World Journal of Vascular Surgery

Research Article
Published: 01 Oct, 2018

Infected Aortic Aneurysm: Experience of Phramongkutklao Army Hospital

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Abstract

Introduction: Infected Aortic Aneurysm (IAA) is rare condition but has high mortality rate. Open surgical repair is goal standard treatment of IAA, however, in the last decades; endovascular treatment became the alternative treatment for high risk patients and preferred treatment in many centers. The aim of this study was to evaluate the predictive factors of persistent infection and mortality rate, and to report outcome of endovascular treatment.

Method: This study was retrospective analysis of 40 consecutive IAA patients undergoing treatment in single center from 2008 to 2017. Demographic data, clinical presentation, imaging characteristic and treatment were analyzed by univariate and multivariate logistic regression to assess risk factors of poor treatment outcome. Cumulative survival rate was calculated by Kaplan Meier method.

Result: We identified 31 patients with the average age of 66 years (40 years to 89 years), 26 out of 31 (83.9%) patients were male. The most common presentations were abdominal or back pain, fever and shock (90.3%, 41.9% and 38.7% respectively). Bacterial hemoculture was positive in only 41.3% of patients and the two most common pathogens identified were *Staphylococcus aureus* (19.4%) and Salmonella group D species (16.1%). Most common location of aneurysm was infrarenal type (87.1%). Persistent infection was only one third of cases. The presences of shock and aortoenteric fistula were the predictive factors of persistent infection. There were increasing mortality rate in patients with COPD, leukocytosis (WBC >10,000 cell/cm^3), positive bacterial hemoculture especially *Staphylococcus aureus* and Salmonella group D species, and imaging characteristic of periaortic gas. Endovascular treatment improved survival rate significantly.

Conclusion: IAA has high mortality and was highly concerned for persistent infection. Presentation of shock was the predictive factors of persistent infection and higher mortality rate. Endovascular treatment was the appropriate alternative treatment for IAA and improved survival rate compared with conventional open treatment.

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Received Date: *31 Aug 2018*
Accepted Date*: 27 Sep 2018*
Published Date*: 01 Oct 2018*

Citation:
Taengsakul N, Boontham P. Infected Aortic Aneurysm: Experience of Phramongkutklao Army Hospital. World J Vasc Surg. 2018; 1(2): 1011.

Introduction

Infected Aortic Aneurysm (IAA) is rare condition but has high mortality rate. Incidence of IAA was around 0.65% to 2% of abdominal aortic aneurysm cases in European country but was reported higher in Asian country [1-5]. IAA carries a very poor prognosis because it has a tendency to grow rapidly and rupture [4]. The patients with IAA usually had severe morbidities, particularly immunodeficiency disease and co-existing sepsis. Conventional open treatment of aneurysm resection and extensive debridement followed by revascularization with *in situ* reconstruction or extra anatomical bypass is a gold standard but carries high morbidity and mortality rate [6-9]. Furthermore, anatomic location of aneurysm sometimes made aneurysmal reconstruction more difficult or impossible [10]. Endovascular treatment has been alternative modality for IAA treatment for few decades [11]. Comparing with open surgical treatment, endovascular surgery was less invasive and more advantage in term of reducing perioperative morbidity and mortality rate in high risk patients. However, major disadvantage of endovascular surgery was the left behind infected tissue including the aneurysm itself. This may lead to recurrent infection and infected endograft [12].

The aim of this study was to examine contemporary management of IAAA including open debridement (*in situ* reconstruction, aortic stump closure and extra anatomical bypass) and endovascular surgery in single center with 9 year experience.

Method

All IAA patients treated at Phramongkutklao Hospital from 2008 to 2017 were identified.

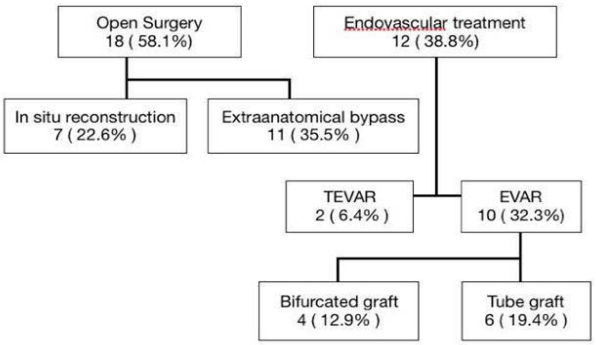

Figure 1: Percentage and number of cases for treatment option.

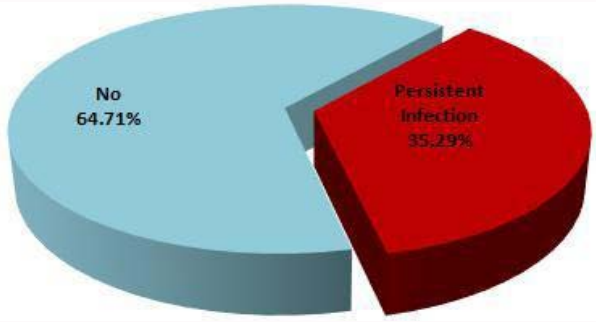

Figure 2: Proportion between persistent infection and no persistent infection.

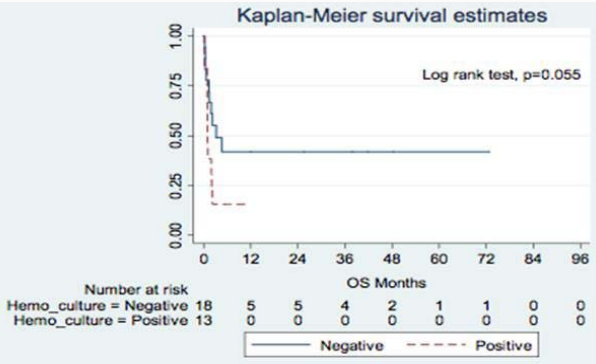

Figure 3: Kaplan Meier survival between Negative and positive hemoculture.

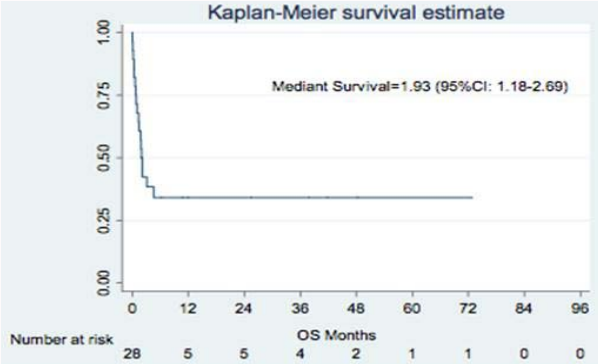

Figure 4: Kaplan Meier survival of Infected Aortic Aneurysm (IAA).

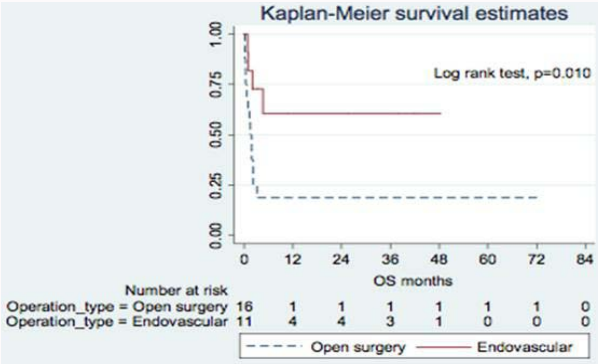

Figure 5: Kaplan Meier survival of Infected Aortic Aneurysm (IAA) patients between open surgery and endovascular.

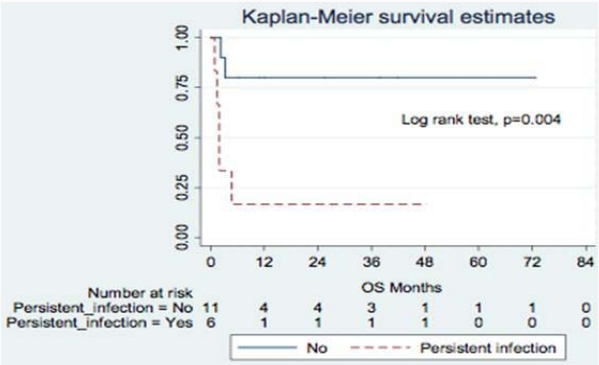

Figure 6: Kaplan Meier survival between No persistent infection and persistent infection.

IAA was defined as the presence of two or more of the followings. 1) Sepsis defined as fever (body temperature >37.5°C), leukocytosis (White blood cell >10,000 cell/cm^3) and pain. 2) Positive bacterial hemoculture. 3) Positive bacterial tissue culture from aneurysmal wall or thrombus, positive radiographic appearance of irregular aortic wall, rapid growth rate, saccular appearance of aneurysm and periaortic gas.

All patients were received antibiotics preoperatively and postoperatively. Initial antibiotics was intravenous broad spectrum antibiotic and then converted to specific antibiotics guided by result of bacterial culture in case of positive culture. Patients with negative culture were received broad spectrum antibiotics based on clinical suspicion of infective agent. In case of patient's vital sign was stable and considered to do intervention, a preoperative antibiotic was given until negative bacterial hemoculture or patient had no fever. If patient presented unstable vital sign, clinical of severe sepsis or clinical of aneurysmal rupture, patients were considered to do urgency treatment with intervention and single dose of preoperative antibiotics. After patients were discharged from hospital, they were prescribed lifelong oral antibiotics.

All of cases were retrospectively reviewed. Patient's demographic data and clinical presentation include sex, age, past medical history, immunodeficiency status; laboratory blood tests and bacterial culture were collected. Aneurysmal characteristics include status, location, specific computed tomographic findings such as rapid expansion, saccular appearance, multilobular and periaortic gas were also recorded. Surgical treatment given to patients was defined as endovascular, sub-classified as AUI with femorofemoral crossover, bifurcation graft, tube graft include name of stent Graft Company, open debridement with *in situ* reconstruction or extra anatomical bypass. Given antibiotics course include type, timing and duration

Table 1: Demographic data.

Variables	n	Mean ± SD. or n (%)	Median [min, max]
Age	31	66.19 ± 11.22	66 [40, 89]
<65 yr		11 (35.5%)	
≥ 65 yr		20 (64.5%)	
Sex			
Male		26 (83.9%)	
Female		5 (16.1%)	
Co-morbidity			
Hypertension		21 (67.7%)	
Ischemic heart disease		4 (12.9%)	
Cerebrovascular disease		1 (3.2%)	
COPD		1 (3.2%)	
DM		4 (12.9%)	
Steroid use		2 (6.5%)	
CKD (Cr >2)		1 (3.2%)	
HIV infection		2 (6.5%)	
Clinical presentation			
Fever		13 (41.9%)	
Pain		28 (90.3%)	
Circulatory shock (SBP <90 mmHg)		12 (38.7%)	
Concurrent infection		1 (3.2%)	
Laboratory results			
C-Reactive Protein level	2	99 ± 76.37	99 [45, 153]
WBC count	31	13425.81 ± 6572.62	11400 [4900, 29600]
<10,000		10 (32.3%)	
≥ 10,000		21 (67.7%)	
Hemoculture result (n=30)			
Positive Hemoculture		13 (41.9%)	
S. aureus		6 (19.4%)	
Salmonella gr. D		5 (16.1%)	
Klebsiella pneumoniae		1 (3.2%)	
Burkholderia pseudomallei		1 (3.2%)	
No growth		18 (58.1%)	
Tissue culture (n=13)		13 (41.9%)	
Tissue culture result			
No growth		10 (32.3%)	
S. aureus		2 (6.5%)	
Salmonella gr. D		2 (6.5%)	
Location of aneurysm			
Ascending aorta		0 (0%)	
Descending aorta		3 (9.7%)	
Suprarenal aorta		2 (6.5%)	
Pararenal aorta		1 (3.2%)	
Infrarenal aorta		27 (87.1%)	
Iliac artery		2 (6.5%)	
Size of aneurysm	31	6.66 ± 2.75	7 [0, 14]
CT characteristic			

Rapid expansion		1 (3.2%)	
Saccular shape		24 (77.4%)	
Multilobular		4 (12.9%)	
Periaortitis (fat standing)		21 (67.7%)	
Periaortic gas		1 (3.2%)	
Operation			
Open surgery (*in situ* reconstruction)		7 (22.6%)	
Open Surgery (extra-anatomical bypass)		11 (35.5%)	
EVAR (bifurcated graft)		4 (12.9%)	
EVAR (AUI/tube graft)		6 (19.4%)	
TEVAR		2 (6.5%)	
Preoperative ATB (days)	29	5 ± 7.71	1 [0, 23]
Type of antibiotic			
PGS		1 (3.2%)	
Cef-3		22 (71%)	
Ceftazidime		2 (6.4%)	
Amoxicillin/clavulanate		1 (3.2%)	
Piperacilin/tazobactam		2 (6.5%)	
Sulperazone		1 (3.2%)	
Imipenem		1 (3.2%)	
Course of antibiotic (days)		129.43 ± 315.18	36.5 [1, 1474]
Mortality rate		21 (67.7%)	
Cause of death			
Pneumonia		4 (12.9%)	
Hepatic failure		1 (3.2%)	
Myocardial infarction		3 (9.7%)	
Transfusion related acute lung injury (TRALI)		1(3.2%)	
Sepsis		5 (16.1%)	
UGIB		1 (3.2%)	
Massive hemoptysis		1 (3.2%)	
Cardiac arrest		1 (3.2%)	
Perioperative mortality		13 (41.9%)	
Pneumonia		4 (12.9%)	
Hepatic failure		1 (3.5%)	
Myocardial Infarction		3 (9.7%)	
Transfusion related acute lung injury (TRALI)		1 (3.2%)	
Sepsis		2 (6.5%)	
Perioperative complication			
Disseminated intravascular coagulopathy		1 (3.2%)	
Acute kidney injury		2 (6.5%)	
Abdominal compartment syndrome		1 (3.2%)	
Femoral artery injury		1 (3.2%)	
Distal embolization		1 (3.2%)	
Graft thrombosis		1 (3.2%)	
Duodenal stump leakage		2 (6.5%)	
Bowel ischemia		1 (3.2%)	
Infection related complication			
Aortoenteric fistula		7 (22.6%)	

Paravertebral abscess		1 (3.2%)	
Aortobronchial fistula		1 (3.2%)	
Follow up time		390.86 ± 603.84	80 [8, 2220]
Re-intervention			
Exclusion endograft		1 (3.2%)	

were recorded. Follow up timing, clinical outcome and complications were included into patients' data.

Definition of persistent infection was clinically sepsis, aortoenteric fistula, infected endograft and recurrent new infected aortic aneurysm [2,13-15].

Factors influenced persistent infections were analyzed by independent t-test. Survival analysis was performed according to Kaplan Meier method. Univariable cox regression risk factor analysis was performed by using statistical software (SPSS version 22, IBM Corporation®, Armonk, New York).

Result

Thirty one IAA patients were identified. Demographic data, clinical presentation, laboratory test results and treatment were shown in Table 1. Mostly of IAA patients were older than 65 years (40-89 years, mean 66.19 ± 11.2 years). Male patients were more than female (83.9% *vs.* 16.1%). Most common comorbidity was hypertension (67.7%). Immunodeficiency status include Human Immunodeficiency Virus (HIV) infection and steroid usage were found about 13% (HIV infection was 6.5% and steroid usage was 6.5%). Clinical presentation of IAA patients were abdominal pain or back pain (90.3%), fever (41.9%) and shock (38.7%). We found that white blood cell count was 4,900 to 29,600 (mean 13,425.81 ± 6572 cell/cm^3). Positive bacterial hemoculture was only 41.9% in our series. Two most common pathogen were *Staphylococcus aureus* (19.4%) and Salmonella group D species (16.1%). Positive bacterial tissue culture was found only 4 out of 13 cases. Locations of aneurysm were found mostly infrarenal type (87.1%). Mean size of aneurysm was 6.66 ± 2.75 cm. Two most common computed tomographic characteristic findings were saccular shape (77.4%) and periaortitis (67.7%). Mean duration of preoperative antibiotics was 5 ± 7.71 days, most common antibiotics was Ceftriaxone. The mean duration of antibiotic treatment was 129.43 ± 315 days. The mean of follow up timing was 390.86 ± 60.84 day (8 days to 2,220 days). As we were shown in Figure 1, Treatment was open surgical treatment in 18 patients (58.1%) and endovascular treatment in 12 patients (38.8%). There were 3 stent graft companies in our series (66.7% Zenith®, 16.67% Endurant®, 8.3% Treovance®). There was one case unable to identify stent Graft Company. Perioperative mortality rate was 35.5% which most common cause of death was pneumonia and myocardial infarction. Infection related complications were aortoenteric fistula (22.6%), paravertebral abscess (3.2%) and aortobronchial fistula (3.2%). Aortoenteric fistula was mainly treated by open surgery with extra anatomical bypass (5/7), open surgery with *in situ* reconstruction (1/7) and only one case was treated by endovascular procedure. There were two cases of aortoenteric fistula with open surgery with extraantomical bypass that was duodenal stump leakage. One case of aortoenteric fistula with endovascular treatment was persistent infection and lead to exclusion endograft at 10 months later.

For persistent infection, there were one third of cases in this series as we were shown in Figure 2. In Table 2, we found that factors significantly related to persistent infection were ruptured aneurysm with shock (P=0.028) and aortoenteric fistula (P=0.029). Persistent infection was significantly related to overall mortality rate (P=0.035), patients without persistent infection had mean survival time of 58.8 months while patients with persistent infection had mean survival time of 9.8 months. Persistent infection increased mortality rate of 8.12 times.

Six of nine patients with infection related complication expired, 4 cases expired perioperatively and 2 cases expired later. There was one patient and extracted stent graft from infected endograft. Patients with aortoenteric fistula and aortobronchial fistula related to high mortality rate (50% expired perioperatively and 20% expired later) and persistent infection (25%). Only one case with aortoenteric fistula survived, treated by endovascular treatment, but underwent lifelong oral antibiotic treatment. Mean time of antibiotic treatment for cases with infection related complication was 411 days.

In Table 3, we found that factors related to mortality rate were comorbidity disease especially chronic obstructive pulmonary disease (P=0.012), presentation of shock (P=0.008), leukocytosis (P=0.002). In Figure 3 positive bacterial hemoculture increased mortality rate more than two times. Two identified pathogens significantly related to mortality rate were *Staphylococcus aureus* (P=0.001) and Salmonella group D species (0.026). Computed tomographic characteristics related to mortality rate were saccular type aneurysm (P=0.037) and periaortic gas (P=0.026). Median survival time of IAA patients was 1.93 month as we had shown in Figure 4. Patients treated with conventional open surgery had mean survival time of 13.2 month when patients treated with endovascular treatment had mean survival time of 30.2 month as we were shown in Figure 5. Endovascular treatment significantly improved survival rate of IAA patients (P=0.018). In Figure 6, we found that No persistent infection group significantly improved survival rate of IAA patients (P=0.004).

Discussion

IAA is rare disease and it's management remains challenging [2]. Open surgical repair has been widely accepted as gold standard treatment. This approach carried a significant hospital mortality risk up to 20% to 40% and 5-year survival rate was 30% to 50%, while late graft infection occurred 7% to 10% of cases [1,2,6,7,16-22].

Minimally invasive approach by means of endovascular technique made the possibility of treatment in patients unsuitable for major surgery. However, the endovascular technique for treatment of IAA has been regarded with doubtful because the procedure did not remove the infected tissue. Moreover, the risk of recurrent and persistent infection may raised. Major advantage of endovascular treatment was to prevent hemodynamic compromise by sealing the aortic leakage, there after eradicated infection with specific antibiotics. It became to be preferred treatment option in high risk patients. In many review, endovascular treatment gave result of 30 day and 5 year survival rate of 90% and 53% respectively [23].

Preferred operative technique was shifted from conventional open

Table 2: Factor that influencing persistent infection.

Variables	Persistent Infection (n=6)	No (n=11)	OR (95% CI)	P-Value
Age				
<65 yr	2 (33.3%)	6 (54.5%)	0.56 (0.14, 2.29)	0.62
≥ 65 yr	4 (66.7%)	5 (45.5%)	1.78 (0.44, 7.25)	0.62
Sex				
Male	5 (83.3%)	10 (90.9%)	0.67 (0.14, 3.17)	1
Female	1 (16.7%)	1 (9.1%)	1.5 (0.32, 7.14)	1
Co-morbidity				
Hypertension	5 (83.3%)	8 (72.7%)	1.54 (0.25, 9.6)	1
Ischemic Heart Disease Cerebrovascular	1 (16.7%)	1 (9.1%)	1.5 (0.32, 7.14)	1
Disease	0 (0%)	0 (0%)	NA (NA, NA)	NA
COPD	0 (0%)	0 (0%)	NA (NA, NA)	NA
DM	1 (16.7%)	1 (9.1%)	1.5 (0.32, 7.14)	1
Steroid use	0 (0%)	1 (9.1%)	0 (0, 1)	1
CKD (Cr>2)	0 (0%)	0 (0%)	NA (NA, NA)	NA
HIV infection	1 (16.7%)	0 (0%)	3.2 (1.55, 6.62)	0.353
Clinical presentation				
Fever	3 (50%)	4 (36.4%)	1.43 (0.4, 5.12)	0.644
Pain	6 (100%)	8 (72.7%)	0 (0, 1)	0.515
Circulatory shock (SBP <90 mmHg)	4 (66.7%)	1 (9.1%)	4.8 (1.26, 18.31)	0.028*
Concurrent infection	0 (0%)	1 (9.1%)	0 (0, 1)	1
Laboratory result				
WBC count				
<10,000	2 (33.3%)	6 (54.5%)	0.56 (0.14, 2.29)	0.62
≥ 10,000	4 (66.7%)	5 (45.5%)	1.78 (0.44, 7.25)	0.62
Positive hemoculture	2 (33.3%)	2 (18.2%)	2.25 (0.23,22.14)	0.487
CT characteristic				
Rapid expansion	0 (0%)	1 (9.1%)	0 (0, 1)	1
Saccular shape	5 (83.3%)	10 (90.9%)	0.67 (0.14, 3.17)	1
Multilobular	1 (16.7%)	1 (9.1%)	1.5 (0.32, 7.14)	1
Periaortitis (fat standing)	4 (66.7%)	6 (54.5%)	1.4 (0.35, 5.65)	1
Periaortic gas	0 (0%)	0 (0%)	NA (NA, NA)	NA
Operation type				
Open surgery	4 (66.7%)	5 (45.5%)	1.78 (0.44, 7.25)	0.62
Endovascular	2 (33.3%)	6 (54.5%)	0.56 (0.14, 2.29)	0.62
Preoperative antibiotics (days)	1 [0-2]	1 [0-23]	0.8 (0.5, 1.3)	0.371
Total course of antibiotic (days)	44 [30-1474]	90 [13-1014]	1 (1, 1)	0.505
Perioperative mortality Infection related complication	1 (16.7%)	1 (9.1%)	1.5 (0.32, 7.14)	1
Aortoenteric fistula	3 (50%)	0 (0%)	4.67 ((1.71, 12.72)	0.029*
Aortobronchial fistula	1 (9.1%)	0 (0%)	0 (0, 1)	1
Paravertebral abscess	0 (0%)	1 (9.1%)	0 (0, 1)	1

repair to endovascular treatment after 2001. The rate of endovascular treatment was zero from 1994 to 2000, raised into fifty-five percent and sixty percent in 2001 to 2007 and 2008 to 2014 respectively. The recent study of Sorelius et al. [12], the largest study of IAA, reported 132 IAA patients treated with open surgical treatment and endovascular treatment. 3 months survival rate was significantly lower in conventional open repair group than endovascular group (74% *vs.* 96%, P<0.001). One year survival rate was still significantly lower in open repair group (73% *vs.* 84%, P=0.054). However, there was no difference in 5-year survival rate (60% *vs.* 58%, P=0.771), infection related complications (18% *vs.* 24%, P=0.439) and re-operation (21% *vs.* 24%, P=0.650). This study preferred endovascular treatment in which improved short term survival rate together with not higher serious infection related complications.

There were studies of IAA in asia, Kan et al. [21] reported that

Table 3: Factor that influencing mortality.

Variables	HR (95% CI)	p-value
Age	1.01 (0.97, 1.05)	0.528
<65 yr	1	Reference
≥ 65 yr	1.29 (0.52, 3.2)	0.588
Sex		
Male	1	Reference
Female	1.99 (0.71, 5.57)	0.189
Co-morbidity		
Hypertension	0.96 (0.39, 2.4)	0.937
Ischemic Heart Disease	1.67 (0.49, 5.77)	0.414
Cerebrovascular Disease	7.13 (0.8, 63.82)	0.079
COPD	19.66 (1.94, 198.84)	0.012*
DM	1.31 (0.38, 4.45)	0.67
Steroid use	1.48 (0.34, 6.41)	0.598
CKD (Cr >2)	2.2 (0.28, 17.09)	0.45
HIV infection	2.98 (0.67, 13.24)	0.152
Clinical presentation		
Fever	0.98 (0.41, 2.34)	0.972
Pain	26.96 (0.16, 4639.13)	0.21
Circulatory shock (SBP <90 mmHg)	3.35 (1.38, 8.11)	0.008*
Concurrent infection	0.05 (0, 207.3)	0.472
Laboratory result		
WBC count	1 (1, 1)	0.005*
<10,000	1	Reference
≥ 10,000	3.6 (1.2, 10.81)	0.002*
Hemoculture result		
Positive Hemoculture	2.52 (1.06, 6)	0.036*
S. aureus	5.79 (1.97, 17.03)	0.001*
Salmonella gr. D	3.72 (1.17, 11.79)	0.026*
Klebsiella pneumoniae	0 (0, 1)	0.987
Burkhodoria pseudomallei	0 (0, 1)	0.987
No growth	1	Reference
Tissue culture result		
No growth	1	Reference
S. aureus	1.99 (0.4, 9.97)	0.401
Salmonella gr. D	1.89 (0.36, 9.81)	0.451
Location of aneurysm		
Descending aorta	0.75 (0.17, 3.22)	0.695
Suprarenal aorta	1.25 (0.29, 5.44)	0.763
Pararenal/ Juxtarenal aorta	0.98 (0.13, 7.38)	0.986
Infrarenal aorta	1.51 (0.44, 5.18)	0.512
Iliac artery	0.04 (0, 17.91)	0.302
Size of aneurysm	1.09 (0.93, 1.28)	0.294
CT characteristic		
Rapid expansion	0.05 (0, 322.51)	0.495
Saccular shape	0.35 (0.13, 0.94)	0.037*
Multilobular	1.57 (0.52, 4.7)	0.423
Periaortitis (fat standing)	2.01 (0.73, 5.54)	0.176
Periaortic gas	15.19 (1.37, 167.76)	0.026*
Type of operation		
Open surgery (*in situ* reconstruction)	1.76 (0.64, 4.87)	0.275
Open surgery (Extra-anatomical bypass)	1.7 (0.71, 4.08)	0.231
EVAR (bifurcated graft)	0.22 (0.03, 1.64)	0.139
EVAR (AUI/tube graft)	0.32 (0.07, 1.37)	0.124
TEVAR	0.41 (0.05, 3.09)	0.387
Persistent infection	8.12 (1.55, 42.64)	0.013*
Operation type		
Open surgery	1	Reference
Endovascular	0.26 (0.09, 0.79)	0.018*

IAA patients treated with endovascular treatment had 30-day survival rate of 89.6% and 2-year survival rate of 82.2%. By univariate analysis, age 65 years and older, rupture of aneurysm including those with aortoenteric fistula and aortobronchial fistula, and fever at the time of operation were identified as significant predictors of persistent infection and preoperative use of antibiotics for longer than 1 week. Adjunct procedure combined with endovascular treatment was also identified as significant protective factor of persistent infection by univariate analysis. However, by multivariate logistic regression analysis, significant independent predictive factors of persistent infection were the ruptured of aneurysm and fever at the time of operation [22]. The recent study in Asia, Luo et al. [23], reported long term outcome of endovascular aortic treatment in mycotic aneurysm with cumulative 1 year and 5 year survival rates were 71% and 53% respectively. Persistent or recurrent infection occurred in 20% of cases. Patients with persistent infection were treated with long-term medical therapy, but all cases expired within 6 months of the treatment. There was better survival rate in patients with negative bacterial culture [23].

In Thailand, there were many reports of pathogen and treatment of IAAA. For pathogen, many case reports mentioned about Mellioidosis (Burkhodoria pseudomallei), also reported from Brazil and South Korea but not common in Europe [24,25]. One case report of *Streptococcous* suis was from northern of Thailand [26]. These pathogen reports were diversity in Thailand. For endovascular treatment of IAAA, there were 2 case series reported. First were from southern of Thailand [27], Kritpracha et al. [27]. This study classified patients in fistula and non-fistula group. The overall in-hospital mortality rate was 19%. In-hospital mortality rate was 60% in the fistula group and only 6% in the non-fistula group. During follow-up period, one of two survivors in the fistula group expired at 18 months from unrelated cause, while there were no expired cases in all 15 patients of non-fistula group, with an average follow-up timing of 22 months (range 1 month to 54 months). There was no late conversion. Bacterial hemoculture was positive in 10 patients (48%), 8 patients for Salmonella species and 2 patients for Burkholderia pseudomallei. They concluded that endovascular treatment was providing excellent short and mid-term outcome in non-fistula group but poorer outcome in fistula group. Another case series was from northern of Thailand, Laohapensang et al. [28], found that common pathogens of IAAA were Salmonella species (5 cases), *Escherichia coli* (2 cases) and *Burkholderia pseudomallei* (2 cases). Forty-four percent of the patients presented with ruptured aneurysm were needed emergency surgery. There was no 30 days mortality or significant morbidity. Three patients had infected stent grafts at 10, 26 and 36 months

respectively after endovascular surgery, subsequently treated with computed tomography guided percutaneous tube drainage and 2 patients needed later stent graft explanation. The immediate results of endovascular treatment for IAA were fair with no 30 days mortality with few complications. The midterm results are not satisfied due to rate of infected stent graft as high as 33.33%.

In this report, there were 31 cases of IAA patients. Three most common co-morbidities were hypertension, diabetes mellitus and ischemic heart disease. Immuno compromised patients were steroid use 6.5% and Human immunodeficiency virus infection 6.5%. Common clinical presentation were abdominal pain or back pain (90.3%), fever (41.9%) and shock 38.7%. Leukocytosis (white blood cell count >10,000 cell/cm^3) was found in two third of cases. Positive bacterial hemoculture was 41.9%, four pathogens were identified (*Staphylococcus aureus* 19.4%, Salmonella group D species 16.1%, *Klebsiella pneumoniae* 3.2% and *Burkholderia pseudomallei* 3.2%). Bacterial tissue culture was sent in only 13 cases and positive culture was 4 out of 13 cases (*Staphylococcus aureus* 2 cases and almonella group D species 2 cases). Most common location of aneurysm was infrarenal type. Common computed tomography characteristic finding were saccular shape 77.4% and periaortitis 67.7%. Endovascular treatment was done in forty percent of cases and open surgical treatment was for sixty percent of cases. The mean of preoperative antibiotics treatment was 5 ± 7 days and most of cases received third-generation cephalosporin (71%). There were two cases received ceftazidime because of highly suspicion of Melioidosis infection and two cases received Piperacilin with tazobactam as broad spectrum antibiotics due to clinical of severe sepsis. Total course of antibiotics was 129.43 ± 315 days because of high mortality and loss follow up. Postoperative complication were 2 cases of acute kidney injury from intraopertive hypovolemic shock, 2 cases of duodenal stump leakage after repairing of duodenum in aortoenteric fistula patients, one case of disseminated intravascular coagulation due to massive blood transfusion, one case of bowel ischemia due to prolonged hypovolemic shock after suprarenal aneurysm repair, one case of graft thrombosis that was the same case of bowel ischemia, one case of distal embolization after treated by infrarenal aneurysm open repair with *in situ* reconstruction, and one case of femoral artery injury after treated with percutaneous endovascular aortic repair which need surgical repair. Infection related complication were aortoenteric fistula (22.6%), aortobronchial fistula (3.2%) and paravertebral abscess (3.2%).The mean of follow up time was 390 days. There was one patient only needed exclusion of endograft due to infected endograft.

From earlier study, elderly (age >65 years), ruptured aneurysm including aortoenteric and aortobronchial fistula, and fever at time of operation were risk factors for persistent infection, however, this study, risk factors were presentation of shock (or 4.8; 95% CI 1.26 to 18.31) and aortoenteric fistula (or 4.67; 95% CI 1.71 to 12.72). Although, persistent infection increased mortality rates high as 7.14 times to those without, patients in this study received antibiotics until negative result of bacterial hemoculture and patients had no fever, clinical results were better than earlier study.

In study of Sorelius et al. [2], there was no risk factor for 3 months and 5 years mortality, and study of Luo et al. [23] found that chronic kidney disease and surgical complications were associated with higher mortality rate. In this study, there were many risk factors related to mortality rate, there were chronic pulmonary obstructive disease (P=0.012), shock (P=0.008), leukocytosis (WBC >10,000 cell/cm^3) (P=0.002), positive result of bacterial hemoculture (P=0.055) especially *Staphylococcus aureus* (P=0.001) and Salmonella group D species (P=0.026), computed tomographic characteristic especially saccular type of aneurysm (P=0.037) and periaortic gas (P=0.026) and persistent infection (0.004) [23].

In this study, although endovascular treatment improved short and long term mortality rate (P=0.012) but number of patient treated by open surgery was more because of surgeon preference and unavailability of stent graft at time of emergency operation. For these reasons, more severe case especially patients with shock tend to be treated with conventional surgery. This may influenced the results, so that open surgery group carried worse outcome.

Conclusion

IAA was still high mortality condition and be highly concerned for persistent infection. Presentation of shock was a predictive factor of persistent infection and higher mortality rate. Mortality rate was also higher in patients with chronic obstructive pulmonary disease, leukocytosis (WBC >10,000 cell/cm^3), positive bacterial hemoculture especially *Staphylococcus aureus* and Salmonella group D species) and imaging characteristic of periaortic gas. Endovascular treatment improved survival rate of IAA patients.

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