University " Ovidius"
CONSTANTA

FACULTY OF MEDICINE

AORTIC ANEURYSMS - CORRELATIONS BETWEEN CLINICAL EVALUATION, IMAGING AND THERAPEUTIC ASPECTS

ABSTRACT

SCIENTIFIC LEADER:
PROF. UNIV. DR. ELVIRA CRAIU

PhD
MIRELA-MARIA COROESCU

CONSTANȚA
2013

CONTENTS

ABBREVIATIONS AND ACRONYMS

AVC = Stroke

AA = Aortic Aneurysm

AAA = Abdominal Aortic Aneurysm

A.P. = Peripheral Arterial Disease

ANG Aasc = Angiography of the ascending aorta

B. COR. = coronary artery disease

BMI = Body Mass Index (kg/m²)

BSA = Body Surface Area

BVA = Bicuspid aortic valve

CEC = Cardiopulmonary bypass

COL = Cholesterol

COMPL. = Complications

CRpOP = Postoperative serum creatinine

CT = Computer Tomography

DAA = Acute Aortic Dissection (AAD)

ECO Aasc = Ultrasonography of the ascending aorta

EDD = End Diastolic Diameter

EDV = End Diastolic Volume

ESD = End Sistolic Diameter

ESV = End Sistolic Volume

ETE = Transoesophageal echocardiography (TEE)

ETT = Transthoracic echocardiography (TTE)

ETT Aasc = TTE of the ascending aorta

EVAR - 2 = Endovascular Aortic Repair (lot 2)

HTA = High Blood Pressure

HTC% SO = Hematocrit (in the operating room)

ICH -1 = surgical intervention (lot 1)

MPO = Postoperative mortality

PAP = Pulmonary artery pressure

OP = Open Repair

QSGP = Quantity of blood loss (ml)

RMN = Nuclear Magnetic Resonance

SA = Aortic Stenosis

TAS = Systolic blood pressure

TRSG = Blood transfusion

TIPO = Postoperative intensive care unit (ICU)

Keywords: aortic aneurysm, aortic imaging, image segmentation, graphical user interfaces, statistical correlations, aneurysms’ treatment.

IMPORTANCE of the TOPIC

Among cardiovascular diseases, aortic diseases are an important cause of morbidity and mortality. Most aortic aneurysms are asymptomatic, with no correlation to a physical examination, their discovery being circumstancial, through routine imaging examination (chest radiography, echocardiography). The rapid progress of new methods of investigation, invasive and noninvasive, show that aortic aneurysms are more common than previously believed, and the severity of their complications and high mortality rate, despite this progress and new treatment techniques, show the real size of this pathology. Aneurysm, regardless of its location on the aorta, is a life-threatening condition because once it is over a certain size (5 cm), it tends to grow rapidly, leading to serious complications such as acute aortic dissection or rupture, mortality being still high although progress in diagnosis and treatment. Sometimes even the smaller aneurysms can become symptomatic and may crack, announcing an acute dissection or imminent rupture. Aneurysmal disease is known for over 4000 years and aneurysm word derives from the Greek word "aneurysma" which means "a widening" of the vessel. Achievements made so far in the management of aneurysms of the aorta include not only improved surgical techniques, but also the development of a scientific database realised from clinical trials, increased application of new methods of endovascular treatment, new possibilities in noninvasive and invasive perioperative diagnostic, and following of the results and associated comorbidities [1].

Diagnosis of aortic diseases and their complications is based on clinical appearance and use of imaging techniques available for rapid and accurate evaluation that helps to avoid major risks involved in this disease. New possibilities of endovascular therapeutic approach and modern techniques for diagnosing congenital disorders that affect the aortic wall too (Marfan syndrome, Ehler - Danlos, etc.), familial forms of aortic aneurysms and aortic dissections will allow studies to correlate clinical data, and invasive and noninvasive diagnostic methods available, with the therapeutic method having the greatest benefit to the patient at the time of diagnosis of aneurysm or its complications. Even with these advances, people presenting with aortic dissection are actually identified as patients who had been previously either misdiagnosed or late diagnosed for aortic aneurysm [2,3].

An aortic aneurysm may be a marker of a diffuse cardiac disease. It was found that approximately 13% of patients diagnosed with aortic aneurysm present multiple aneurysms and about 25% of patients with thoracic aortic aneurysm have presented simultaneously abdominal aortic aneurysm. For this reason, in patients in whom it is discovered an aortic aneurysm, it is recommended examination of the entire aorta [4].

The major concern in the case of aortic aneurysms remains the one related to their tendency to rupture. This major complication is responsible for an overall mortality of about 80%. The risk of rupture increases with aneurysm size and it has been shown by the assessments made by Darling et al. It is estimated that aneurysms less than 4 cm in diameter have a risk of rupture between 0-2%, while those who have more than 5 cm in diameter presents a risk of rupture of 22% over the next two years. These two sizes - the diameter of the aneurysm and the growth rate over time - are the criteria considered by surgical therapy [5].

With the development of endovascular techniques for correction of aortic aneurysms ("Endovascular Aortic Repair" - EVAR) and continuous improvement of prostheses and techniques have opened a new era of therapeutic possibilities, which tends to decrease mortality due to this disease. Experience drawn from the EUROSTAR registry ("European Collaborators on Stent Graft for Abdominal Aortic Aneurysm Repair Technique") has helped define the parameters to be used in selecting patients to be subjected to endovascular treatment [6]. The introduction of customized prostheses (custom - crafted) - with “windows” of perfusion of the collaterals originated from the aorta that allow endovascular technique approach, including juxtarenal free packeage AAA and endovascular approach of aneurysm of the ascending aorta, aortic arch, or descending aorta, especially in emergency situations (DAA) - provides a new perspective upon the management of this condition. An effective correlation between both clinical and imaging examination means accurate and rapid diagnosis, appropriate treatment, hence reduction in mortality [7,8].

In the **general section** of the thesis are presented data on the current state of knowledge as presented in the literature, anatomy and physiology data of the aorta, epidemiology, etiopathogenesis, location, classification and symptoms of aneurysms and their complications. It also presents non-invasive and invasive imaging tests used in the diagnosis of aneurysms and their complications, and current therapeutic possibilities and selective bibliography for each chapter.

In the **special section** of the thesis I have presented the results obtained from processing and statistical correlation of data from retrospective studies that I have conducted in the Clinic San Gaudenzio, in Novara, Italy, on a lot of 223 patients. I have chosen a clinic in Italy for the study because it is the country with the largest number of aortic aneurysms in Europe.

The results of the statistically processed parameters from the database, sampled in APPENDIX 1 and APPENDIX 2, individualized for the most significant variables were compared with the values known in literature. Both aspects were revealed as consistent or inconsistent with the literature values, and new correlations whose analysis I considered to be necessary, although they have not been addressed in the literature consulted. In addition, in order to facilitate image interpretation work purchased by the examining physician it has been designed an original GUI graphical user interface, using facilities of MATLAB [110,111]. The interface allows the loading of images acquired and then, it allows segmenting them mono, multi and fuzzy modes by outlining the significant elements of the image. In the last chapter it is presented, in alphabetical order, the bibliography consulted.

Part of the results were presented at international events in Cluj-Napoca (2002), Bucharest (2002) and published in full in the journal B + and indexed BDI (Constanta Maritime University Annals, 2013, a paperwork), and journal B + and indexed EMBASE / Excerpta Medica (Archives of the Balkan Medical Union, in 2013, two paperworks).

Especially, I respectfully thank to Professor of Cardiology Elvira Craiu for the scientific guidance and the moral support given to finalize this thesis.

Thanks to my family for permanent encouraging and supporting throughout this period. Also, I thank to San Gaudenzio Clinic, in Novara (Gruppo Sanitario Policlinico di Monza), Italy, for the opportunity given to conduct clinical trials.

SPECIAL SECTION

5. AIM AND PURPOSES

The aim of the study is to identify the data with applicability in the management of aortic aneurysm by linking clinical data and therapeutic imaging obtained by a retrospective study in San Gaudenzio Clinic, in Novara, Italy - the country with the highest incidence of aortic aneurysms in Europe.

The study **objectives** include:

establishing statistical correlations between clinical, imaging methods used in the diagnosis, and treatment of aortic aneurysm, in order to highlight some parameters that could influence the therapeutic management of aneurysms;

comparative statistical study of perioperative variables impacting the length of stay time of surgical patients in the intensive care department, duration which is directly reflected on morbidity, mortality and high costs for this group of patients;

establishing correlations between variables: creatinine, hematocrit, blood volume loss, location of the aneurysm and postoperative mortality;

correlations between the two studied groups, regarding the treatment : open surgery and endovascular therapy;

stratifying patients into groups at risk for surgical treatment after Euro-SCORE value;

identification of aortic aneurysms and aortic dissection by designing, implementing and testing a new graphical user interface using integrated development environment for graphical interfaces GUIDE ("Graphical User Interfaces Development Environment") of MATLAB software ("Mattrix Laboratory"), for viewing the acquired images in an efficient manner;

utility of interface should be noted, especially in aortography, which allows visualization of the aneurysm, reducing the amount of contrast medium, thus reducing aggression on renal function, however, this method even allows real-time image processing.

6. METHODS AND STAGES OF WORK

6.3. The study protocol

The **retrospective study** was conducted on a lot of 223 patients, all data were obtained by studying the records and registers of operations in the operating room. Demographic, clinical, laboratory data, and treatment were organized in 163 variables, the most important being subject to statistical processing of correlation.

The study period included patients who were operated between 2003 - 2004 and 2009-2011. Different years were chosen because between 2003 - 2004, patients were treated inclusively endovascular, although in a very small number compared to surgery (**Table 2).**

Variable number obtained from clinical chart was 163, of which 139 were placed in sampled final tables of the database. Some of these parameters were statistically analysed to obtain data that show a correlation between the clinical, imaging and therapy aspects. For each patient, I calculated the *additive and logistic EuroSCORE*, their values being integrated in the last two columns of the final tables.

Table 2. The distribution of interventions per years

YEAR OF INTERVENTION	FREQUENCY	PERCENT	VALID PERCENT	CUMULATIVE PERCENT
2003	41	18.4	18.4	18.4
2004	43	19.3	19.3	37.7
2009	53	23.7	23.7	61.4
2010	55	24.7	24.7	86.1
2011	31	13.9	13.9	100.0
Total	223	100.0	100.0	

Key variables studied are:

- § demographic aspects: age, gender;
- § main diagnosis: aortic aneurysm with aortic segments location;
- § AA complications: acute and chronic dissection of the aorta;
- § associated comorbidities: congenital heart disease - BVA, associated valvulopathy, hypertension, dyslipidemia, diabetes mellitus, coronary artery disease, lower limb arterial occlusive disease and carotid stenosis, chronic lung disease, chronic heart failure - LVEF%;
- § treatment: medical, surgical, endovascular (type of intervention for each case);

- biological parameters: cholesterol, HDL-C, LDL-C, triglycerides, creatinine, hematocrit (creatinine and hematocrit on admission, pre and postoperative creatinine after administration of contrast agent);
- echocardiographic parameters: FEVS%, EDD, EDV, ESD, ESV, PAP;
- aneurysm diameter measured by: echocardiography, CT, MRI, angiography;
- operators parameters: time of cardiopulmonary bypass, time of clamping the aorta, aortic endotracheal intubation time, amount of blood loss, amount of blood given, length of stay time in intensive care unit (TIPO), complications (acute heart failure, acute renal failure, peripheral ischemia, AVC), inotropic medication, additive and logistic Euro-SCORE calculation for each patient.

Statistical analysis of data was performed using the statistical performance package of prediction and analysis of IBM SPSS data ("Statistical Package for the Social Sciences"), version 20 (SPSS Inc, Chicago, IL) for Windows.

From the statistical package, there were used for prediction and analysis the following tools:

- descriptive statistical tests (t test, ANOVA, Crosstabs);
- analysis of univariate and multivariate general linear models;
- correlation tests (Pearson chi-square, linear regression);
- scatterplot graphical method.

In the statistical analysis, all the required satatistical parameters were integrated: average, standard deviation, standard error of mean value test, the number of degrees of freedom, correlation, statistical significance level of 5% and confidence intervals at 95%.

If continuous data have been normally distributed, the comparison between the 2 groups has been performed with the test "t Student" for unpaired indicated samples. Whether the continuous data have not been normally distributed, the test "Mann-Whitney U" or the test "Wilcoxon" were used for independent samples.

Comparison of variable groups was performed using "$\chi 2$" and the test "Fisher". Logistic regression step by step was performed to identify independence predictors of length of stay in intensive care.

RESULTS AND DISCUSSIONS

7.1. Demographic characteristics of the lot

Patients in the study were grouped according to treatment, surgical or endovascular, in the two groups noted ICH-1 and EVAR-2. The analysis of all variables allowed outlining a profile of the patient with aortic aneurysm: male, mean age 65 years, former smoker, hypertension, dyslipidemia, impaired aortic valve with moderate or severe degree in 50% of cases (aortic insufficiency) and with coronary disease in a significant percentage of cases.

Of the 223 patients, 160 (71.7%) were male, and 63 (28.3%) were female the ratio being 2.5:1, to 3:1 as reported in the literature. This is probably due to a higher addressability specialist appointments of women over 50 years, given that aortic aneurysms have the highest incidence in Italy (**Figure 12**).

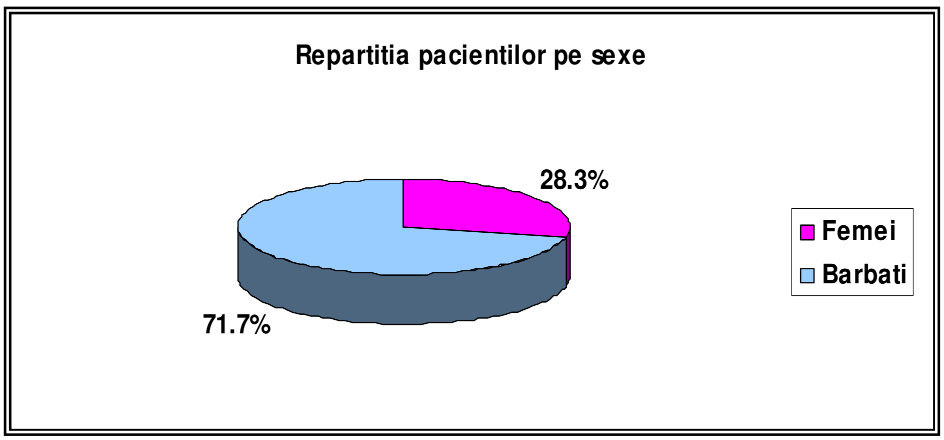

Figure 12. Gender distribution of patients

The mean age of patients was 65.2 ± 11.1 years, range 33 to 87 years. Studying the distribution by age, appears the following distribution:

- < 50 years = 25 patients(11.2%);
- 50 – 70 years = 111 patients (49.8%);
- 70 years = 87 patients (39%).

It is observed that the peak incidence is found in the age group between 50 and 70, thus slightly less than the age limits described in the literature (65 – 80 years) (**Figure 13).** This fact might be expected to be due to the program initiated by SICVE ("Societa 'Italiana di Chirurgia vascolare ed Endovascolare ") in 2010 to prevent rupture of AAA, which includes specialist visits free for men between 65 and 80 years, comprising an ultrasound exam too [111].

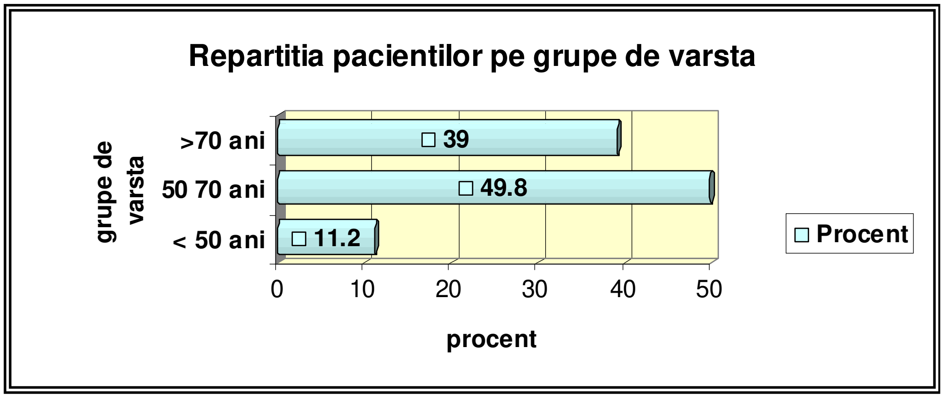

Figure 13. Patient distribution by age

7.2. Risk factors evaluated for aortic aneurysm

7.2.1. Age

Demographic parameters, age and gender, are part of the risk factors for aortic aneurysm. Most affected age group is between 65 and 80 years with absolute incidence of 5% over 65 years. In the study, as shown in **Figure 13**, the most affected patients aged ranging from 50 to 70 - so, slightly lower than the data quoted.

This is possible due to cardiovascular prevention measures applied for the segment of population over 50 years old, in order to reduce the morbidity and mortality of cardiovascular diseases. Availability and low cost of the echocardiographic examination let this investigation be an effective method of diagnosis of aortic aneurysm.

7.2.2. GENDER

As was predictable, the aneurysm was encountered most frequently in males, but with a ratio slightly modified from that described in the literature, namely 2.5:1. It can show the trend of increased incidence among women, but this should be studied in larger groups of patients by echographyc screening in women over 50 years old in order to see if it is a trend, in fact, increasing incidence and which are the factors that determine this change.

Table 3. Gender distribution

PATIENT GENDER	FREQUENCY	PERCENT	VALID PERCENT	CUMULATIV PERCENT
F	63	28.3	28.3	28.3
M	160	71.7	71.7	100.0
Total	223	100.0	100.0	

Legend: F - female, M – male

7.2.3. SMOKING

The data of this study shows that over 90% (90.7%) patients were smokers, but some gave up a number of years ago (incomplete data in the observation charts), and others kept smoking after being diagnosed with this disease (**Figure 14).**

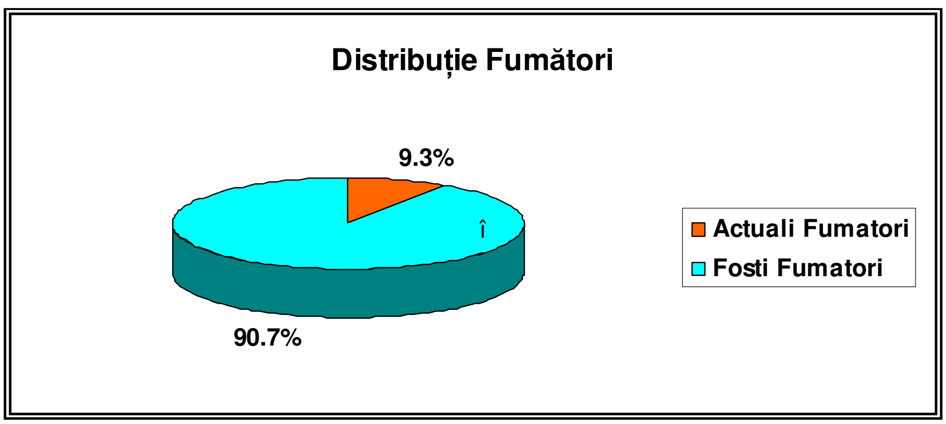

Figure 14. Smoking distribution

7.2.4. Associated pathology

Associated pathology with aortic aneurysm was systematized in a table, with each disease reporting the total number of patients. It is noted that most of the patients are hypertensive (77.1%), which is consistent with the data of IRAD (72.1%) and dyslipidemia (69.1%), in the study IRAD atherosclerosis being present in 31.0% of the subjects.

More than half of the subjects had aortic regurgitation (59.2%) and a higher proportion had coronary artery disease (38.1%). Besides aneurysmal etiology, there are found associated risk factors of the aortic regurgitation, namely: age, history of hypertension.

From the data presented in the figure, it is revealed the predominance of four types of comorbidities: hypertension, dyslipidemia, coronary artery disease and aortic insufficiency (**Figure 15).**

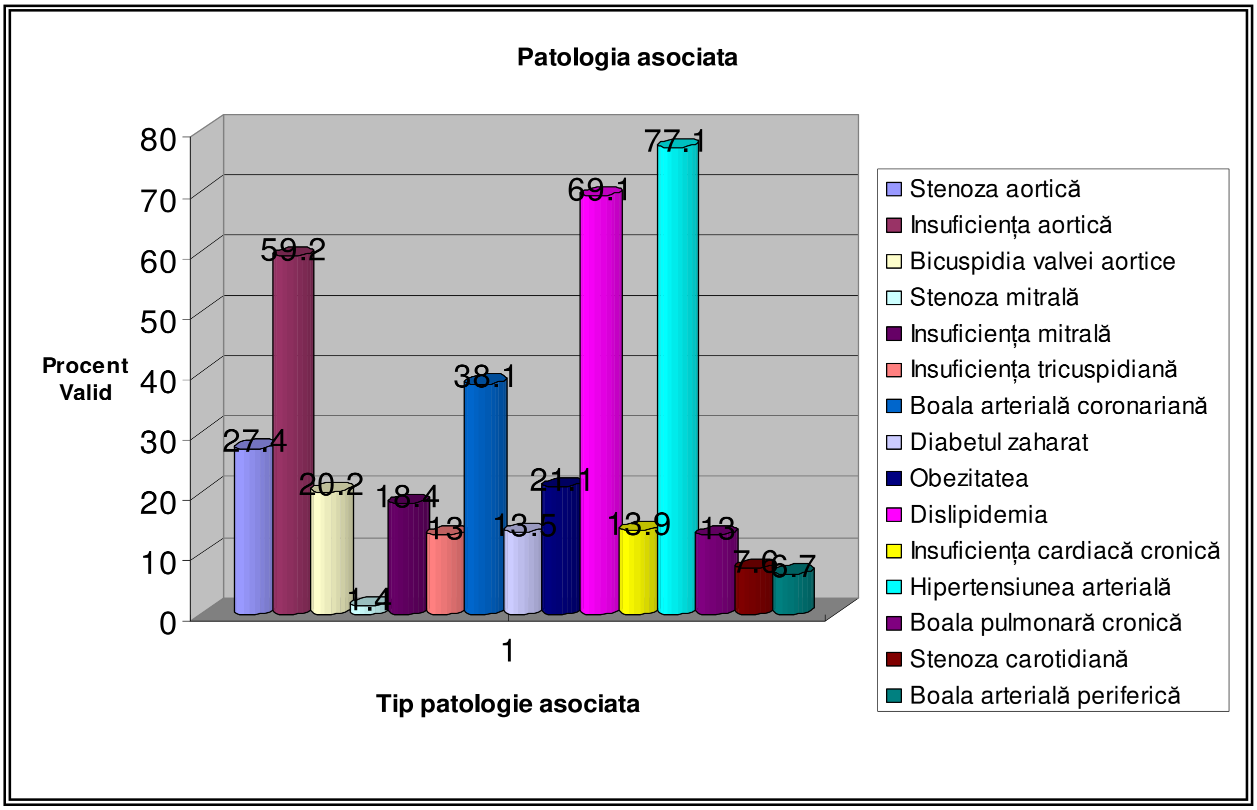

Figure 15. Associated pathology

7.2.4.1. Arterial hypertension

Among the major risk factors, hypertension was the most common pathology associated with aneurysm of the ascending aorta, being found in 77.1% of patients (n = 172), and of these 89 (39.9%) had values equal to or greater than 135 mmHg (TAS) (**Table 4).**

Table 4. Incidence of hypertension (HTA)

ARTERIAL HYPERTENSION	FREQUENCY	PERCENT	VALID PERCENT	CUMULATIVE PERCENT
0	**51**	**22.9**	**22.9**	**22.9**
1	**172**	**77.1**	**77.1**	**100.0**
Total	**223**	**100.0**	**100.0**	

Legend: 0 – without HTA; 1 – with HTA.

7.2.4.2. Dyslipidemia

Dyslipidemia was the second comorbidity in frequency, associated with aortic aneurysm (69.1%), this percentage showing a significant presence in the segment of the population that was analyzed, which is consistent with the presence of atherosclerotic manifestations in the second and third decades of life.

Serum levels of lipids represent one of the major risk factors of atherosclerosis, dyslipidemia management reducing both cardiovascular mortality and the general one.

Also, the assessment of obesity within the cardiovascular risk factors showed a frequency of 21.1% for the study group.

Given the large number of patients with dyslipidemia, a correlation was established between impaired peripheral vascular territory (coronary disease, hemodynamically significant carotid stenosis and occlusive disease of the lower limbs), systolic blood pressure, total cholesterol and LDL – C, and the independent variable - the presence of postoperative complications, using One-Way ANOVA (**Tables 12, 13**).

Table 12. One-Way ANOVA 9 Descriptives

COMPL		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
B.COR.	0	151	.71	1.093	.089	.53	.88	0	3
	1	72	.79	1.074	.127	.54	1.04	0	3
	Total	223	.74	1.085	.073	.59	.88	0	3
TAS mmHg	0	151	130.95	19.503	1.587	127.82	134.09	90	210
	1	72	134.93	20.114	2.370	130.20	139.66	100	200
	Total	223	132.24	19.745	1.322	129.63	134.84	90	210
ST.C.	0	151	.06	.238	.019	.02	.10	0	1
	1	72	.11	.316	.037	.04	.19	0	1
	Total	223	.08	.266	.018	.04	.11	0	1
A.P	0	151	.05	.211	.017	.01	.08	0	1
	1	72	.11	.316	.037	.04	.19	0	1
	Total	223	.07	.251	.017	.03	.10	0	1
COL mg/dl	0	151	196.13	58.900	4.793	186.66	205.60	0	311
	1	72	181.89	61.401	7.236	167.46	196.32	0	311
	Total	223	191.53	59.953	4.015	183.62	199.45	0	311
LDL-C mg/dl	0	151	123.007	43.3207	3.5254	116.041	129.972	.0	206.0
	1	72	109.528	49.5026	5.8339	97.895	121.160	-93.0	230.0
	Total	223	118.655	45.7346	3.0626	112.619	124.690	-93.0	230.0

Table 13. One-Way ANOVA 9 ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
B.COR.	Between Groups	.336	1	.336	.285	.594
	Within Groups	261.054	221	1.181		
	Total	261.390	222			
TAS mmHg	Between Groups	771.075	1	771.075	1.987	.160
	Within Groups	85779.328	221	388.142		
	Total	86550.404	222			
ST.C.	Between Groups	.129	1	.129	1.835	.177
	Within Groups	15.575	221	.070		
	Total	15.704	222			
A.P	Between Groups	.204	1	.204	3.277	.072
	Within Groups	13.787	221	.062		
	Total	13.991	222			
COL mg/dl	Between Groups	9891.036	1	9891.036	2.774	.097
	Within Groups	788050.462	221	3565.839		
	Total	797941.498	222			
LDL-C mg/dl	Between Groups	8857.475	1	8857.475	4.298	.039
	Within Groups	455488.938	221	2061.036		
	Total	464346.413	222			

Analyzing tables it results a statistically significant correlation between the LDL-C value and postoperative complications, which suggests that a decrease in this parameter's value by treatment may reduce the rate of cardiovascular complications in patients undergoing cardiac surgery.

Knowing the role of statines in reducing cholesterol level and mortality from all causes by 20% - as shown in clinical trials -, and the fact that reduction in LDL-C value reduces cardiovascular events, it has been performed a correlation between taking statins, TAS values, values of cholesterol, LDL-C values and the diameter of the ascending aorta - as an independent factor (**Tables 14, 15).**

Table 14. One-Way ANOVA 11 Descriptives

ECOAasc mm		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
TAS mmHg	≤ 40	55	134.65	19.572	2.639	129.36	139.95	100	180
	> 40	168	131.45	19.795	1.527	128.43	134.46	90	210
	Total	223	132.24	19.745	1.322	129.63	134.84	90	210
STATINE	≤ 40	55	.18	.389	.052	.08	.29	0	1
	> 40	168	.17	.374	.029	.11	.22	0	1
	Total	223	.17	.377	.025	.12	.22	0	1
COL mg/dl	≤ 40	55	176.95	93.762	12.643	151.60	202.29	0	311
	> 40	168	196.31	42.922	3.312	189.77	202.85	0	311
	Total	223	191.53	59.953	4.015	183.62	199.45	0	311
LDL-C mg/dl	≤ 40	55	111.073	68.6542	9.2573	92.513	129.633	-93.0	206.0
	> 40	168	121.137	35.0898	2.7072	115.792	126.482	.0	230.0
	Total	223	118.655	45.7346	3.0626	112.619	124.690	-93.0	230.0

Table 15. One-Way ANOVA 11 ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TAS mmHg	Between Groups	426.449	1	426.449	1.094	.297
	Within Groups	86123.954	221	389.701		
	Total	86550.404	222			
STATINE	Between Groups	.010	1	.010	.067	.796
	Within Groups	31.515	221	.143		
	Total	31.525	222			
COL mg/dl	Between Groups	15536.757	1	15536.757	4.389	.037
	Within Groups	782404.741	221	3540.293		
	Total	797941.498	222			
LDL-C mg/dl	Between Groups	4196.852	1	4196.852	2.016	.157
	Within Groups	460149.560	221	2082.125		
	Total	464346.413	222			

It has been considered as the threshold value for the ascending aorta, a diameter of 40 mm, because at this level, depending on the etiology of AA, the annual growth rate, BSA or the presence of symptoms it is also considered a surgical correction in order to prevent a dramatic event such as acute dissection of the aorta.

From the correlations' analysis presented in the tables, it is observed that, the size of the ascending aorta is influenced by high levels of cholesterol, which confirms the important role of dyslipidemia in the initiation and maintenance of the atherosclerotic process, which is the main cause of aortic aneurysm.

7.2.4.3. Bicuspid aortic valve (BVA)

Bicuspid aortic valve is the most common congenital defect of the adult being present in 1-2% of the general population, with a male / female ratio of 2:1. In the the present study, BVA was diagnosed preoperatively in 45 patients (20.2%), of which 2 had aortic monocuspidic valve (4.44%) - diagnosed intraoperatively by TEE. The male / female ratio was 6:1 (seven women - 14%, and 37 men - 86%). Given the frequency found in this study, I considered it is important to correlate this anomaly with the most common complications that accompany it: aortic stenosis, aortic insufficiency, aortic aneurysm with aortic dissection and endocarditis. It is known that the BVA is the most common cause of isolated aortic stenosis in adults. To perform the statistical correlation between the two variables, BVA and SA, I have used the Crosstab Chi-Square Test, obtaining Pearson Chi-Square Likelihood Ratio and Linear-by-Linear Association **Table 18.**

Table 18. BVA * SA Crosstabulation

			SA				Total
			0	1	2	3	
BVA	0	Count	129	11	11	27	178
		Expected Count	118.1	11.2	20.0	28.7	178.0
		% within BVA	72.5%	6.2%	6.2%	15.2%	100.0%
	1	Count	19	3	13	8	43
		Expected Count	28.5	2.7	4.8	6.9	43.0
		% within BVA	44.2%	7.0%	30.2%	18.6%	100.0%
	2	Count	0	0	1	1	2
		Expected Count	1.3	.1	.2	.3	2.0
		% within BVA	0.0%	0.0%	50.0%	50.0%	100.0%
Total		Count	148	14	25	36	223
		Expected Count	148.0	14.0	25.0	36.0	223.0
		% within BVA	66.4%	6.3%	11.2%	16.1%	100.0%

Table 19. BVA * SA Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	**27.944[a]**	**6**	**.000**
Likelihood Ratio	**24.377**	**6**	**.000**
Linear-by-Linear Association	**12.659**	**1**	**.000**
N of Valid Cases	**223**		

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is .13.

In the tables, it results highly significant correlation between the two variables in the rows and columns, the value obtained for Asymp. Sig. being 0.000, showing indeed a strong link between BVA and SA. By the time, the aortic asymmetric cusps suffer reshuffling processes and calcium deposits, giving rise to SA appeareance and may cause dilation of aortic superjacent segment, resulting in dilation or aortic aneurysm.

7.2.5. Perioperative variables used in evaluation of patients

7.2.5.1. Correlations between imaging methods used in the diagnosis of aortic aneurysms

The preoperative imaging examinations used in the diagnosis of disease had the following distribution: transthoracic echocardiography (TTE) - 214 patients (96%) Multi-Detector Computer Tomography (MDCT) - 53 patients (24%) MRI - 7 patients (3%); angiographic examination (angiography aortography) - 197 patients (88%).

In the distribution it is shown that almost all patients were examined by ETT compared to the data from IRAD, where echocardiography was performed in 33% of patients; these latters suffered a major complication of AA - acute aortic dissection. By the study, only 8 patients (3.6%) had aortic dissection, of whom 5 (2.2%) had acute aortic dissection.

Most of the patients had aneurysm located at the level of the ascending aorta, hence the choice of transthoracic echocardiography as a method of choice in the evaluation. Ultrasound exam allows viewing at a distance of a few centimeters of ascending aorta in the parasternal long axis and can be performed through essentials measurements : annulus, bulb, sino-tubular junction, ascending aorta; they assess symmetry or asymmetry of dilation, the distance from the valvular plane to sino-tubular junction, and appreciate insufficience and stenosis degree and the structure of aortic valve.

In the parasternal short axis there are viewed all three cusps, appreciating morphology in diastole and there is vizualized aortic oriffice in systole.

Ultrasound exam is currently the most used method in assessing cardiac performance, especially of the left ventricle, it provides accurate data related to diastolic function - elements essential for the prognosis of patients with cardiovascular diseases; also, it accurately appreciates morfofunction of right heart.

For cardiac operated patients, it is the most accessible method in their perioperative monitoring, allowing to take a decision on further examinations (CTA, angiographic examination) or therapeutic management. ETT was chosen as the standard AA examination due to a team well trained in the management of cardiac surgery patients, but also for economic reasons.

Perhaps, the CT has not been carried out for all patients echographic examined, because most of them (n = 197, 88%) have been subjected to angiographic investigation to assess the coronary tree, the aortic valve (the assessment of the aortic insufficiency), as well as aorta and its side branches, especially large vessels of the neck and major abdominal collaterals (renal arteries, celiac trunk, superior and inferior mesenteric arteries).

All patients underwent transesophageal echocardiographic examination (TEE) in the operating room at the beginning of intervention, during and after surgery for an accurate assessment of aneurysm (size, affecting of the aortic valve - the degree of regurgitation or stenosis and other valvular pathology) and the immediate postoperativ outcome.

A comparison of values obtained by different imaging methods can only be made between echocardiography and angiography, CT and MRI not having a representative number of patients examined.

Tables 39, 40, 41, 42 and **43** show the descriptive statistics of ascending aorta angiography (ANG Aoasc) and ascending aorta transthoracic echocardiography (TTE Aoasc), for which there have been determined the mean and standard deviation for the 92 patients who performed both tests, as well as distribution of patients by type of imaging examination performed (ETT, CT, MRI, angiography).

Table 45 shows a pair t-test sample, with a mean difference of -6.940 mm between the two chosen methods ($p < 0.001$). Analyzing the Pearson correlation between the two chosen methods, I found a coefficient of correlation of 0.578 ($p < 0.001$) and a coefficient of determination R2 (R Sq Linear) of 0.334.This latter value is also shown in the diagram Scatterplot (**Figure 17**).

Graphical distribution of the values obtained by the two methods shows that compared to angiographic examination, ETT gives an average of 7 mm *underestimation* for the ascending aorta.

Table 39. Preoperative ETT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	5	2.2	2.3	2.3
	1	214	96.0	97.7	100.0
	Total	219	98.2	100.0	
Missing data		4	1.8		
Total		223	100.0		

Valid 0 - did not perform ETT at the clinic . Valid 1 - patients who performed ETT. Missing data - patients who do not performed ETT at the clinic or other medical units.

Table 40. Preoperative CT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	167	74.9	75.9	75.9
	1	53	23.8	24.1	100.0
	Total	220	98.7	100.0	
Missing data		3	1.3		
Total		223	100.0		

Valid 0 - did not perform CT at the clinic . Valid 1 - patients who performed CT. Missing data - patients who do not performed CT at the clinic or other medical units.

Table 41. Preoperative RM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	214	96.0	96.8	96.8
	1	7	3.1	3.2	100.0
	Total	221	99.1	100.0	
Missing data		2	0.9		
Total		223	100.0		

Valid 0 - did not perform RM at the clinic . Valid 1 - patients who performed RM. Missing data - patients who do not performed RM at the clinic or other medical units.

Table 42. Preoperative angiographyc exam

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	**21**	**9.4**	**9.6**	**9.6**
1	**197**	**88.3**	**90.4**	**100.0**
Total	**218**	**97.8**	**100.0**	
Missing data	**5**	**2.2**		
Total	**223**	**100.0**		

Valid 0 - did not perform the exam at the clinic . Valid 1 - patients who performed exam. Missing data - patients who do not performed the exam at the clinic or other medical units.

Comparing the values measured by the four imaging methods, it was performed the correlation between ultrasound and angiography exam (common number of patients examined was 92). Therefore, based on tables 39 and 42, it was designed Table 43, with descriptive statistics of ETT Aoasc and ANG Aoasc - for which it had been determined the average and standard deviation values found and it had also been determined N value for the 92 valid patients.

Table 43. Distribution by type of investigation

	N	Minimum	Maximum	Mean	Std. Deviation
ETT Aoasc	**183**	**32**	**82**	**49.21**	**6.152**
ANG Aoasc	**106**	**47**	**78**	**56.55**	**6.461**
Valid N (listwise)	**92**				

ETT Aoasc – Transthoracic echocardiography ascending aorta. ANG Aoasc – Angiography ascending aorta. Valid N - Number of patients valid for both examinations.

In **Table 44**, there have been statistically analyzed - for the two chosen methods - , pairs of measured values for the 92 valid patients, thus determining the standard deviation and average standard errors.

Table 44. Paired Samples Statistics

Pair number	Variables	Mean	N	Deviation	Std.Error Mean
Pair 1	**ETTAoasc**	**50.05**	**92**	**5.166**	**.539**
	ANG Aoasc	**56.99**	**92**	**6.655**	**.694**

In **Table 45**, it has been made the t-test for paired variables ("Paired Samples Test") for the difference of values of the two chosen methods.

Table 45. Paired samples t-test

		Pairs difference					t	df	Sig.(2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	ETT Aoasc – ANG Aoasc	-6.940	5.589	.583	-8.098	-5.783	-11.911	91	.000

In **Table 46**, there have been established the Pearson Correlations for those two methods, the resulting correlation r being 0.578, and the square of the correlation (R Sq Linear) being 0.334. This last value is necessary for graphic correlation Scatterplot in **Figure 17**.

Table 46. Pearson Correlation

	TTEascAo	ANGascAo
Pearson Correlation (Sig. (2-tailed) N	1 183	578** .000 92
Pearson Correlation (Sig. (2-tailed) N	578** .000 92	1 106

***** Correlation is significant at the 0.01 level (2-tailed).***

I used the the graphic method Scatterplot where I decided that the explanatory variable – ANG Aoasc (explanatory variable) - is plotted on the abscissa, and the variable response (response variable) - ETT Aoasc - is plotted on the ordinate. The method allows to establish the dependence between the two variables, manifested as shape, direction and efficiency (**Figure 17**).

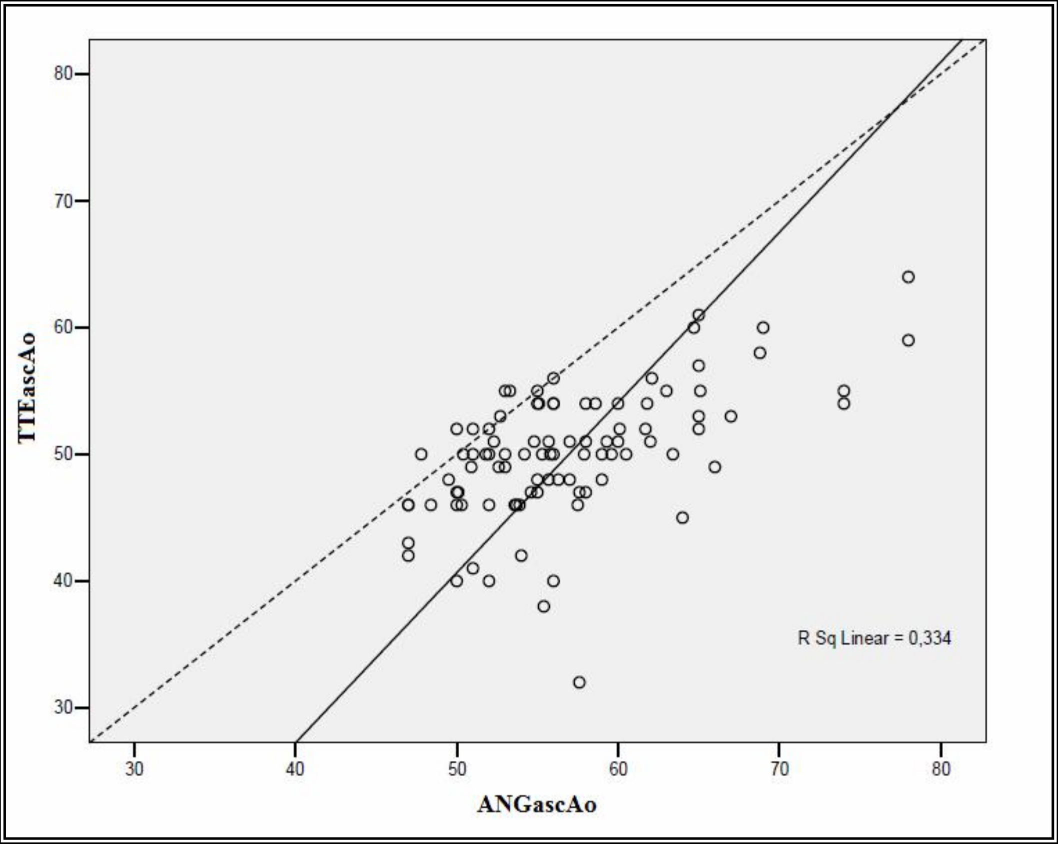

Figura 17. Scatterplot

Explanatory variable is an independent variable that explains or causes changes in the response variable. Response variable, as the dependent variable, measures the outcome of the study and is practically a operator-dependent value, as confirmed by the results of this study.

Graphical distribution of the values obtained by the two methods shows a statistically significant difference (about 7 mm) between angiographic exam and ETT.

Echocardiographic examination (TTE and TEE) may be performed in emergency situations due to availability of all medical units, bedside accessibility, repeatability, low cost, high specificity, but is highly operator-dependent exam.

Although the review team is trained to assess the patient's cardiac surgery, there is a significant difference between the two types of examinations.

7.2.5.2. Segmentation in MONO, MULTI and FUZZY modes

In order to recognize objects from a given image is necessary that the image is divided in significant areas. Segmentation is the process of partitioning the image into a set of non-overlapping regions whose union is even the entire image. In practice, it is very difficult to find a criterion to produce a meaningful segmentation. Generally, regardless of the chosen criteria, we can say that regions of the segmented images must be homogeneous and with well-defined bounds. Currently, there are available in practice many ways of segmentation.

A possible approach of segmentation is to obtain edge area pixels, using a local operator edge detection, followed by a procedure for bonding or contouring the edges. Local edge detection operators often do not generate continuous edges or boundaries, therefore the method must be used in delineation or bonding of the edges after the detection, in order to obtain the continuity.

Another approach in order to segment the image is "thresholding", in which the input image histogram is used to obtain a threshold value. In this way, a simple image that contains a background and an object produces a histogram with two peaks, and the threshold is the one that will separate the two peaks in the histogram.

The segmentation in this case is in the "*uniseg*" mode, in which is outlined only one single element of the image. The simple thresholding segmentation mode works well when we have a histogram with a maximum of two distinct peaks [106].

In practice, an image contains multiple objects, and the simple thresholding segmentation type is not applicable. If we have a histogram with more than two peaks, then we need more than a threshold value.

For a histogram with three peaks, one of the peaks in the histogram represents the background and the other two peaks may represent two different objects in the image. The segmentation in this case is in the "*multiseg*" mode, in which there are outlined many shape elements of the image.

After segmentation of such image, the next step is to obtain a representation for the different regions found. Objects have often different shapes, and as the features of objects there are commonly used **shape descriptors**.

The segmenting techniques generate data in the form of pixels contained into a region. In order to recognize or label the region, we will have to extract the features that highlight the region.

However, sometimes, prior to extracting the characteristics, we use the representation which in addition to the characterization of the region will produce a reduced set of data. Schemes of data representation commonly used in this case are special codes "*chain codes*", signature and transformation centreline [107].

FCM segmentation mode (“Fuzzy C-Means") was a technical method developed by Dunn in 1973, improved by Bezděk in 1988, by Hall in 1992 and by Kulkarny in 2001, being widely used in pattern recognition and medical imaging [108].

This method of fuzzy segmentation (“*fuzzyseg*") is based on minimizing an objective function through iterative optimization procedure in order to obtain finally fuzzy partitioning, with the update of cluster centers.

Data are grouped by a member function, constructing a matrix of subunit values representing the degree of belonging between data centers and clusters.

In the FCM approach, the same data is not exclusive to a well-defined group, but they can be placed in a middle position. In this case, the member function indicates that each data may belong to several clusters with different values of the coefficient of membership. The algorithm stops when the deviation is less than an sub-unit imposed error [109].

7.2.5.3. The user interface for identifying aortic aneurysms and aortic dissection

In order to facilitate the interpretation of images acquired by the examining physician it has been developed a graphical user interface GUI using GUIDE facility (“*Graphical User Interface Development Environment* “) in MATLAB [110,111].

The interface allows to upload acquired images through the push-button "*Import JPG Images*" and then, using the technique of thresholding, it is obtained mono image segmentation by the "MONOSEG", outlining one significant segment of the image, or multisegmentation by push-button “MULTISEG", outlining several significant elements of the image.

Exit from the program is auctioned by pressing the push-button "**CLOSE**". Newly designed graphical user interface for medical image segmentation is presented in **Figure 18** [112].

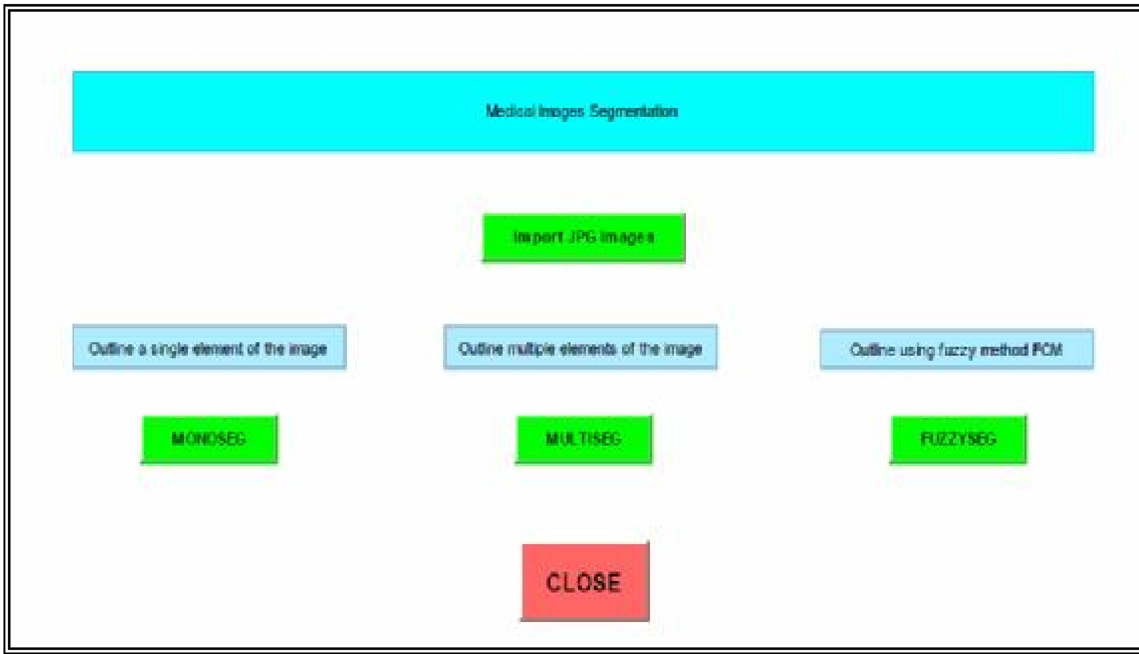

Figure 18. The graphical user interface GUI for medical image segmentation

For each one of the 5 buttons of the GUI interface, it was associated a software Matlab function, having the structure shown in detail in the article [112].

The new software allows to entry into the segmentation program using the first button ("**Import JPG Images**"), with role in importing images in JPG format, while the 5th button ("**CLOSE**") is designed to exit from the the program.

The software Matlab function attached to the 2nd push-button of the GUI interface ("**MONOSEG**"), with the role in a single image element segmentation, generates the images shown in **Figure 19** [112].

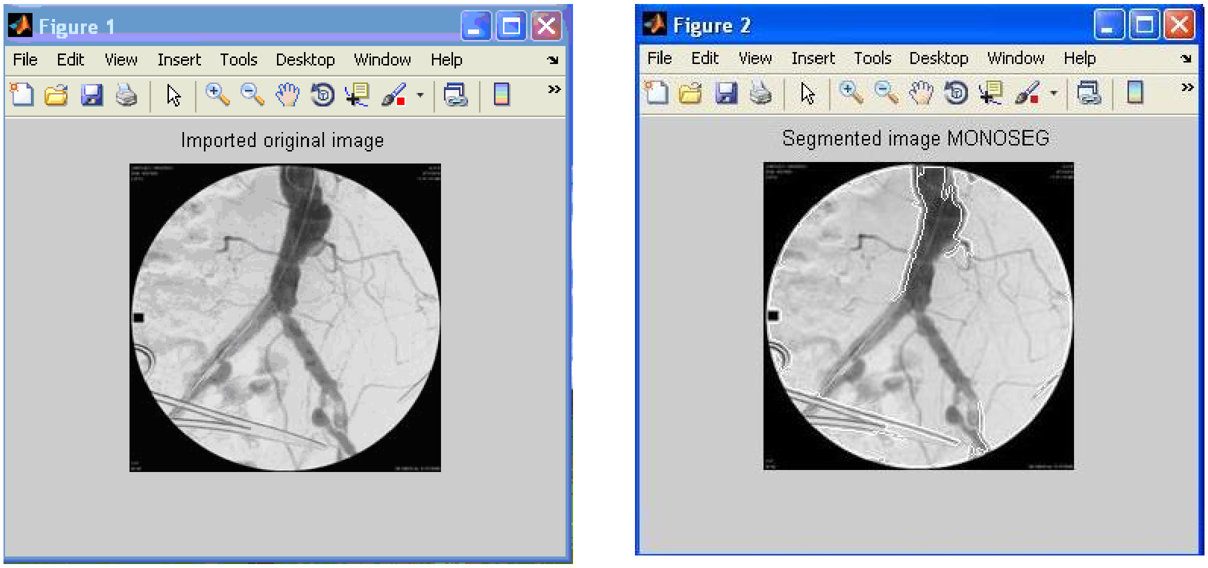

Figure 19. Original and segmented images using MONOSEG

The software Matlab function attached to the 3rd push-button of the GUI interface ("**MULTISEG**") , with the role in multiple elements segmentation, generates the images shown in **Figure 20** [112].

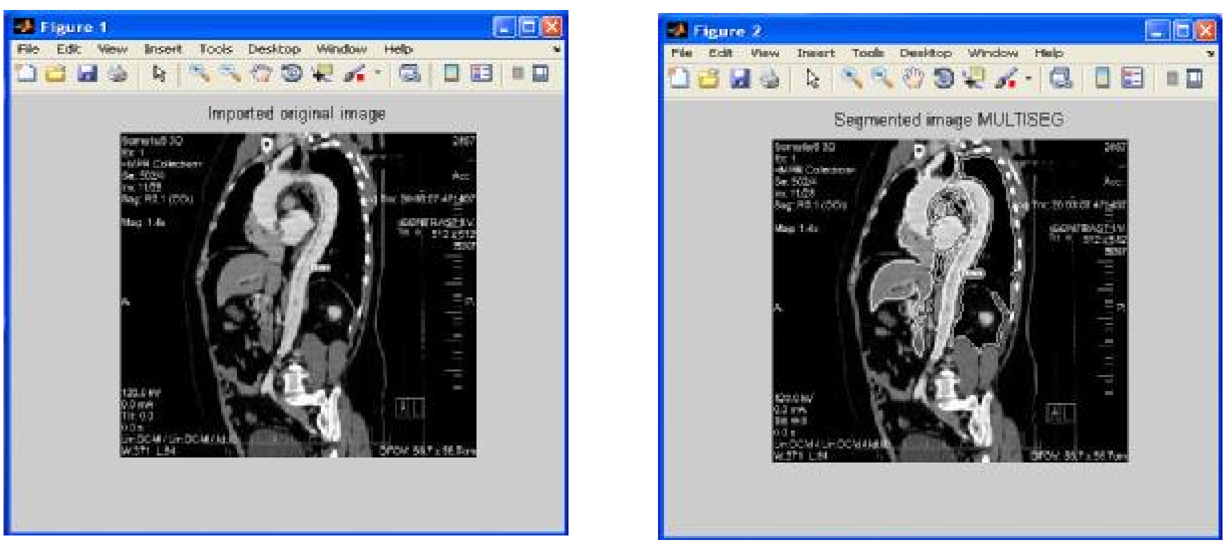

Figure 20. Original and segmented images using MULTISEG

The software Matlab function attached to the 4th push-button of the GUI interface („**FUZZYSEG**"), with the role in obtaining fuzzy segmentation, generates images presented in **Figure 21** [112].

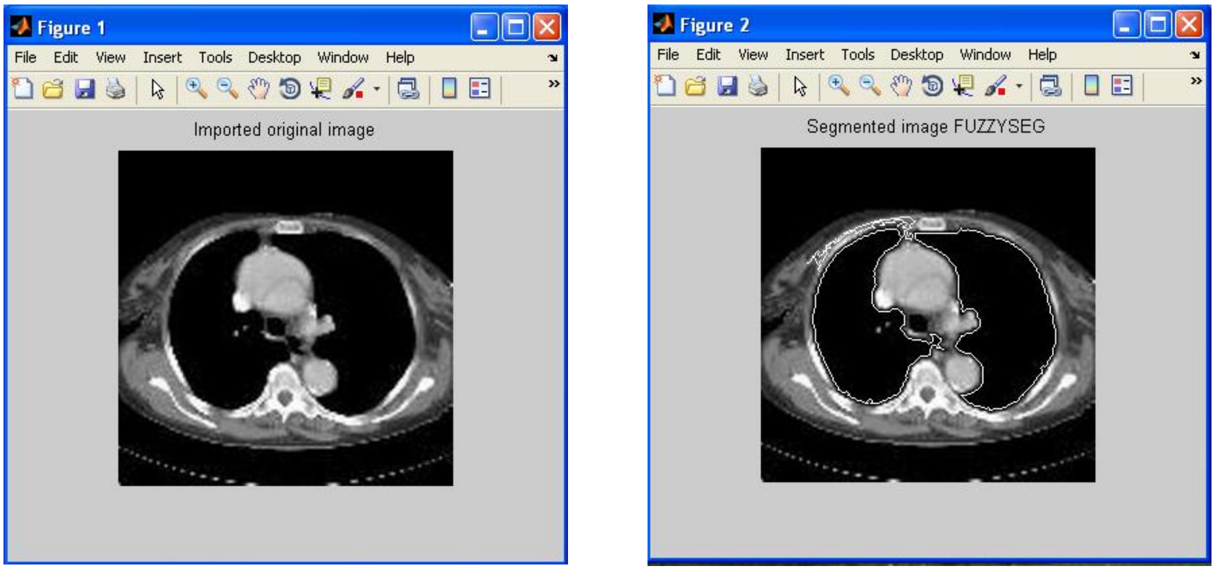

Figure 21. Original and segmented images using FUZZYSEG

7.2.5.4. Statistical analysis of significant perioperative variables

In the **retrospective study,** I identified a number of significant variables, that I used to performe statistical correlations in order to characterize the study group and obtain results that could be used in the management of this disease. Initially, I identified the type of treatment applied to the study group. Patients who had been treated surgically were 215 in number (n = 215, 96.4%, and those treated endovascular were 8 in number (n = 8, 3.6%) . Particularly, among the patients operated, 203 had undergone interventions on the ascending aorta, and 20 patients had had interventions on the aortic arch and descending aorta. Most patients had aneurysms at the level of the ascending aorta, but also in the other segments or at multiple sites simultaneously.

The following variables were recorded for all patients: hematocrit and creatinine values, the amount of blood loss, volume of blood transfused, type of intervention, aortic clamping time (minutes), the time of cardiopulmonary bypass (minutes), associated pathology, additive and logistics Euro-SCORE and the number of days in the intensive care unit.

Depending on the distribution of values, hematocrit was classified into 3 groups: <25%, 25-30%,> 30%. The values of creatinine above 1.2 mg / dl were used for the definition of renal impairment. Post-operatively, the blood loss of an amount above 500 ml was considered to be excessive.

It was found that the relative size of the aneurysm in relation to body size - ASI (“Aortic Size Index") is a very important indicator in predicting complications and patients can be classified into 3 groups in relation to this index:

- those with ASI <2.75 cm/m2 are at low risk of rupture (4% / year);
- between 2.75 - 4.25 cm/m2 are at moderate risk (8% / year);
- ASI > 4.25 cm/m2 are at high risk of rupture.

Using this index to classify patients in the study, I found the following:

- 103 patients (46.2%) had a reduced risk of rupture;
- 118 patients (52.9%) had moderate risk of rupture;
- 2 patients 0.9%) were with high risk of rupture.

In order to assess the surgical risk of patients, I have used additive Euro-SCORE and obtained the following results:

- 8 patients (3.6%) were in the range of 0-2 = low surgical risk;
- 47 patients (21%) were in the range of 3-5 = medium surgical risk;
- 168 patients (75.3%) had values above 6 = high surgical risk.

The two results shown above indicate that there is a high surgical risk population and with a medium risk of rupture but, however, mortality was recorded in the values presented in the literature. This fact confirms that the patients under observation and the planned elective surgery ones have a reduced post-operative mortality.

It had been created a statistical correlation between hematocrit and creatinine values in the immediate postoperative period and the amount of blood loss, the amount of blood transfused, and lenght of stay in intensive care unit. In addition, I compared mortality in surgical and endovascular treatment subgroups. For all patients, there were monitored over the time hematocrit and creatinine values, the amount of blood loss, the blood volume transfused, and the number of days in intensive care unit, and they were correlated, using statistical methods to integrate the results.

Depending on the values, the hematocrit was distributed into three groups: < 25% - 6 patients (2.7%); 25 to 30% - 31 patients (13.9%); > 30% - 185 patients - 83% (**Table 47**) .

Table 47. Correlation HTC% * SO

HTC% in the operating room	Frequency	Percent	Valid percent	Cumulative percent
< 25	6	2.7	2.7	2.7
25 - 30	31	13.9	14.0	16.7
> 30	185	83.0	83.3	100.0
Total	222	99.6	100.0	
Missing data	1	.4		
Overall total	223	100.0		

Legend: missing data - nonexistent information in the clinical chart.

The total number of patients transfused was 89 in number (39.9%) (**Table 48)** . Concerning the amount of blood loss, the patients were divided into two groups: those who had lost more than 500 mL (n = 53, 23.8%) and those who had lost more than 500 mL (n = 160, 71.7%) (**Table 49**).

Table 48. Amount of transfused blood TRSG

Blood transfusion	Frequency	Percent	Valid Percent	Cumulative Percent
0	134	60.1	60.1	60.1
1	89	39.9	39.9	100.0
Total	223	100.0	100.0	

Legend: 0 - without transfusion, 1 - with transfusion.

Table 49. The amount of lost blood QSGP

Lost blood amount / ml	Frequency	Percent	Valid Percent	Cumulative Percent
≤ 500 ml	53	23.8	24.9	24.9
> 500 ml	160	71.7	75.1	100.0
Total	213	95.5	100.0	
Missing data	10	4.5		
Overall total	223	100.0		

On basis of serum creatinine, patients were divided into two groups: those with the values below 1.2 mg / dL (n = 107, 48.0%), and those with values above 1.2 mg / dL (n = 116, 52.0%) .

Table 50. Postoperative creatinine values CRpOP

CR pOP mg/dl	Frequency	Percent	Valid Percent	Cumulative Percent
0	107	48.0	48.0	48.0
1	116	52.0	52.0	100.0
Total	223	100.0		

Legend: 0 = with values ≤ 1.2 mg/dl; 1 = with values >1.2 mg/dl;

Cross analysis between hematocrit values and perioperative mortality could not demonstrate a significant correlation (**Table 51**) .

Table 51. CROSSTAB _HTC%SO – MPO

HTC%SO		MPO		Total
		0	1	
< 25	Count	6	0	6
	Expected Count	5.8	.2	6.0
	% within HTC%SO	100.0%	.0%	100.0%
25 – 30	Count	30	1	31
	Expected Count	30.0	1.0	31.0
	% within HTC%SO	96.8%	3.2%	100.0%
> 30	Count	179	6	185
	Expected Count	179.2	5.0	185.0
	% within HTC%SO	96.8%	3.2%	100.0%
Total	Count	215	7	222
	Expected Count	215.0	7.0	22.0
	% within HTC%SO	96.8%	3.2%	100.0%

Legend: MPO - immediate postoperative mortality, 0 - no immediate postoperative deaths, 1 - with the immediate postoperative deaths.

Table 52. Chi-Square Test

	Value	df	Asymp. Sig. 2-sided)
Pearson Chi-Square	**.201[a]**	**2**	**.904**
Likelihood Ratio	**.390**	**2**	**.823**
Linear-by-Linear Association	**.088**	**1**	**.766**
N of Valid Cases	**222**		

a. ***2 cells (33.3%) have expected count less than 5. The minimum expected count is .19.***

The hematocrit values correlate with the likelihood of being transfused: 6 patients with values below 25% - 5 transfusions (83.3%); 31 patients with values between 25-30% - 16 transfused (51.6%); 185 patients with values above 30 % - 68 transfused (36.8%).

An important parameter in the evolution of operated patients is the **length of stay in intensive care unit (ICU)**. Extending this duration is burdened by complications, which may cause the patient's death.

Therefore, in this study I correlated the biological perioperative parameters (creatinine and the hematocrit values, the amount of lost blood, and the amount of transfused blood), with the lenght of stay in the intensive care unit in patients with aortic aneurysm undergoing the surgical treatment or endovascular therapy.

Surgical treatment of aneurysm of the aorta, because of the complexity and pathological associated conditions with these patients, correlates with a longer period of hospitalization, which causes high costs and, therefore, the need to improve the management of this pathology.

In addition, I compared mortality in surgical and endovascular treatment subgroups, in order to assess the trend correlated with the type of surgery and associated pathology.

Initial characteristics of all patients are summarized in **Table 53**. It is a high-risk surgical population, with a mean logistic Euro-SCORE of 12.3%.

Most patients had the associated pathology: dyslipidemia (69.1%), coronary artery disease (38.1%), hypertension (77.1%), and aortic insufficiency (59.2%).

Table 53. Characteristics of the patients (n=223)

Patients characteristics	Number	Valid percent	Range	Average
Gender				
Male	**160**	**71.7**	**-**	**-**
Female	**63**	**28.3**	**-**	**-**
Age (years)	**-**	**-**	**33 - 87**	**65.2 ± 11.1**
Age groups (years)				
< 50	**25**	**11.2**	**-**	**-**
50 – 70	**111**	**49.8**	**-**	**-**
> 70	**87**	**39.0**	**-**	**-**
BMI [Kg/m^2]	**-**	**-**	**18 - 38**	**26.3 ± 3.7**
BSA [m^2]	**-**	**-**	**1.4 - 2.5**	**1.86 ± 0.2**
Coronary disease	**85**	**38.1**	**-**	**-**
Dyslipidemia	**126**	**56.5**	**-**	**-**
Hypertension	**98**	**43.9**	**-**	**-**
Renal impairement	**32**	**14.3**	**-**	**-**
Ejection fraction	**-**	**-**	**25 - 70**	**53.3 ± 9.6**
Pulmonary hypertension	**24**	**10.8**	**-**	**-**
Previous surgery	**4**	**1.8**	**-**	**-**
Additive Euroscore	**-**	**-**	**2 - 16**	**7.5 ± 2.7**
Logistic Euroscore	**-**	**-**	**1.2 - 70.3**	**12.3 ± 10.7**

Identification of associated pathology is very important, both in planning surgery and in subsequent evolution of these patients (**Table 54**) .

Table 54. Associated pathology

Associated pathology	Number of patients	Valid percent [%]
Aortic stenosis	**61**	**27.4**
Aortic insufficiency	**132**	**59.2**
Bicuspid aortic valve	**45**	**20.2**
Mitral stenosis	**3**	**1.4**
Mitral insufficiency	**41**	**18.4**
Tricuspid insufficiency	**29**	**13.0**
Coronary disease	**85**	**38.1**
Diabetes mellitus	**30**	**13.5**
Obesity	**47**	**21.1**
Dyslipidemia	**154**	**69.1**
Chronic heart failure	**31**	**13.9**
Arterial Hypertension	**172**	**77.1**
Chronic pulmonary disease	**29**	**13.0**
Carotid stenosis	**17**	**7.6**
Peripheral arterial disease	**15**	**6.7**

The operational features are shown in **Table 55**. 215 patients (96.4%) underwent conventional surgery, and for 8 patients (3.6%), it was performed endovascular treatment.

Table 55. Operative features

Operative characteristic	Number	Valid percent	Range	Average
Type of intervention				
Open surgery (OP)	**215**	**96.4**	**-**	**-**
EVAR	**8**	**3.6**	**-**	**-**
Surgical approaches				
Bentall intervention	**30**	**13.5**	**-**	**-**
Wheat intervention	**64**	**28.7**	**-**	**-**
David intervention	**23**	**10.3**	**-**	**-**
EVAR	**8**	**3.6**	**-**	**-**
Ascending aorta replacement	**65**	**29.1**	**-**	**-**
Aortic arch replacement	**7**	**3.1**	**-**	**-**
Thoraco-abdominal aorta replacement	**5**	**2.2**	**-**	**-**
Ascending aorta repair	**21**	**9.4**		
Clamping time of the aorta (minutes)	**-**	**-**	**21 - 193**	**76.4 ± 30.9**
Cardio-pulmonary bypass time (minutes)	**-**	**-**	**48 - 396**	**109.8 ± 46.6**
Hematocrit levels (%)				
< 25	**6**	**2.7**	**-**	**-**
25 – 30	**31**	**13.9**	**-**	**-**
> 30	**186**	**83.4**	**-**	**-**

Postoperative results indicate the following: (**Tables 56 and 57**) : in-hospital mortality was 3.1%); the mean logistic Euro-SCORE for these 7 deaths was 39.1%).

All these patients underwent open heart surgery: 5 patients had the intervention on the ascending aorta and 2 patients had the intervention on the descending aorta.

Average of lenght of stay in the intensive care was of 48 hours, with 89 patients (39.9%) who needed postoperative transfusion. Post-operative renal failure, defined by the values of creatinine greater than 1.3 mg / dL occurred in 89 patients (39.9%).

Table 56. Postoperative outcomes 1

Postoperative outcome	Number of patients	Valid percent	Range	Average
Postoperative blood transfusion	**89**	**39.9**	**-**	**-**
Lost blood amount (ml/dL) **≤ 500** **> 500**	 **55** **168**	 **24.7** **75.3**	 **-** **-**	 **-** **-**
Postoperative creatinine values > 1.3 mg/dL	**89**	**39.9**	**-**	**-**
Length of stay in intensive care unit TIPO (hours)	**-**	**-**	**48 - 72**	**48**
Hospital mortality	**7**	**3.1**	**-**	**-**

Using the hematocrit values - that were correlated with the probability of being transfused (6 patients with the values below 25%, of which 5 transfused: 83.3%; 31 patients with values between 25-30%, of which 16 transfused: 51.6 %; 186 patients with values exceeding 30%, of which 68 transfused: 36.6%) -, it was obtained $p = 0.025$.

The correlations between the amount of lost blood, transfusions and the perioperative mortality showed that there was no significant correlation between the amount of lost blood and mortality, with the mortality rate of 3.8% in patients who had lost an amount ≤ 500, and 3.1 % mortality in patients who had lost an amount > 500 ml, while, as expected, a correlation was observed between the amount of lost blood and transfusion ($p = 0.003$). Analysis of mortality in patients with normal and elevated serum creatinine have indicated that mortality was determined by creatinine values; in the statistical analysis, in this case, it was used the threshold value for creatinine 1.3 mg / dl (creatinine ≤ 1.3 mg / dL: n = 134, 1 death (0.7%); creatinine > 1.3 mg / dL: n = 89, 6 deaths (6.7%) $p = 0.034$). A significant correlation was found in patients with serum creatinine above 1.3 mg / dl in patients who needed a transfusion, indicating that an increase in the creatinine level, increased probability of being transfused (60.7 % vs 26.1; $p < 0.001$). Also, there were no statistically significant correlations between the type of surgery with the variable lenght of stay in the intensive care unit, creatinine levels during the postoperative period, blood loss amount and the time of clamping of the aorta.

Instead, the correlation between the type of intervention and the time of cardiopulmonary bypass appears to be statistically significant: an average time of 108 minutes for interventions upon the ascending aorta, compared to 151 minutes for those upon aortic arch and the descending aorta (p = 0.011). The lenght of stay in the intensive care unit appears to be directly related to the age of the patient, pulmonary hypertension, the time of cardiopulmonary bypass and the time of clamping of the aorta, postoperative transfusions, and postoperative renal failure (creatinine > 1.3 mg / dl).

Reported to the body surface (BSA), there seems to be inversely proportional relation. Multivariate analysis showed that only patient age (OR = 1.058, p = 0.003), time of cardiopulmonary bypass (OR = 1.021, p <0.001), and renal failure (OR = 2.137, p = 0.041) are independent predictors for the length of stay in the intensive care unit. **Table 57** presents the risk factors and perioperative determinant factors for prolonged lenght of stay in the intensive care unit. Potential prognostic factors were initially selected through a bivariate statistical analysis.

Table 57.

Postoperative outcome	All patients (n = 223)	TIPO ≤ 48 ore (n = 157)	Length of stay in the ICU (TIPO) > 48 ore (n = 66)	p
Gender **Male** **Female**	 160 (71.7%) 63 (28.3)	 118 (75.2%) 39 (24.8%)	 42 (63.6%) 24 (36.4%)	0.114
Age (years)	65.2 ± 11.1	63.5 ± 11.0	69.1 ± 10.3	0.001
Age groups (years) < 50 **50 – 70** **> 70**	25 (11.2%) 111 (49.8%) 87 (39.0%)	20 (12.7%) 85 (54.2%) 52 (33.1%)	5 (7.6%) 26 (39.4%) 35 (53.0%)	0.020
BMI (Kg/m^2)	26.3 ± 3.7	26.5 ± 3.7	25.7 ± 3.5	0.230
BSA (m^2)	1.86 ± 0.18	1.88 ± 0.17	1.81 ± 0.20	0.031
Coronary disease	85 (38.1%)	54 (34.4%)	31(47.1%)	0.103
Dyslipidemia	126 (56.5%)	95 (60.5%)	31 (47.0%)	0.099
Arterial Hypertension	98 (43.9%)	67 (42.7%)	31 (47.0%)	0.658
Kidney failure	32 (14.3%)	20 (12.7%)	12 (18.2%)	0.396
Ejection fraction	53.3 ± 9.6	53.8 ± 9.2	52.1 ± 10.3	0.219
Pulmonary hypertension	23 (10.3%)	11 (7.0%)	12 (18.2%)	0.038
Previous surgery	4 (1.8%)	2 (1.3%)	2 (3.0%)	0.727
Clamping time of the aorta (minutes)	76.4 ± 30.9	71.3 ± 27.3	89.1 ± 35.5	0.001
Cardiopulmonary bypass time (minutes)	109.8 ± 46.6	98.3 ± 34.0	137.7 ± 59.9	0.001
Hematocrit levels (%) **< 25** **25 - 30** **> 30**	 6 (2.7%) 31 (13.9%) 186 (83.4%)	 2 (1.3%) 23 (14.6%) 132 (84.1%)	 4 (6.1%) 8 (12.1%) 54 (81.8%)	0.123
Postoperator blood transfusion	89 (39.9%)	43 (27.4%)	46 (69.7%)	0.001
Quantity of lost blood (ml/dL) **≤ 500** **> 500**	 55 (24.7%) 168 (75.3%)	 48 (30.6%) 109 (69.4%)	 7 (10.6%) 59 (89.4)	0.006
Postoperative creatinine	89 (39.9%)	47 (29.9%)	42 (63.6%)	0.001

8. CONCLUSIONS

1. Setting up a database through a retrospective study on a representative number of patients (223) has allowed the profiling of patients with aortic aneurysm: male, mean age of 65 years, hypertensive, with dyslipidemia, former smoker, with moderate or severe impairment of aortic valve (aortic insufficiency) in 50% of cases, and the coronary artery lesions in a significant proportion.

2. The study showed a decrease in the male / female ratio for aortic aneurysm, which is probably due to increased addressability for expert advice of the women over 50 years old through programs of cardiovascular prevention. This trend of increased incidence among female population should be studied in larger groups of patients by ultrasound screening, and in women over 50 years old - to establish the real factors that lead to increased incidence.

3. Also, it was found a reduction in the age range from 50 to 70 years for maximum incidence of AA, which might be due to the prevention program started in 2010 in Italy, primarily for abdominal aortic aneurysms in men, called "Un minuto che vale una vita "of the SICVE ("Societa 'Italiana di Chirurgia vascolare ed Endovascolare "), in which men between 65 and 80 years old receive free specialist visits, which include an abdominal ultrasound examination too. This program seeks to reduce mortality from ruptured AAA, that makes 6000 deaths per year in Italy.

4. The data of this study reveales that over 90% of patients with AA are former smokers, aspect that confirms that tobacco use is a major risk factorin the apparition and development of the aneurysm.

5. From the analyzed data, it is observed the predominance of four types of comorbidities associated with aortic aneurysm in a significant percentage (hypertension, dyslipidemia, coronary artery disease and aortic insufficiency), which influence the development and therapeutic management of this disease.

6. Corelating systolic blood pressure values with the total cholesterol values, it has been noted that there is no tight dependency between the two parameters from the statistical point of view, more than half of the patients, both those with treatment controlled values and those miscontrolled having the total cholesterol values over 190 mg / dl.

7. Statistically there was a tight correlation between LDL-C and immediate postoperative complications in patients with AA surgically treated, which confirms that a reduction in LDL-C reduces cardiovascular events in the immediate postoperative.

8. Statistical correlation between BVA and SA has confirmed their dependence, therefore, supervision by ETT and scheduled surgery avoids aortic dissection.

9. Concerning the aortic root size, a relatively strong correlation occurs between BVA and dilated aortic annulus aspect that must to be verified by accurate measurements by ETT performed regularly because normally the annulus is not prone to dilation. Even patients under 50 years must be followed up by serial measurements at this level.

10. In regard to aortic bulb sizes, there was no significant correlation with the BVA, however, dilation of the bulb has correlated with the high values of TAS, which is explained by hemodynamic stress on the aortic wall.

11. 11. Availability and low cost of ecocardiographic examination make this investigation method of first choice in the diagnosis of aneurysm of the ascending aorta and assessment of aortic valve damage.

12. Echocardiography (TTE and TEE) may be performed in emergency situations due to availability at all medical units, bedside accessibility, repeatability, low cost, high specificity, *but it is highly operator-dependent exam.* Although medical staff is trained to assess the patient's cardiac surgery, there is a significant difference between the two types of examination, echocardiography and angiography.

13. Echocardiography can be a useful tool in the operating room through transesophageal approach because it helps in planning surgery and it checks immediate postoperative results.

14. If available, CT is the method of choice in the diagnosis of the aneurysm of the aorta and its complications. Number of examinations in the study group was low and did not allow a conclusion regarding the overvaluation or undervaluation of aneurysm size compared to other used methods. Concerning patients who died, the difference between the diameters of the ascending aorta measured by ETT and those measured by CT has ranged between 4 mm and 40 mm, which demonstrates once again the high dependency of operator in the ETT exam. In order to obtain a more precise correlation is necessary that the number of examinations to be equivalent to CT and echocardiography.

15. In the study group , echocardiography was prevalent compared to other methods available at the clinic. The small number of patients examined by CT is explained by performing angiography and TEE.

16. Magnetic resonance examination has maximum sensitivity and specificity in aortic aneurysms and their complications , but it has been slightly used in the study - only 7 patients, not

statistically significant. Despite the performances, the following: high cost, lack of staff trained to manage the patient with AA and limitations present - especially in emergencies-, do not indicate this type of examination in the first line of diagnosis.

17. From the present study, it appears that angiographic examination may overestimate the measured values for aortic aneurysms. Angiography is redefined in the endovascular treatment, although in the present study, the number of endovascular interventions was low and did not allow a statistically valid correlation regarding the perioperative morbidity and mortality. Resumption of endovascular therapy ,in particular in 2011, allows the formation of a data base which can be, in the future, compared with the results of surgery, in order to assess quality of life and survival after surgery or endovascular treatment.

18. Multiple location of aortic aneurysm is associated with a high early postoperative mortality. Although the study population presented a high surgical risk and an average risk of rupture, mortality enrolled in the values reported in the literature. This fact confirms that the patients under observation and with planned elective surgery have a reduced post-operative mortality.

19. In the evaluation of aortic insufficiency associated to aortic aneurysm, there are taken into account the risk factors associated with aortic regurgitation, such as: age, hypertension, left ventricular systolic dysfunction.

20. The total number of patients operated over five years has been of 223, of which only 8 (3.6%) were endovascular treated. A correlation between mortality and type of intervention, open surgery or endovascular treatment (EVAR) can not be made because of the small number of patients with endovascular treatment, which did not allow a fair comparison. However, hospital mortality by open surgery was similar to that found in the literature (7 deaths, 3.3%). These findings require further research through complex studies with adequate numbers of patients and new additional parameters to consider.

21. Cross analysis between hematocrit values and perioperative mortality could not demonstrate a significant correlation, however, hematocrit values correlate with the likelihood of being transfused.

22. Correlations between the amount of lost blood, transfusions and perioperative mortality have shown that there is no significant correlation between the amount of blood loss and mortality, but as expected, a correlation was observed between the amount of blood loss and transfusions ($p = 0.003$).

23. Analysis of mortality in patients with normal and elevated serum creatinine values has indicated that mortality has been conditioned by creatinine values. A significant correlation has been found in patients with serum creatinine values above 1.3 mg / dl and in patients who needed a transfusion, indicating that an increase in the creatinine level has increased likelihood of being transfused ($p < 0.001$).

24. There was no statistical correlation between the location of aneurysm and type of dissection. Also, there were no statistically significant correlations between the type of surgical procedure with the duration of lenght of stay in intensive care unit, creatinine levels in the postoperative, blood loss and aortic clamping time. Instead, the correlation between the type of intervention and cardiopulmonary bypass time appears to be statistically significant: an average time of 108 minutes for the ascending aorta, compared to 151 minutes for aortic arch and the descending aorta ($p = 0.011$).

25. The duration of length of stay time in the intensive care unit appears to be directly related to the age of the patient, pulmonary hypertension, cardiopulmonary bypass time and time of clamping of the aorta, postoperative transfusions and postoperative renal failure. Reported to body surface area (BSA), there seems to be an inversely proportional relation. Multivariate analysis has shown that only patient age (OR = 1.058, $p = 0.003$), cardiopulmonary bypass time (OR = 1.021, $p < 0.001$) and postoperative renal failure (OR = 2.137, $p = 0.041$) are independent predictors of length of stay in the intensive care unit.

26. Regarding the risk of rupture, according to the classification of patients by ASI index, although half of them had a moderate risk of rupture, this event did not occur because these patients underwent elective scheduled intervention on the aneurysm . This aspect is reflected in the classification by EuroSCORE, that I realized for every single patient, and it indicated a high percentage of patients (75.3%) with high surgical risk.

27. There were highlighted the perspectives of identifying aortic aneurysms and their complication - aortic dissection by design, deployment and testing a new graphical user interface GUI for medical imaging by using integrated development environment for graphical interfaces GUIDE in MATLAB application with segmentation of acquired images purchased in modes MONO , MULTI and FUZZY , which allows viewing of these images in an efficient manner and in real-time.

28. Practical usefulness of the new designed graphical user interface is of certain perspective, in particular in aortography, which allows viewing of the aneurysm with reduction in the amount of contrast medium, resulting in lowering of the aggresion upon renal function.

29. As perspective, highly accurate segmented acquired aneurysm images can build a database of the aortic aneurysm imaging, by using advanced techniques of pattern recognition, thereby being possible identification by computer - and in real-time - of the morphological appeareance evolution of new-onset aortic aneurysms.

Selected References

1. (98) Bianco G., Micheletti E., Silvestri F., Laezza F., Plati S. et al. La nostra esperienza nel trattamento degli aneurismi dell`aorta addominale con metodica endovascolare. Il Giornale Italiano di Cardiologia Invasiva, 2009; 2: 19 - 23.
2. (42) Booher A M, Eagle K A. Diagnosis and Management Issues in Thoracic Aortic Aneurysm. American Heart Journal, 2011; 34(3) : 38 - 46.
3. (15) Bordei P., Şapte E., Iliescu D. Double Renal Arteries Originating From The Aorta. Surgical Radiological Anatomy, Paris, Vol. 26, Nr. 6, 2004, pp. 474.
4. (7) Boscarini M., Uslenghi F., Realini M., Oggioni M Le Endoprotesi Fenestrate Per Via Percutanea Negli Aneurismi Aortici Addominali Juxtarenali Il Giornale Italiano di Cardiologia Invasiva 4 / 2005, pp. 20-29.
5. (5) Braunwald E. Heart Disease, Editura M.A.S.T. 2000, Vol. II, pp. 1546-1580.
6. (21) Centers for Disease Control and Prevention, National Center for Health Statistics. Compressed Mortality File 1999–2006. CDC WONDER On-line Database, compiled from Compressed Mortality File 1999-2006 Series 20 No. 2L, 2009.
7. (44) Coman I. Diagnosticul modern al disecției de aortă. Bucureşti, 2003.
8. (112) Coroescu MM., Coroescu T. Aortic Aneurysms And Aortic Dissection Identification Using Image Segmentation With MATLAB. Constanta Maritime University Annals, 2013, Year XIV, Vol 20, pp. 8.
9. (109) Coroescu MM., Coroescu T., Constantin S. Medical Image Processing using Segmentation and Feature Extraction Process based on Fuzzy-Neural Networks. A III-a Conferinta de Inginerie Biomedicala cu participare internationala, INGIMED – 2002, Bucuresti, pp. 1-8.

10. (58) Coroescu MM., Craiu E., Furdu I., Blaj C. CT examination and impications in therapeutic management of aortic aneurysm. Archives of the Balkan Medical Union, 2013; 48 (2): 154 - 158.
11. (54) Coroescu MM., Craiu E., Novelli E. Risk factors and perioperative determinants of prolonged length of stay in the intensive care unit and transfusion requirements in surgical and endovascular treatment of aneurysms of the aorta. Archives of the Balkan Medical Union, 2013; 48 (1): 10 – 15.
12. (107) Coroescu T., Constantin S., Coroescu MM. Feed-Forward Associative Neural Networks for 3-D Image Processing, Reconstruction and Modelling in Coronary Arteries. Proceedings of 2002 IEEE-TTTC International Conference on Automation, Quality and Testing, Robotics, Tome II: Robotics, Image and Sygnal Processing , Applications, 2002, Cluj-Napoca, Romania, pp. 99-104.
13. (39) Craiu E., Ginghina C., Țintoiu I., Voiculeț C. Certitudini în Cardiologia Modernă Cap. XII; Editura Dobrogea, Constanța, 2001, pp. 605 - 617.
14. (4) Crawford E.S., Coselli J.S., Svensson L.G., Safi H.J., Hess K.R. Diffuse aneurysmal disease (chronic aortic dissection, Marfan, and mega aorta syndromes) and multiple aneurysm. Treatment by subtotal and total aortic replacement emphasizing the elephant trunk operation. Ann. Surg. 1990; 211(5): 521–537).
15. (6) Eliason J.L., Upchurch G.R. Endovascular Abdominal Aortic Aneurysm Repair. Circulation 2008; 117: 1738-1744.
16. (50) Ensor RE, Fleg IL, Kim YC & col: Longitudinal chest x-ray changes in normal man. J. Gerontol., 1983, 38: 307 - 314.
17. (79) Erbel R, Engberding R, Daniel W, Roelandt J, Visser C, Rennollet H. Echocardiography in diagnosis of aortic dissection. Lancet 1989: 457 – 461.
18. (2) EVAR, DREAM, ACE and OVER tril updates, 2010; www.whichmedicaldevice.com
19. (46) Frederick JR., Woo YJ. Thoracoabdominal aortic aneurysm. Annals of Cardiothoracic Surgery, Vol 1, no. 3, 2012.
20. (16) Gallagher MJ., Raff JL. Use of multislice CT for the evaluation of emergency room patients with chest pain: the so-called "triple rule-out". Catheter Cardiovasc. Interv. 2008; 71(1): 92 - 99.
21. (91) Ginghina C. Mic Tratat de Cardiologie, Ed. Academiei Române, Bucureşti, 2010; pp. 759-773; 451 - 453.

22. (106) Gonzales R., Woods R., Eddins S. Digital Image Processing Using MATLAB, Second Edition, Gatesmark Publishing LLC, Natick, USA, 2009.
23. (8) Grabenwoeger M., Alfonso F., Bachet J., Bonser R., Czerny M. Thoracic Endovacular Aortic Repair (TEVAR) for the treatment of aortic diseases; a position statement from the European Association for Cardio-Thoracic Surgery (EACTS) and the European Society of Cardiology (ESC), in collaboration with the European Association of Percutaneous Cardiovascular Intervention (EAPCI). European Heart Journal, 2012.
24. (93) Greenhalgh S. The Endovascular Revolution: Findings of the European Vascular & Endovascular Monitor (EVEM), 2010.
25. (47) Hagan PG., Nienaber ChA., Isselbacher EM et al. The International Registry of Acute Aortic Dissection (IRAD): New Insights Into on Old Disease. JAMA: 2000; 283(7), pp. 897 - 903.
26. (111) Hahn BD., Valentine DT. Essential MATLAB for Engineers and Scientists, Third Edition, Elsevier Ltd, Oxford, 2007, Chap. 13: Graphical User Interfaces GUIs, pp. 292-305.
27. (20) Hiratzka LF., BakrisGL., Beckman JA., Bersin RM., Carr VF. ACC/AHA Pocket Guideline. Based on the 2010 ACCF/ AHA/ AATS/ ACR/ ASA/ SCA/ SCAI/ SIR/ STS/ SVM. Guidelines for the Diagnosis and Management of Patients Whith Thoracic Aortic Diseases, 2010.
28. (12) Hutchison SJ. Aortic Diseases Clinical Diagnostic Imaging Atlas. 2009; Chapter 3 Examination and Imaging of the Aorta, pp. 33 – 53.
29. (14) Ifrim M, Niculescu Gh, Bareliuc N, Cerbulescu B. Atlas de Anatomie Umană, Vol II, Editura Ştiinţifică şi Enciclopedică, Bucureşti 1984, pp. 73 – 77.
30. (108) Kulkarni A. Computer Vision and Fuzzy-Neural Systems. Prentice Hall PTR, Upper Saddle River, New Jersey (USA), 2001.
31. (56) Lesko NM, Link KM, Grainger RG. The thoracic aorta. In: Grainger RG, Allison D, eds. Diagnostic radiology: a textbook of medical imaging. 3rd ed. Edinburgh, Scotland: Churchill Livingstone, 1997; pp. 854 – 857.
32. (17) Mao SS., Ahmadi N., Shah B., Beckmann D., Chen A, Ngo L, Flores F.R, Gao YL, Budoff MJ. Normal thoracic aorta diameter on cardiac computed tomography in healthy asymptomatic adults impact of age and gender. Acad. Radiol. 2008 Jul; 15(7): 827 - 34.
33. (110) Marchand P., Holland O.T. Graphics and GUIs with MATLAB, Third Edition, Chapman & Hall CRC, Boca Raton, 2003.

34. (23) Mingazzini P., Cappelli M., Sampaolo A., Scavone G. Screening Per Aneurisma Dell'aorta Addominale Presso Un'associazione Di Società Cooperative. Il Bassini - Volume XXXII - 44 Gennaio-Giugno, 2011.
35. (3) Revista Română de Cardiologie, vol XIX, Suplimentul B, An 2004.
36. (78) Ruggiero M, Lenti ML, Cavallari D, Dicillo CP, Mascolo AR, Musci S et al. Screening for abdominal aortic aneurysm during transthoracic echocardiography. A prospective study in 1202 consecutive patients at high risk: incidence, correlation with risk factors, feasibility, diagnostic accuracy, and increase in echocardiography time. G. Ital. Cardiol. 2006; 7: 217 – 223.
37. (113) SICVE (Societa` Italiana di Chirurgia Vascolare ed Endovascolare). „*Un minuto che vale una vita”* Il Progetto di Prevenzione per l'Aneurisma Aortico Addominale, 2010.
38. (97) Simonett G., Pistolese GR., Gandini R., Ippoliti A., Fabiano S., et al. Trattamento endovasculare degli aneurismi dell`aorta addominale. Emodinamica 2004, 36: 15 - 25.
39. (43) Svensson LG., Crawford ES. Aortic dissection and aortic aneurysm surgery: clinical observations, experimental investigations and statistical analyses. Part. II. Curr. Probl. Surg. 1992; 29: 913 - 1057.
40. (103) Țintoiu I. Circulația Extracorporeală şi Asistarea Circulatorie, Sylvi, 1998.
41. (104) Țintoiu I. Managementul Bolilor Cardiovasculare, Vol I, Editura Militară, Bucureşti, 1998.
42. (1) Upchurch GR Jr., Criado E. Aortic Aneurysms. Pathogenesis and Treatment. Humana Press 2009.