intensive care significantly more often. This is consistent with the trends described by Morgenstern and Shapiro, according to whom the total somatic burden is a leading factor in a complicated postoperative course.

The spleen is a parenchymal organ located beneath the left hemidiaphragm and is frequently affected by abdominal trauma. Historically, splenectomy was the only treatment for splenic injury, but in recent years non-operative management has largely replaced surgical treatment because of the risk of immune deficiency after splenectomy. Recent advances in both interventional radiology and diagnostic imaging, particularly computed tomography angiography and angioembolization, have established these methods as preferred therapeutic approaches over splenectomy in selected patients.

However, the spleen is a highly vascular organ, and its injury may easily lead to hemoperitoneum followed by hemorrhagic shock. Therefore, early diagnosis and appropriate treatment are essential in the management of splenic injury.

Splenic injuries may be classified according to the mechanism of injury,

hemodynamic changes, and severity of injury. From the mechanistic point of view, blunt injuries may occur, such as those caused by motor vehicle accidents, as well as penetrating injuries, such as stab wounds and gunshot wounds. According to hemodynamic status, trauma patients may be divided into two categories: stable and unstable.

The American College of Surgeons Committee on Trauma, through the Advanced Trauma Life Support guidelines, provides a generally accepted definition of hemodynamically stable and unstable patients based on pulse rate, blood pressure, skin perfusion, and level of consciousness.

In 2017, the American Association for the Surgery of Trauma published a grading scale for splenic injuries based on anatomical findings identified by computed tomography and intraoperative assessment. However, the degree of injury or intra-abdominal bleeding identified on computed tomography is not, by itself, an absolute indication for emergency laparotomy. In addition, the degree determined during surgery does not always correspond to the degree assessed on computed tomography because of technical limitations and variability in radiological interpretation.

In fact, some patients undergo emergency surgery before formal classification, depending on their hemodynamic status. For this reason, the guidelines of the World Society of Emergency Surgery recommend a classification system based on both the anatomical severity of injury and the hemodynamic condition of the patient.

In recent years, hybrid emergency care systems, in which the contrast-enhanced computed tomography unit is positioned within the emergency department, have become increasingly popular in Japan. In this way, the time required to access computed tomography can be significantly shortened compared with conventional emergency care, which may expand the indications for its use even in patients with unstable hemodynamic status.

Transarterial embolization in splenic injury may be performed in two forms:

proximal embolization, carried out as close as possible to the origin of the splenic artery from the celiac trunk, and distal embolization, performed selectively by delivering the embolic agent into the affected arterial branch.

It is generally accepted that distal embolization should be used for focal vascular injuries, whereas proximal embolization is more suitable for multiple vascular lesions. Higher failure rates of non-operative management have also been reported after proximal embolization in patients with more severe arterial injury. In the meta-analyses of Frandon (2014) and Schnüriger (2011), however, no significant difference in efficacy between proximal and distal embolization was demonstrated. In practice, the experience and preference of the interventional radiologist often determine the choice of approach.

In proximal embolization, blood supply to the spleen is maintained through the short gastric arteries and collateral pathways, thereby achieving hemostasis at the splenic hilum while reducing the risk of splenic infarction. Even in the absence of active contrast extravasation on angiography, embolization should be considered if contrast leakage has been observed previously on computed tomography. In 2.3 to 47 percent of cases with contrast leakage identified on computed tomography, the finding cannot be confirmed during subsequent angiography. An analysis of 143 patients with contrast leakage detected on computed tomography showed that in those who did not undergo embolization, the risk of failure of non-operative management due to recurrent bleeding was twice as high.

The incidence of serious complications after angiography and angioembolization ranges from 3.7 to 28.5 percent and includes rebleeding, total or partial splenic infarction, splenic abscess, acute renal failure, pseudocysts, and access-related complications. Mild complications range from 23 to 61 percent and include fever, pleural effusion, drain displacement, and pain. Selective embolization of a peripheral artery naturally leads to infarction in the supplied area. Most splenic infarctions are asymptomatic and rarely require additional treatment, but they may

lead to abscess formation. Such abscesses may be treated by percutaneous or open drainage. The body of the pancreas receives blood supply from the inferior pancreatic artery, and the tail of the pancreas is supplied by terminal branches arising directly from the distal splenic artery. Therefore, embolization of branches supplying the pancreas may result in pancreatitis. It is sometimes difficult to determine whether a complication is caused by embolization itself, because the traumatic force that initially caused the splenic injury may also damage the pancreas and lead to leakage of pancreatic fluid into the surrounding tissues and subsequent pancreatitis.

Hemoperitoneum, detected preoperatively in 16 patients (13.7%), is a clinically significant marker of disease severity and is associated with an increased need for intensive care and higher mortality. In 14 of these patients (87.5%), prolonged monitoring and treatment in an intensive care unit were required. A similar relationship between hemoperitoneum and adverse outcomes is highlighted in the 2017 guidelines of the World Society of Emergency Surgery, according to which the presence of hemoperitoneum or contrast extravasation on imaging studies is a strong predictor of treatment difficulty and a higher risk of postoperative complications.

The in-hospital mortality rate in the study group was 6.84 percent, which is relatively low compared with a similar study from Colombia by Rey Chaves et al. (2024), in which the ninety-day mortality reached 16.4 percent. In our group, traumatic patients accounted for only 9.4 percent of cases, whereas in their series they represented approximately one third of all patients, which logically contributes to higher overall mortality. Nevertheless, the two series demonstrate a similar trend: complications, hemoperitoneum, and high anesthetic risk classification are predictors of increased risk of adverse outcome. Correlation analysis in our study showed a statistically significant association between hemoperitoneum and mortality, with a correlation coefficient of 0.359 and a probability value below 0.001, which is consistent with clinical observations that active bleeding and systemic inflammatory response substantially worsen prognosis.

Comparison of our results with the twenty-year single-center study conducted in Colombia by Rey Chaves et al., published in 2024, reveals a number of important similarities as well as some expected differences resulting from the distinct patient structure, surgical approaches, and resource settings. In the present study, all 117 patients underwent conventional splenectomy, whereas 134 patients were analyzed in the Colombian series, in which 58.2 percent of operations were performed by conventional surgery and 41.8 percent laparoscopically, with conversion in 10.9 percent of cases. This structural difference is essential for interpreting the results, since the laparoscopic approach is associated with lower morbidity, shorter hospital stay, and reduced need for intensive care, whereas open procedures, especially for traumatic or infectious indications, are generally performed in more severe cases and require greater resource utilization. The average age and sex distribution of patients in the two studies were similar, approximately in the fifth decade of life and with comparable biological profile. This demographic similarity permits a meaningful comparison of results. In our study, 56 out of 117 patients (47.9 percent) required intensive care, whereas in the compared study this proportion was 55 out of 134 patients (41.0 percent). A substantial difference was observed between conventional splenectomy, in which 48.7 percent required intensive care, and laparoscopic splenectomy, in which 30.4 percent required intensive care, thereby providing additional context for the similarity between the two overall results. These data confirm that the postoperative burden of open splenectomy remains high and is significantly influenced by the underlying disease and the patient's preoperative condition.

The average length of hospital stay in our study was 12 days, which is longer than the values described in laparoscopic series, where the average stay is usually 4 to 6 days, but is comparable to reported outcomes after open procedures performed in patients with complications or combined resections.

Comorbidity also had a pronounced impact on postoperative outcomes. Fifty-

nine percent of patients had cardiovascular disease, 21.4 percent had metabolic disorders, and 18.8 percent had pulmonary disease. According to Brunicardi (2022), the presence of more than two chronic diseases increases the likelihood of postoperative complications by up to 35 percent, which is consistent with our observations of more frequent need for intensive care and increased mortality in this group.

Microbiological analysis complements the clinical picture and confirms the high infectious risk in patients after splenectomy. Of the 34 examined cases, intraoperative cultures were sterile in 44.1 percent, while among the isolated pathogens *Staphylococcus aureus* and *Staphylococcus epidermidis* predominated, followed by *Pseudomonas aeruginosa* and members of the Enterobacteriaceae family.

In terms of survival, 24.8 percent of patients died within the first year, 15.38 percent between the first and third year, and 11.97 percent between the third and fifth year, while 47.01 percent of patients survived more than 5 years. These values are consistent with published data on mixed populations with oncohematological pathology, where five-year survival ranges from 40 to 50 percent. According to data published by Schwartz et al., splenectomy, when performed with proper indication and followed by adequate follow-up, provides good medium-term control of the underlying disease, which is also confirmed by the present study.

In the present study, 11 patients with splenic abscess were identified, with an average age of 54.8 years and an average hospital stay of 9.8 days. In 5 patients (45.5 percent), the need for intensive care after surgery was reported, and no in-hospital mortality was recorded. All patients underwent conventional total splenectomy. This probably explains the finding that in 3 out of 10 cultures, representing 30 percent, no microbial growth was observed. Of the remaining 7 positive cultures, the isolated microorganisms included *Mycobacterium tuberculosis* in 2 cases, as well as *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Enterococcus faecium*,

Escherichia coli, and *Salmonella enteritidis*. The predominance of gram-positive cocci, particularly coagulase-negative staphylococci, with more limited involvement of gram-negative bacteria, outlines an infectious profile characteristic of localized bacterial processes in patients with early and adequate surgical control of the source of infection.

These results are comparable to the classic observations of Nelken et al. (1987), who, in a series including 19 original cases and 170 cases from the literature, found a predominance of aerobic bacterial isolates (57 percent), dominated by *Staphylococcus aureus*, *Escherichia coli*, and *Salmonella* species, with lower proportions of fungal (26 percent) and anaerobic (18 percent) pathogens. The authors emphasized that the introduction of computed tomography significantly reduced the proportion of sterile cultures and enabled earlier detection of localized lesions. The mortality rate in their series reached 13 percent, but with timely surgical intervention it fell to 7.8 percent.

A similar trend is described by Ferraioli et al. (2009), according to whom bacterial abscesses accounted for 62.5 percent of all cases, fungal abscesses for 25 percent, and amoebic abscesses for 12.5 percent. They reported positive cultures in 80 percent of cases and polymicrobial infections in 44 percent, with *Staphylococcus aureus* being the most common isolate, a finding that corresponds to our results. The authors noted that percutaneous drainage and antibiotic therapy may be successful in localized lesions, but that in multilocular or advanced processes splenectomy remains the gold standard.

In summary, the present results show that bacterial etiology remains predominant in splenic abscesses, with *Staphylococcus aureus* and other gram-positive cocci continuing to be the most common causative agents. In the studied patients, surgical treatment demonstrated high effectiveness, low postoperative morbidity, and excellent disease control.

Patients who underwent splenectomy for hematological diseases included a

total of 66 individuals, 52 with malignant and 14 with benign diagnoses. All underwent planned conventional splenectomy following discussion and decision by an oncohematology committee. Imaging diagnostics were performed systematically. Ultrasound examination was applied in almost all patients, namely 92.5 percent. Computed tomography was performed more frequently in patients with malignant hematological diseases, 71.2 percent versus 42.9 percent in benign hematological diseases. Magnetic resonance imaging was used to a limited extent, in one patient from each group. Chest and abdominal radiographs were performed according to clinical judgment, in 44.2 percent of malignant and 14.3 percent of benign hematological diseases. The postoperative need for intensive care and admission to an intensive care unit was higher in malignant cases: 21 out of 52 patients (40.4 percent), compared with 2 out of 14 patients (14.3 percent) in the benign group. The average hospital stay was nearly 13 days. In-hospital mortality among hematological cases was minimal and was limited to one patient in the malignant hematological group.

Laboratory dynamics demonstrated the expected corrective effect of splenectomy on cytopenia, but also a different postoperative profile between the two groups. In malignant diseases, the average preoperative values were hemoglobin 114 grams per liter, leukocytes 9.13×10^9 per liter, and platelets 154×10^9 per liter, while in the early postoperative period they were hemoglobin 97 grams per liter, leukocytes 23.25×10^9 per liter, and platelets 394×10^9 per liter. The leukocytosis reflects postoperative stress and inflammatory response, as well as the oncohematological background. In patients with benign diseases, the average preoperative values were hemoglobin 119 grams per liter, leukocytes 9.10×10^9 per liter, and platelets 113×10^9 per liter, while postoperative values were hemoglobin 108 grams per liter, leukocytes 15.61×10^9 per liter, and platelets 340×10^9 per liter.

A more moderate leukocytosis and a pronounced increase in platelet count were observed in benign conditions, corresponding to the clinical purpose of the

operation in immune thrombocytopenia and other benign indications. These differences reinforce the clinical impression of a more difficult postoperative course and greater resource utilization in malignant diagnoses, without affecting in-hospital mortality.

Annual survival showed a clear divergence between the two groups. In the malignant group, 14 out of 52 patients survived up to 1 year, 9 out of 52 up to 3 years, 6 out of 52 up to 5 years, and 23 out of 52 patients, or 44.2 percent, survived more than 5 years. In the group with benign pathologies, 3 out of 14 patients survived up to 1 year, no patients died in the interval up to 3 years, 2 out of 14 survived up to 5 years, and 9 out of 14, or 64.3 percent, survived more than 5 years. Thus, the long-term outlook was more favorable for benign hematological diseases after splenectomy. Despite the greater need for intensive care and longer hospital stay, in-hospital mortality remained low, confirming that the immediate surgical risk in a carefully selected, planned, and interdisciplinarily evaluated population remains limited, whereas long-term survival is determined mainly by the nature and stage of the underlying hematological disease.

The study by Alobuia et al. (2020) included 161 patients who underwent splenectomy for hematological diseases. Laparoscopic splenectomy was performed in 76 percent of cases, hand-assisted laparoscopic splenectomy in 11 percent, conventional splenectomy in 8 percent, and conversion during surgery was required in 6 percent. Severe complications were reported in 13 percent of patients, thirty-day mortality was 2 percent, representing 3 out of 161 patients, and an additional 9 percent died after the thirtieth day. The follow-up period was 761 days. Compared with our group, these findings highlight the expectedly more difficult postoperative recovery and longer hospital stay after conventional access, whereas laparoscopy reduces the duration of hospitalization to an average of 2 days in benign and 3 days in malignant hematological diseases, with a range between 1 and 41 days.

Onisâi et al. (2020) included 54 patients with lymphoproliferative diseases,

with particular focus on patients with splenic marginal zone lymphoma. Of these, 34 patients, or 63 percent, underwent splenectomy: 12 for diagnostic and 22 for therapeutic purposes. The authors reported 38.5 percent complications, most of them mild and controllable, as well as a tendency toward better overall survival, approximately 64 months versus 59 months in non-splenectomized patients, and a higher proportion of complete response among patients with marginal zone lymphoma. Although the design of that study differs from ours, the results support our observations that in malignant hematological disease splenectomy remains the method of choice in selected cases, while the frequency of complications is sensitive to the general condition and concomitant systemic treatment.

Two consecutive studies with predominantly laparoscopic access have shown how the choice of access affects immediate outcomes. Shakya et al. (2018) analyzed 50 patients with hematological diseases, predominantly immune thrombocytopenia, in whom laparoscopic splenectomy was completed in 90 percent, with a conversion rate of 10 percent and a mean postoperative stay of 4 days. This differs substantially from our average stay of 13 days and the high proportion of patients requiring intensive care, a difference that is expected given the exclusively open access, the diversity of diseases, and the resource limitations. Similarly, Docimo et al. (2006) reported 76 consecutive laparoscopic cases, with 94.7 percent completed laparoscopically, a conversion rate of 5.2 percent, severe complications in 7.8 percent, perioperative mortality in 1.3 percent, and splenoportal thrombosis in 9.7 percent. Compared with our patient group, these data suggest that part of the difference in morbidity and in-hospital stay is due precisely to the surgical approach, but also to age, spleen size, and the type and stage of the underlying disease.

Comparison with four different centers presents a consistent picture: in benign hematological indications, laparoscopy reduces morbidity and hospital stay, whereas in malignant diseases the outcomes depend to a greater extent on age, spleen volume, comorbidity, and systemic therapy. Our results demonstrate a longer stay and a

greater need for intensive care compared with laparoscopic series, but remain comparable in significance to the published studies on hematological patients, especially when the different surgical approach and patient profile are taken into account. This confirms the validity of the surgical strategy in the context of available resources and highlights that structural differences are the key determinants of the observed variations in immediate outcomes.

Our study included four patients diagnosed with isolated echinococcosis of the spleen who underwent surgical treatment. The sex distribution included three males and one female. The average age of the patients was 49 years, which corresponds to the predominant age group for the occurrence of clinically significant echinococcosis. The average hospital stay was approximately 9 days, reflecting a stable postoperative recovery period in the absence of severe complications.

In most patients, pronounced clinical manifestations were registered, and fever was observed in three of them. Two patients had metabolic comorbidities and two had cardiovascular comorbidities. In half of the cases, a short stay in an intensive care unit was necessary, reflecting the need for close postoperative monitoring after splenectomy, without the development of serious complications or hemodynamic instability.

In the diagnostic process, computed tomography played a central role and was performed in all patients, as the method with the highest sensitivity and informativeness for the localization, size, anatomical characteristics of the cystic lesions, and the extent of the process. Ultrasound examination was performed in only one patient, while chest and abdominal radiography complemented the assessment in three cases. Laboratory findings showed a minimal change in hemoglobin, with a mean preoperative to postoperative difference of minus 0.75 grams per liter, an expected increase in leukocytes in the early postoperative period with an average increase of 4.92×10^9 per liter, and moderate thrombocytosis with an average increase of 92.5×10^9 per liter, consistent with reactive platelet elevation after

splenectomy. No relapses were observed during follow-up. No in-hospital mortality occurred. Three patients survived more than 5 years, and one patient died in the fourth year. No patient developed infectious or hematological complications, and no reoperations were required. During long-term follow-up, no recurrence of echinococcosis was detected.

In summary, the present series confirms that open splenectomy in isolated splenic echinococcosis provides a reliable and definitive curative result, combining low morbidity, absence of recurrence, and good survival. This confirms the role of total splenectomy as the standard treatment in anatomically unfavorable cysts, especially in central or hilar localization, where spleen-preserving techniques are technically difficult or risky.

A retrospective study by Meimarakis et al. (2009) analyzed 10 cases of splenic echinococcosis among 250 patients with abdominal echinococcosis. The average age in their study was 37.7 years, with female predominance, eight women to two men. All patients underwent conventional surgery, with seven undergoing total splenectomy and three organ-preserving echinococcectomy. The average hospital stay was 8.5 days, and no mortality was registered. No relapses were observed during long-term follow-up, and post-splenectomy incidence was low.

Compared with their results, our patients were older and predominantly male, probably reflecting local demographic differences and the limited sample size. The duration of hospital stay was similar, 9.25 versus 8.5 days, and the absence of relapse and mortality completely corresponded to their observations. In both series, computed tomography was the principal diagnostic method, and both teams emphasized the need for a complex diagnostic approach including serology and histological verification. The more recent cohort study by Aljaioussi et al. (2024) presents a different perspective, that of minimally invasive and spleen-preserving treatment. The study included 18 patients with primary splenic echinococcosis in whom laparoscopic techniques such as partial splenectomy or echinococcectomy

were applied. The average age of the included patients was 33.7 years, with female predominance of 61.1 percent. The hospital stay was significantly shorter, averaging 4.28 days, and the incidence of complications was 22.2 percent, mostly mild, including pleural effusion, anemia, and atelectasis. Relapses were observed in 11 percent of patients within two years, whereas no mortality was reported. The authors emphasized the advantages of laparoscopic methods in terms of recovery and preservation of immune function, but also pointed to the need for strict follow-up and long-term albendazole therapy to prevent recurrence.

Compared with our results, minimally invasive methods show a shorter hospital stay, but also a higher risk of recurrence, whereas open splenectomy performed in our series showed no recurrence of disease. The two studies are not contradictory but complementary, outlining different therapeutic strategies according to the localization and characteristics of the lesion.

The findings from the three series highlight the need for an individualized therapeutic approach to splenic echinococcosis. Total splenectomy remains the gold standard for large, central, or multiple cysts, in which preservation of the organ would be risky. At the same time, spleen-preserving laparoscopic techniques are justified in peripheral, solitary cysts in young patients, providing shorter hospitalization and preservation of immune function, but requiring strict follow-up and mandatory antiparasitic therapy.

From a diagnostic perspective, all three series confirm the central role of computed tomography, which provides the most complete information regarding the morphology and anatomical relationships of the cysts. Combining computed tomography with ultrasound further improves diagnostic accuracy and guides the choice of surgical approach. From a therapeutic point of view, no recurrences or mortality were observed in our patients, which testifies to the radical nature and safety of conventional splenectomy when performed with the correct indications.

The study included eleven patients with splenic rupture. All were admitted

under emergency conditions and underwent conventional splenectomy within the first six hours of hospitalization. All cases were admitted in the context of acute hemodynamic instability and a clinical picture corresponding to intra-abdominal bleeding, which defined the surgical approach as urgent and life-saving. This series represents a realistic sample of emergency surgical practice, in which time for extensive diagnostic clarification is limited and the decision to operate is based on rapid clinical assessment and a low threshold for intervention.

The average age of the patients was 63.8 years, significantly higher than the average age described in classical trauma studies. Men predominated, accounting for 9 out of 11 patients, which is in line with the general trend of a higher incidence of abdominal trauma in male patients. This age and sex profile places our group closer to atraumatic or secondary traumatic ruptures, often associated with underlying vascular, hematological, or inflammatory changes in the spleen. Most patients had significant comorbidities, with cardiovascular and metabolic disorders being the most common.

The anesthetic risk classification showed a clear predominance of severe general condition: five patients were classified as class three, five as class four, and only one as class two. This distribution emphasizes the fact that our series included precisely the highest-risk patients, in whom the choice of surgical strategy was not only justified, but in practice the only possible one.

Upon admission, hemodynamic parameters demonstrated pronounced instability, with mean systolic blood pressure of 98 millimeters of mercury and diastolic blood pressure of 57 millimeters of mercury, with an average heart rate of approximately 93 beats per minute. In 10 cases there was evidence of hemoperitoneum, and the same number of patients required postoperative treatment in an intensive care unit, which clearly places the group in the most severe category according to the modern classification of the World Society of Emergency Surgery.

Despite the urgency of the cases, abdominal computed tomography was

performed in all patients as the primary diagnostic and severity stratification method. This indicates a high degree of protocol adherence and an ability to make rapid decisions. Ultrasound examination was performed in seven patients, usually as an initial assessment, while chest and abdominal radiographs were used in the same number to exclude associated injuries. Magnetic resonance imaging was not applied in any case, which is entirely logical given its limited role in emergency traumatology and its impracticality in unstable patients.

This diagnostic model, namely initial ultrasound followed by confirmation with computed tomography, is fully comparable to the modern algorithms described by the World Society of Emergency Surgery and demonstrates high diagnostic discipline even in the emergency setting.

Laboratory findings outline a typical profile for a patient after splenectomy. The average preoperative hemoglobin was 110 grams per liter, decreasing to 86.8 grams per liter postoperatively, an average difference of minus 23.4 grams per liter, which corresponds to expected blood loss and hemodilution. This change falls within the expected physiological limits in hemorrhage associated with surgery for rupture of a parenchymal organ.

Leukocyte count showed a moderate increase, from 12.74×10^9 per liter to 14.38×10^9 per liter, reflecting postoperative stress and inflammatory response, but without indicating infectious complications.

Platelet count increased from 207.8×10^9 per liter preoperatively to 371.5×10^9 per liter postoperatively, corresponding to reactive postsplenectomy thrombocytosis and requiring strict monitoring and prevention of thrombotic events.

The average hospital stay was 10.7 days, which is in accordance with published data on patients undergoing conventional splenectomy, especially in the presence of concomitant diseases and the need for intensive care.

In the early postoperative period, fever was observed in only one patient, with no evidence of purulent or hemorrhagic complications. No recurrent bleeding

occurred, no reoperations were recorded, and most patients recovered with gradual stabilization of hemodynamic parameters.

Overall survival in this series was as follows: four patients survived more than 5 years, one patient survived up to 3 years, and six patients died within the first year after surgery. This survival pattern should be interpreted in the context of the severe clinical presentation and high anesthetic risk score, rather than as an indicator of failure of surgical treatment. It is important to note that none of the patients died because of bleeding or surgical complications, but rather as a result of systemic decompensation related to concomitant disease. This fact highlights that splenectomy fulfilled a definitive and life-saving role by achieving hemorrhage control and enabling stabilization.

When the results of our series are considered in a broader historical and scientific context, the evolution of the approach to splenic injury becomes clearly visible.

In the study by Bee et al. (2001), one of the first large retrospective analyses dedicated to the evaluation of failed attempts at non-operative treatment in blunt splenic trauma was presented. The study included 558 patients treated over 46 months. Of these, 128 patients, or 23 percent, underwent immediate surgery because of hemodynamic instability, while the remaining 430 patients, or 77 percent, were managed conservatively. The authors reported an overall failure rate of non-operative treatment of 8 percent and identified two independent predictors of failure through multivariate analysis: age greater than or equal to 55 years and grade three to five injury. When both factors were present, the risk of failure reached 30 to 40 percent, especially when hemoperitoneum was also present. Mortality was comparable between non-operative and operative management, 12 percent and 9 percent respectively, which, according to the authors, indicates that non-operative treatment can be safe with careful patient selection and strict monitoring. Bee et al. emphasized that advanced age and severe parenchymal injury are not absolute

contraindications to conservative treatment, but require exceptional clinical precision and readiness for immediate surgery.

When those data are considered in the context of our series, a clear difference emerges in both the patient profile and the treatment strategy. Our group included 11 high-risk patients, all with evidence of hemodynamic instability. The median age was 63.8 years, placing them in the group with the highest risk of failure of non-operative treatment according to Bee et al. Almost all patients had impaired preoperative status and imaging evidence of hemoperitoneum, which clearly defined surgical treatment as the only adequate option.

In terms of outcomes, first-year mortality in our series was 36 percent, higher than that reported by Bee et al., but this should be interpreted in the context of substantial differences in population characteristics. Our patients were older, had more comorbidities, and presented with more severe hemodynamic destabilization. In contrast, Bee et al. studied mainly younger and physiologically stable patients who were suitable for an initial conservative approach. However, the absence of recurrent bleeding and the absence of reoperations in our series demonstrate that splenectomy provided definitive hemostasis and prevented complications associated with late decompensation after failure of non-operative management.

Overall, comparison of our study with that of Bee et al. highlights the key principle that hemodynamic status and age are the leading determinants in therapeutic decision-making. Our results confirm their conclusions from a practical perspective: in patients older than 55 years, with pronounced hemoperitoneum and instability, non-operative treatment carries a high risk of failure, whereas early surgical intervention achieves reliable control of blood loss and a predictable postoperative course. Therefore, our material may be regarded as a natural clinical continuation of the analysis of Bee et al., focused on those patients in whom conservative management is no longer possible and splenectomy remains a life-saving procedure.

Rajani et al. (2006) followed the change in clinical practice over a 15-year period and showed that the introduction of angioembolization dramatically increased the proportion of successfully non-operatively managed patients. Their curve of change reflects the global trend toward selective preservation of the spleen, but also clearly defines the limit of this approach: unstable patients continue to require immediate surgery. Despite the differences in study design, our results, including an average hospital stay of 10 days, absence of recurrence, and reliable hemostatic control, are fully comparable to the surgical outcomes reported in the earlier phase of their study.

The multicenter study by Velmahos et al. (2010) included 189 patients with severe grade four and five lesions. Of these, 42 percent were operated on immediately, and approximately 38 percent of attempts at non-operative treatment failed, meaning that more than half of the patients eventually underwent surgery. The average hospital stay in the study of Velmahos et al. was 9 days, practically identical to our result of 10.7 days. Although mortality in their study was lower, this reflects the younger patient population and the absence of marked comorbidity, whereas in our series mortality was determined by the general condition rather than by the surgical procedure itself.

The 2017 consensus of the World Society of Emergency Surgery summarizes the accumulated experience and systematizes the approach by classifying patients according to hemodynamic status. Within this system, all our patients fall into the most severe category, namely unstable patients with an indication for immediate laparotomy and subsequent splenectomy. Our results are fully consistent with these recommendations. In stable patients, non-operative treatment with angioembolization is recommended, whereas in unstable patients emergency surgery remains mandatory. This concept legitimizes the surgical choice in such a population and places our data in full accordance with modern standards.

The present series confirms that in patients with splenic rupture and

hemodynamic instability, open splenectomy remains the gold standard of treatment. The absence of recurrence, the predictable postoperative course, and the achievement of definitive hemostasis in every case testify to the high effectiveness and safety of this approach when applied in a timely manner and with proper indications.

Although the literature demonstrates a clear trend toward increasing use of non-operative approaches, borderline cases, namely adult, polymorbid, hemodynamically unstable patients, continue to require classical surgery. In this context, conventional splenectomy is not an anachronism, but a necessity supported both by our own experience and by the latest international recommendations.

Based on the results of this study, we propose a standardized management algorithm applicable to patients with splenic diseases, which is expected to optimize treatment outcomes and improve the quality of care for both patients and surgeons.(Fig. 8)

CONCLUSION

The spleen is an organ with complex biology and central importance in immunohematological regulation. The diagnostic and therapeutic approach to its diseases is based on precise morphological and functional assessment, strict risk stratification, and prioritization of organ preservation where clinically feasible. The combination of accurate imaging, interdisciplinary expertise, and preventive measures against infectious and thrombotic complications is crucial for achieving optimal outcomes across a wide range of conditions, from trauma and infarction to benign and malignant hematological disorders, systemic storage diseases, and rare structural abnormalities. A thorough understanding of the anatomy, physiology, and pathophysiology of the spleen directly determines patient safety, the quality of therapeutic decisions, and long-term prognosis.

The analysis of clinical outcomes and the literature emphasizes the importance of timely diagnosis, appropriate indications for surgical treatment, and interdisciplinary collaboration between surgeons, hematologists, anesthesiologists, and intensivists. In this context, surgical intervention should not be considered in isolation, but as part of a comprehensive treatment process aimed at optimizing both short-term and long-term patient outcomes.

At present, laparoscopic and robotic surgical approaches are increasingly established in the treatment of splenic diseases, providing reduced surgical trauma, faster recovery, and comparable therapeutic efficacy in selected patients. In the future, the integration of artificial intelligence, autonomous robotic systems, and advanced diagnostic-therapeutic algorithms has the potential to transform splenic surgery toward a more precise, personalized, and predictive paradigm.

CONCLUSIONS

1. The analysis of the literature demonstrates that the etiology and pathogenesis of surgical splenic diseases are multifactorial, with leading factors including traumatic injuries, hematological disorders, infectious processes, and neoplastic conditions. In our cohort, a predominance of patients with hematological diseases was observed, followed by traumatic and infectious splenic conditions.
2. Post-splenectomy complications, including an increased risk of infections, remain clinically significant, highlighting the need for adequate prevention through vaccination, antibiotic prophylaxis, and regular follow-up.
3. There is a need for standardization of diagnostic and therapeutic algorithms, including clear indications for surgical treatment, criteria for method selection, and structured postoperative follow-up, in order to optimize outcomes and reduce complications.
4. Accurate diagnosis requires a comprehensive assessment, including clinical evaluation, laboratory investigations, and imaging studies.
5. Conventional (open) splenectomy, particularly in emergency settings and in cases of significant splenomegaly, remains the method of choice due to improved exposure, better control of intraoperative hemorrhage, and safe ligation of vascular structures, resulting in reduced operative risk and perioperative complications.

CONTRIBUTIONS OF THE DISSERTATION

1. The clinical and diagnostic features of patients with spleen diseases are systematized.
2. The preoperative risk and the predictive risk factors influencing the duration of the hospital stay and the outcome of the disease are specified and analyzed.
3. An analysis of the results of the applied surgical treatment and long-term follow-up of patients was carried out.
4. Modern and precise criteria for surgical behavior in patients with diseases of the spleen have been created, introduced into the practice of the clinic.
5. An algorithm for the treatment of patients with the most common diseases of the spleen has been prepared for the working conditions in Bulgaria.

PUBLICATIONS RELATED TO THE DISSERTATION

1. **V. Velikov**, F. Gabarski, D. Ahmedov, R. Madzhov, Surgical Diseases of the Spleen, Proceedings of the III Symposium, "Spring Surgical Days" – Ruse 2024 p. 95 - ISBN 978-954-712-946-7
2. **V. Velikov**, V. Bozhkov, Abscess of the spleen - Collection of Papers XIX National Congress of Surgery 2024, page 635, p. 637 ISBN: 978-619-93018
3. **V. Velikov**, V. Bozhkov, A Rare Clinical Case of a Patient with Spleen and Liver Sarcoidosis - Journal of Surgery 4(2025), p. 103 DOI: 10.5281/zenodo.17668397 Print ISSN: 0450-2167, Online ISSN: 3033-151X