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A Comparative Study of the Early and Short-Term Outcomes of Aortic Replacement in Patients with Stanford type A Aortic Dissection and Ascending Aortic Aneurysm.

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ABSTRACT

Ascending aortic replacement is a challenging and complex surgery. The mortality, morbidity, and outcomes depend on the causes of the ascending aortic pathology and the type of operation. The research was conducted utilizing an observational, prospective, and cohort study of patients at a single center with ascending aortic replacement because of aneurysm and dissection. In thehospital, mortality, morbidity, and short-term outcomes were measured. A total of 85 patients participated in this research. 65.9% of the participants were male, while 34.1% were female. Furthermore, thirty-three patients had Stanford type A aortic dissection (STAAD), whereas 52 had ascending aortic aneurysm (ASAA). Early mortality was (21.21% and 1.9%) for STAAD and ASAA, respectively, while the survival rate after one year was (75.8% and 96.15 %) for ascending dissection and aneurysm, respectively. The results of our study show higher early surgical mortality and morbidity and a lower short-term survival rate for STAAD surgery compared with ASAA surgery.

1. INTRODUCTION

The discussion of aneurysm and dissection is difficult without a complete understanding of the aorta, which is the biggest blood vessel. It is an artery that starts at the upper part of the left ventricle and continues down to the back of the body at the area of the fourth lumbar vertebra that splits into the left and right common iliac arteries [1]. It is composed of four various segments as the following: ascending aorta, aortic arch, descending aorta, and also abdominal aorta. Three layers form the aortic wall from the outside to the inside of the vessel, including adventitia, media, and also intima. [2, 3] (Figure 1A). Aortic dissection is a dangerous and common condition that affects the aorta. It has a high mortality and morbidity rate as a result of fatal and potential complications if untreated. The incidence of aortic dissection is 3 per 100,000 population years [4, 5]. There are two anatomical classification systems for aortic dissection: the Stanford and DeBakey classifications. The first classification is Stanford categorizes dissections into Stanford Type A and Stanford Type B. The Stanford Type A Dissection (STAAD) affects the ascending aorta (before and closer to the brachiocephalic artery). In contrast, when the dissection involves the descending aorta that does not affect ascending aorta is called Stanford Type B Dissection (STABD) [6, 7]. Aneurysm of the ascending aorta is a localized, permanent aortic dilatation with a diameter at least 50% larger than average and includes all three layers of the aorta [8]. The frequency of the developing ascending aortic aneurysms is approximately 5-10/100000 people [9]. (Figure 1C).

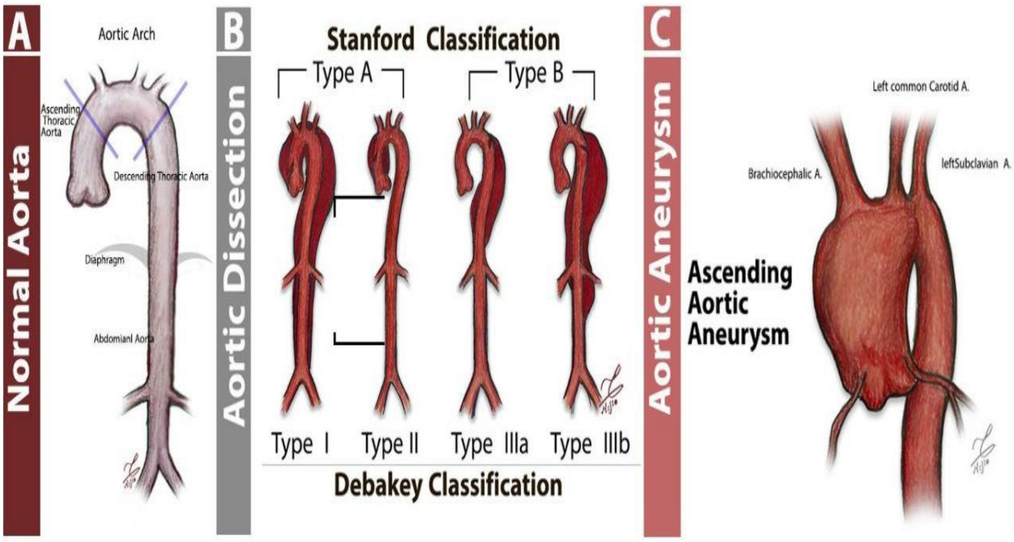

Figure 1: (A) normal aorta. (B) aortic dissection. (C) aortic aneurysm
*This picture is drawn by Zryan Mejio

Many risk factors are causing the development of aortic dissection or aneurysm, including hypertension, male gender, bicuspid aortic valve (B.A.V.), dyslipidemia, atherosclerosis degeneration of the aorta, smoking, congenital abnormality, and connective tissue disorder for example Marfan syndrome (M.F.S.). They are among the most common risk factors for aortic dissection. In addition to infection, vasculitis and trauma are three additional, less common causes of this condition [6, 10].

Sudden and intense chest pain are among the most common symptoms of Stanford type A. The pain is usually retrosternal or substernal [6]. The absence of upper limb pulses on physical examination is a sign of ascending aortic involvement. Other clinical manifestations include low blood pressure, cerebrovascular accident, lower limb paralysis, kidney failure, and abdominal pain [5]. The enlargement of the ascending part of the aorta is very slow, needs years to grow, and has no symptoms in the beginning. This pathology continues unnoticed unless it is accidentally shown on cardiovascular imaging tests linked to other conditions or when catastrophic complications occur [8].

There are various imaging tests exist for the detection of the aneurysm and ascending aortic dissection. The chest Roentgenogram (X-ray) shows a large mediastinum in ascending aortic aneurysm. Still, the aortic dissection cannot be excluded by a normal chest X-ray test [8, 12]. Transthoracic echocardiography (T.T.E.) offers a straightforward method that does not involve invasive procedures for analyzing the morphology of the aortic root, proximal ascending aorta, aortic valve, and left ventricle. In addition, it is very effective for diagnosing most patients. More detailed information is obtained with transesophageal echocardiography (T.E.E.), especially to identify fluid in the pericardium and aortic valve diseases. In many cases, it is able to determine the location of the primary intimal tear in the aortic root. Furthermore, transesophageal echocardiography (T.E.E.) is an effective diagnostic test, and its sensitivity and specificity are one hundred percent accurate when used by trained professionals [13].

The computed tomography scan (C.T. scanning) of the aorta is the test that is the most reliable and the fastest mechanism for verifying the diagnosis. The purpose of C.T. is to illustrate the false and true lumen of the aorta when the aorta is being dissected. It also evaluates the degree of the dissection and the involvement of the aorta and its arch branches. Furthermore, it detects tears in the intima that are located in between the lumen. C.T. also contributes to the process of planning the surgical procedure and the cannulation sites. The C.T. method has a sensitivity and specificity that can reach up to 100%. The benefits of C.T. angiography in patients with impaired kidney function or an allergy to contrast are still debatable. Other radiographic measures, such as magnetic resonance angiography (M.R.A.), may be considered an alternative since they provide precise measurements and documents of all parts of the aorta [14].

It is recommended that patients diagnosed with STAAD all be evaluated for possible emergency surgical repair of the ascending aorta [6, 7]. In the case of degenerative ASAA, indications for elective repair include a diameter of 5.5 centimeters or greater or a growth rate of 0.5 centimeters per year [15]. When the patient is undergoing other cardiac surgeries, it is preferable to replace the ascending aorta if the internal diameter of the ascending aorta is five centimeters or greater. Patients who have connective tissue abnormalities like M.F.S., B.A.V., or family background of dissection of the ascending aorta must have their aortas replaced preventatively at a diameter of 4.5 centimeters or over [8]. Surgical technique for ascending aortic dilatation or dissection includes: supra coronary ascending aortic replacement (SCAAR), supra coronary ascending aortic replacement and sub coronary aortic valve replacement (SCAAR+AVR), the Bentall procedure, and hemi arch replacement surgery [16, 17, 18].

The particular aim of the research was to compare the mortality and morbidity of the ascending aortic replacement in STAAD and ASAA in the early period (intraoperative, in-hospital, or outside the hospital within the first month) and measure short-term outcomes and survival rates (from the time of the operation until one year postoperatively).

2. PATIENTS AND METHODS

This study was an observational, prospective, and cohort study at a single center with a total of 85 patients included between January 1st, 2014 to June 30th, 2021, who underwent ascending aortic replacement because of STAAD and ASAA at the Sulaimani Cardiac Hospital, cardiac surgery department, and they were followed up for one year. A scientific committee of the University of Sulaimani/College of Medicine (No. 186 on 17/11/2021) and the Ethics Committee of the University of Sulaimani / College of Medicine (No. 235 on 19/12/2021) approved this study. All patients were given the opportunity to provide their informed consent in writing, allowing them to use their operation images and photos solely for scientific purposes.

Patients who underwent ascending aortic replacement surgery were classified into two groups. Group A (n = 33) includes patients with STAAD, while Group B (n = 52) includes patients with ASAA. All patients' age, sex, and risk factors were pre-operatively documented.

In the preoperative stage, following a detailed clinical assessment, specific investigations were performed, such as chest radiography, electrocardiography (E.C.G.), transthoracic echocardiography (T.T.E.), computed tomography of the aorta, thyroid function test, complete blood count (C.B.C.), liver function test, virology, renal function test and pulmonary function tests for elective patients. In addition to blood preparation, fresh frozen plasma and platelets.

Intraoperatively, the time of cardiopulmonary bypass (CPBT), time of aortic cross-clamp (ACCT), the need to decrease the body temperature till 16 C0 (deep hypothermic circulatory arrest), and the type of operations were documented. Postoperatively, re-exploration, duration of intubation, acute kidney injuries, stroke, respiratory complications, arrhythmia, gastrointestinal bleeding (GITB), and death were documented.

The procedure was performed under general anesthesia, through a median sternotomy incision. An arterial cannula was inserted into the femoral artery, axillary artery, and sometimes into the distal ascending aorta during surgery, while a venous cannula was placed to the right atrium or femoral vein. The surgery was done on cardiopulmonary bypass (C.P.B.) after an aortic cross-clamp, and the patient was given cardioplegia.

Inclusion Criteria: patients undergoing ascending aortic replacement due to ascending aortic dissection or aneurysm**.**

Exclusion Criteria*:* Patients aged less than 18 years old and Re-operative patients.

Statisticalanalysis: The statistical analysis was conducted by utilizing Statistical Package for the Social Sciences (IBM SPSS 24) and an appropriate statistical test for the research data set to determine the significant differences between the two groups.

Patient Scoring: Neurological complication was scaled according to the NIHSS [19]. Acute kidney injuries are classified according to the (RIFLE) criteria [20].

3. RESULTS

Eighty-five patients underwent ascending aortic replacement, and the patients were classified into two groups, Group A (STAAD) (n = 33) and Group B (ASAA) (n = 52). The mean age ± standard deviation (S.D.) for Group A was 54 ± 9.8 years, while for Group B was 52 ± 10.8 years, without any significant difference in age for both Group A and Group B with (P-value = 0.38). Twenty-two patients from Group A, and 34 from group B were males, and the male: female ratio was (1.9:1). In addition to a male predominance, the most frequently detected risk factor was hypertension (H.T.) (75.8% -and 63.5%) for group A and group B, respectively, followed by dyslipidemia (Dys), diabetes mellitus (D.M.), smoking, and bicuspid aortic valve (B.A.V.) without any statistically significant difference between Group A and Group B with (p-value > 0.05). (Table 1).

Table 1: Patients' Risk Factor

		Diagnoses				
		STAAD		**ASAA**		
		Number	Percent %	Number	Percent %	P-value
H.T.	Yes	25	75.8%	33	63.5%	0.23
	No	8	24.2%	19	36.5%	
Gender	Male	22	66.7%	34	65.4%	0.9
	Female	11	33.3%	18	34.6%	
Dys	Yes	12	36.4%	18	34.6%	0.89
	No	21	63.6%	34	65.4%	
B.A.V.	Yes	5	15.2%	14	26.9%	0.2
	No	28	84.8%	38	73.1%	
D.M.	Yes	8	24.2%	17	32.7%	0.4
	No	25	75.8%	35	67.3%	

Smoking	Yes	9	27.3%	16	30.8%	0.73
	No	24	72.7%	36	69.2%	
C.L.D.	Yes	5	15.2%	5	9.6%	0.44
	No	28	84.8%	47	90.4%	
M.F.S.	Yes	1	3.0%	2	3.8%	0.84
	No	32	97.0%	50	96.2%	
CoA	Yes	1	3.0%	1	1.9%	0.74
	No	32	97.0%	51	98.1%	

STAAD: Stanford type A aortic dissection. ASAA: ascending aortic aneurysm. H.T.: hypertension. Dys: dyslipidemia. B.A.V.: bicuspid aortic valve, D.M.: diabetes mellitus, C.L.D.: chronic lung diseases, M.F.S.: Marfan syndrome. CoA: Coarctation of the aorta.

Intraoperatively there is a significant difference between the groups (P-value <0.05) for intraoperative measure and duration of intubation, as shown in (Table 2).

Table 2: Intraoperative and Duration of Intubation Measure

Variables	Diagnosis	Mean	Std. Deviation	P-value
CPBT (min)	STAAD	207	49	0.008
	ASAA	177	51	
ACCT (min)	STAAD	144	37	0.023
	ASAA	125	39	
Duration of intubation (Hrs.)	STAAD	25	15	0.089
	ASAA	21	8	

CPBT: Cardiopulmonary Bypass Time. ACCT: Aortic Cross-Clamp Time

All patients in this study underwent the ascending aorta replacement, with or without concomitant replacement of the aortic valve or aortic root. The most frequent kind of operation for group A is SCAAR+AVR, while the Bentall procedure is the most frequent type of surgery for group B. There is not any significant difference between the two studied groups. Furthermore, only one patient participant of group A and two patient participants of group B underwent concomitant mitral valve replacement (M.V.R.), and three from group B underwentCoronary Artery Bypass Graft (CABG) surgery with ascending aortic replacement. The concomitant procedure and circulatory arrest through hypothermic are illustrated in (Table 3).

Table 3: Distribution of Type of the Operation and Concomitant Surgery

		Diagnoses			
		STAAD		ASAA	
		Number	Percent %	Number	Percent %
Type of the operation	SCAAR+AVR	11	33.3%	14	26.9%
	SCAAR	8	24.2%	12	23.1%
	Bentall procedure	9	27.3%	22	42.3%
	Hemiarch replacement	5	15.2%	4	7.7%
Need HTCA	Yes	26	78.8%	15	28.8%
	No	7	21.2%	37	71.2%
Concomitant operation	MVR	1	3%	2	3.8%
	CABG	0		3	5.8%

The frequent early postoperative complications were arrhythmia-related with a ratio of (21.21% and 19.23%) for group A and group B, while the renal impairment (according to RIFLE criteria) was (21.21 % and 17.3%) for the first group, which is A and group B, shown no statistical differences were found among the groups. Some degree of stroke (according to NIHSS criteria) occurred in 4 patients (12.12%) in Group A and four patients (7.69%) in

Group B. Finally, one patient from group B developed a complete heart block. The details of early postoperative complications are illustrated in (table 4).

Table 4: Early Postoperative Complications

		Diagnoses				
		STAAD		**ASAA**		
		N	%	N	%	P-value
Arrhythmia	A.F.	6	18.2%	8	15.4%	0.84
	No	26	78.8%	42	80.8%	
	V.F.	1	3.0%	1	1.9%	
	Heart block	0	0.0%	1	1.9%	
A.K.I.	No risk for A.K.I.	26	78.8%	43	82.7%	0.65
	Risk for A.K.I.	4	12.1%	6	11.5%	
	A.K.I.	2	6.1%	3	5.8%	
	Failure	1	3.0%	0	0.0%	
	Loss	0	0.0%	0	0.0%	
Stroke	No stroke	29	87.9%	48	92.3%	0.43
	Minor Stroke	2	6.1%	3	5.8%	
	Moderate stroke	1	3.0%	0	0.0%	
	Moderate to severe	0	0.0%	1	1.9%	
	Severe Stroke	1	3.0%	0	0.0%	
Reexploration For bleeding	Yes	5	15.2%	5	9.6%	0.4
	No	28	84.8%	47	90.4%	
Respiratory complication	Yes	2	6.1%	1	1.9%	0.31
	No	31	93.9%	51	98.1%	
Sternal wound Infection	Yes	1	3.0%	1	1.9%	0.7
	No	32	97.0%	51	98.1%	

A.F.: atrial fibrillation, V.F.: ventricular fibrillation, A.K.I.: acute kidney injuries

The mortality rate and cause of death are explained in (Table 5). The overall hospital mortality (defined as in-hospital death or within 30 days after surgery) was 21.21% in the first group and 1.9% in the second group, with a statistically significant difference among the first and second groups (P-value = 0.003). During short-term follow-up, one patient from group A died due to hepatic failure, and another one from group B died because of a rupture of the descending thoracic aneurysm. Only a patient of Group A and two patients of Group B developed a new attack of A.F. While GITB happened in two patients from Group B and only a patient from the group while one patient from Group B developed a stroke. Overall, the survival rate at one year was 75.8% for Group A and 96.15% for Group B (Table 5).

Table 5: Mortality rate, cause of death, and survival rate

		Diagnoses		
		STAAD	**ASAA**	**P- value**
Mortality rate (in the hospital or within 30 days)		21.2%	1.9%	0.003
	Multiorgan failure (N=3)	2	1	

Cause of early Mortality	Bleeding and D.I.C. (N=2)	2		
	Not weaned from the C.P.B. machine (N=2	2		
	Severe stroke (N=1)	1		
Survival rate at in 1 year		75.8%	96.2%	0.004

D.I.C.: Disseminated intravascular coagulation, C.P.B.: cardiopulmonary bypass

4. DISCUSSION

The most dangerous type of aortic pathology that presents in an acute manner is aortic dissection. When acute ascending aortic dissection goes undiagnosed and untreated, the risk of morbidity and death among patients is very high. Aneurysms of the aorta are vessel expansions due to medial weakening, and they do not have any signs and symptoms. For this reason, they are diagnosed incidentally when searching for other diseases. On the other hand, ascending aortic dissections must be differentiated from aneurysms of the aorta in specific ways. Aortic operations have attained outstanding expertise and efficiency. Now, we can replace each part of the aortic in open and thoracic endovascular aortic repair. [?]

To avoid catastrophic complications of an aortic dissection, aneurysms of the ascending aorta are electively operated on according to the size and cause of the aneurysm. In our study, the mean age of the patients who underwent ascending aortic replacement was (54.5 ± 9.8 and 52.45 ±10.8) for STAAD and ASAA, respectively, which is younger compared to a study done by McClure at al. [21]. On the other hand, the major causes for the development of ascending aortic dissection or aneurysm are hypertension, male sex, bicuspid aortic valve, diabetes mellitus, and dyslipidemia; these findings are in line with those of Gudbjartsson, Tomas, et al. [22]; Saliba, Emile, at al. [8]; and Hernandez-Vaquero, Daniel, et al. [16].

Regarding the CPBT and aortic ACCT, there was a significant difference between the two studied groups with a (p-value <0.05). CPBT and ACCT were (207 ± 49 and 144 ± 37) respectively, for group A and it was shorter compared to another research, such as that of Lu et al. [23]. In contrast, B. Chiappini et al. [17] reported a shorter duration of CPBT and ACCT than our study. On the other hand, CPBT and ACCT were (177 ±51 and 125 ±39) respectively for group B, which was a slightly longer duration than a study done in Spain by Hernandez-Vaquero, Daniel, et al. [16] and a study conducted in German by Kallenbach, Klaus, et al. [24]. The reason for the slightly longer duration in Group B compared to previous studies was that most patients had aortic root dilatation and needed complex surgery like Bentall or SCAAR+AVR. Our results have shown statistical differences in early postoperative mortality rates between the two groups (P-value = 0.003). Early operative mortality for group A was 21.2%, which was higher than some other studies, such as that of Lu et al. [23] which was 16.2%.

In contrast, Hagan, Peter G., et al. [26] found that in-hospital mortality was (26%), which was more than our research. Another research from Italy done by D. Paciniet al. [26], showed that early mortality for ascending aortic dissection was 22.1%, which was close to our study. Our study's higher in-hospital mortality rate is related to delays in diagnosis because most patients are referred from primary health care centers or outside governorates and lack proper equipment such as left ventricular assist devices and biological glue. Most studies showed higher in-hospital mortality associated with surgery for ascending aortic aneurysms (4.5- 5.96 %) compared with our study (1.9%) [16, 21, 24]. This high mortality may be due to the total arch replacement involved in that study.

Early postoperative complications were more frequent in group A than in group B except for arrhythmia; these may be due to patients with aortic dissection needing an emergency operation, hypothermic circulatory arrest, more blood transfusions, and the long duration of the operation. The survival rate in the first year was 75.8% and 96.2% for groups A and B, accordingly. There was a significant difference between these two groups (P-value = 0.004), which is slightly higher than in previous studies [16, 26]. During short-term follow-up, only a patient from both group A and group B developed GITB, and stroke happened in only one patient from group B due to inappropriate taking of warfarin and international normalizing ratio (I.N.R.) control.

Strengths: This study includes a clear and detailed comparison of risk factors, intraoperative parameters, postoperative complications, and early and short-term outcomes of dissection and aneurysm of ascending aorta.

Limitation: The sample size of our groups of patients is small, and Stanford type B aortic dissection is not included in our study since no endovascular surgery is done in our center. In addition, this study had a short follow-up.

5. CONCLUSION

The morbidity and mortality for ascending aortic replacement in our study varies according to aortic pathology. Since STAAD is a potentially fatal cardiovascular emergency, so immediate surgical intervention is needed for the patients. The early mortality rate and postoperative complications of ascending aortic replacement in STAAD were higher compared to ASAA replacement. However, the one-year survival rate of STAAD surgery was lower than ASAA surgery.

REFERENCE

[1] P. Komutrattananont, P. Mahakkanukrauh, and S. Das, “Morphology of the human aorta and age-related changes: anatomical facts,” Anatomy & Cell Biology, vol. 52, no. 2, pp. 109–114, Jun. 2019, doi: 10.5115/acb.2019.52.2.109.

[2] H. J. White, S. Bordes, and J. Borger, “Anatomy, Abdomen and Pelvis, Aorta,” PubMed, 2020. https://www.ncbi.nlm.nih.gov/books/NBK537319/

[3] H. Murillo, M. J. Lane, R. Punn, D. Fleischmann, and C. S. Restrepo, “Imaging of the Aorta: Embryology and Anatomy,” Seminars in Ultrasound, CT and MRI, vol. 33, no. 3, pp. 169–190, Jun. 2012, doi: 10.1053/j.sult.2012.01.013.

[4] D. Kamalakannan, H. S. Rosman, and K. A. Eagle, “Acute Aortic Dissection,” Critical Care Clinics, vol. 23, no. 4, pp. 779–800, Oct. 2007, doi: 10.1016/j.ccc.2007.07.002.

[5] I. A. De León Ayala and Y.-F. Chen, “Acute aortic dissection: An update,” The Kaohsiung Journal of Medical Sciences, vol. 28, no. 6, pp. 299–305, Jun. 2012, doi: 10.1016/j.kjms.2011.11.010.

[6] R. S. Elsayed, R. G. Cohen, F. Fleischman, and M. E. Bowdish, “Acute Type A Aortic Dissection,” Cardiology Clinics, vol. 35, no. 3, pp. 331–345, Aug. 2017, doi: 10.1016/j.ccl.2017.03.004.

[7] S. Upadhye and K. Schiff, “Acute Aortic Dissection in the Emergency Department: Diagnostic Challenges and Evidence-Based Management,” Emergency Medicine Clinics of North America, vol. 30, no. 2, pp. 307–327, May 2012, doi: 10.1016/j.emc.2011.12.001.

[8] E. Saliba, Y. Sia, A. Dore, and I. El Hamamsy, “The ascending aortic aneurysm: When to intervene?” IJC Heart & Vasculature, vol. 6, pp. 91–100, Mar. 2015, doi: 10.1016/j.ijcha.2015.01.009.

[9] J. K. Ehrman, A. B. Fernandez, J. Myers, P. Oh, P. D. Thompson, and S. J. Keteyian, “Aortic Aneurysm,” Journal of Cardiopulmonary Rehabilitation and Prevention, vol. 40, no. 4, pp. 215–223, Jul. 2020, doi: 10.1097/hcr.0000000000000521.

[10] M. J. Salameh, J. H. Black, and E. V. Ratchford, “Thoracic aortic aneurysm,” Vascular Medicine, vol. 23, no. 6, pp. 573–578, Oct. 2018, doi: 10.1177/1358863x18807760.

[11] P. D. Patel and R. R. Arora, “Pathophysiology, diagnosis, and management of aortic dissection,” Therapeutic Advances in Cardiovascular Disease, vol. 2, no. 6, pp. 439–468, Sep. 2008, doi: 10.1177/1753944708090830.

[12] E. L. Meredith and N. D. Masani, “Echocardiography in the emergency assessment of acute aortic syndromes,” European Journal of Echocardiography, vol. 10, no. 1, pp. i31–i39, Jan. 2009, doi: 10.1093/ejechocard/jen251.

[13] D. MUKHERJEE and K. EAGLE, “Aortic Dissection—An Update,” Current Problems in Cardiology, vol. 30, no. 6, pp. 287–325, Jun. 2005, doi: 10.1016/j.cpcardiol.2005.01.002.

[14] C. R. Bonnichsen et al., “Aneurysms of the ascending aorta and arch: the role of imaging in diagnosis and surgical management,” Expert Review of Cardiovascular Therapy, vol. 9, no. 1, pp. 45–61, Jan. 2011, doi: 10.1586/erc.10.168.

[15] S. Trimarchi et al., “Contemporary results of surgery in acute type A aortic dissection: The International Registry of Acute Aortic Dissection experience,” The Journal of Thoracic and Cardiovascular Surgery, vol. 129, no. 1, pp. 112–122, Jan. 2005, doi: 10.1016/j.jtcvs.2004.09.005.

[16]D. Hernandez-Vaquero et al., “Life Expectancy after Surgery for Ascending Aortic Aneurysm,” Journal of Clinical Medicine, vol. 9, no. 3, p. 615, Feb. 2020, doi: 10.3390/jcm9030615.

[17] B. Chiappini, M. Schepens, and E. Tan, “Early and Late Outcomes of Acute Type A Aortic Dissection: Analysis of Risk Factors in 487 Consecutive Patients,” ACC Current Journal Review, vol. 14, no. 5, p. 45, May 2005, doi: 10.1016/j.accreview.2005.04.038.

[18] Z. S. Meharwal, S. N. Khanna, A. Choudhary, M. Mishra, Y. Mehta, and N. Trehan, “Ascending Aortic Aneurysm Resection: 15 Years’ Experience,” Asian Cardiovascular and Thoracic Annals, vol. 14, no. 4, pp. 300–305, Aug. 2006, doi: 10.1177/021849230601400407.

[19] “NIH Stroke Scale: National Institutes of Health (NIH) Stroke Scale,” eMedicine, Jun. 2022, Accessed: Sep. 20, 2022. [Online]. Available: https://emedicine.medscape.com/article/2172609-overview.

[20] J. A. Lopes and S. Jorge, “The RIFLE and AKIN classifications for acute kidney injury: a critical and comprehensive review,” Clinical Kidney Journal, vol. 6, no. 1, pp. 8–14, Jan. 2013, doi: 10.1093/ckj/sfs160.

[21] R. S. McClure, S. B. Brogly, K. Lajkosz, D. Payne, S. F. Hall, and A. P. Johnson, “Epidemiology and management of thoracic aortic dissections and thoracic aortic aneurysms in Ontario, Canada: A population-based study,” The Journal of Thoracic and Cardiovascular Surgery, vol. 155, no. 6, pp. 2254-2264.e4, Jun. 2018, doi: 10.1016/j.jtcvs.2017.11.105.

[22] T. Gudbjartsson et al., “Acute type A aortic dissection – a review,” Scandinavian Cardiovascular Journal, vol. 54, no. 1, pp. 1–13, Sep. 2019, doi: 10.1080/14017431.2019.1660401.

[23] Y. Lu et al., “Management strategy of Type A Aortic Dissection in a developing center from China: 16 years experiences,” Journal of Thoracic Disease, vol. 12, no. 11, pp. 6780–6788, Nov. 2020, doi: 10.21037/jtd-20-1866.

[24] K. Kallenbach et al., “Treatment of ascending aortic aneurysms by different surgical techniques: Comparison of early and long-term results,” The Thoracic and Cardiovascular Surgeon, vol. 60, no. S 01, Jan. 2012, doi: 10.1055/s-0031-1297910.

[25] P. G. Hagan et al., “The International Registry of Acute Aortic Dissection (IRAD),” JAMA, vol. 283, no. 7, p. 897, Feb. 2000, doi: 10.1001/jama.283.7.897.

[26] D. Pacini et al., “Acute aortic dissection: Epidemiology and outcomes,” International Journal of Cardiology, vol. 167, no. 6, pp. 2806–2812, Sep. 2013, doi: 10.1016/j.ijcard.2012.07.008.