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Mycotic aortic aneurysms. Epidemiology, etiology, diagnostics and treatment

Arnolda Marija Baškytė[1]

[1] *Lithuanian University of Health Sciences, Academy of Medicine, Kaunas, Lithuania*

Abstract

Infected abdominal aortic aneurysms (IAAAs) or mycotic aortic aneurysms (MAAs) is considered to be one of the most rare and critical disease because of its high mortality and morbidity rate. The most typical pathogens, which cause IAAAs are Staphylococcus, Salmonella and Streptococcus species. The clinical presentation of this uncommon condition is fever with unknown cause, abdominal, chest or back pain, shock symptoms, loss of consciousness and pulsatile mass. The main diagnostic criteria are clinical manifestation, laboratory, radiological and intraoperative findings. The management of MAAs can be divided into three categories: antibiotic therapy, surgery and endovascular repair. Open surgery repair is commonly referred as the gold standard in the treatment of MAAs. Based on different literature sources surgical repair can be divided into aneurysm excision and ligation without arterial reconstruction, excision with immediate reconstruction, excision with interval reconstruction or extraanatomic bypass (EAB) and in situ graft placement.

Keywords: mycotic abdominal aortic aneurysm, infected abdominal aortic aneurysm.

1. Introduction

Infected abdominal aortic aneurysms (IAAAs) also known as mycotic abdominal aortic aneurysms (MAAs) are one of the most difficult and challenging conditions due to its multifarious and non – specific symptoms. In some literature sources it is called microbial arteritis with aneurysm [1]. Although it is infrequent pathology, but it's considered to be critical disease because of its high mortality and morbidity rate. IAAA tends to progress rapidly and rupture unexpectedly, what leads to the patient's death. It is believed, that arterial injuries, antecedent infection, impaired immunity, atherosclerosis, pre - existing aneurysms are the main risk factors for MAAs occurrence [1,2]. However, the most common pathogenesis mechanism is bacterial infection. IAAAs may occur cause of direct bacterial inoculation into the arterial wall after the vascular injury. Another mechanism of pathogenesis may be bacteremic seeding of an existing intimal injury or atherosclerotic plaque. Extension of a contiguous postoperative infection can lead to MAAs too. Especially, the focus of infection can extend after appendectomy, cholecystectomy, colorectal surgery, knee or hip replacement surgery [2]. Other reason may be septic emboli, which from the heart can occlude vessel lumen, what leads to vascular wall infection and MAA formation. So, the purpose of this literature review is to summarize the key data of the infected abdominal aortic aneurysm and to evaluate the diagnostic and treatment options for this rare pathology.

2. Epidemiology

Just 0,7 – 3% of all diagnosed and treated aneurysms are mycotic [3-5]. The most common localization of mycotic aneurysms are the aorta and intracerebral vessels [1]. Some prior researches suggest that the first most often localization is intracerebral vessels, the second is aorta and the third is peripheral blood vessels [6]. The mean age of patients is 67 – 70 years [3,7]. A series of studies have indicated that men are more likely to be sick with MAAs than women [8,9].

3. Etiology

The most typical pathogens, which cause IAAA are Staphylococcus, Salmonella and Streptococcus species. That's bacteria with best affinity for the arterial wall. Staphylococcus aureus is the most common pathogen in Europe followed by Salmonella [1-2,10]. However, Salmonella especially group D species is the most prevalent microorganism in Asia [9, 11]. Salmonella often affects aneurysms with atherosclerotic plaques. MAAs infected with this pathogen are prone to faster progression and have a higher risk of rupture [1]. Other frequent species are Campylobacter and Streptococcus [12]. However, IAAA caused by Streptococcus pneumoniae was much more frequent in the pre - antibiotic era, while Streptococcus pyogenes is extremely rare too [2, 13]. It was reported in literature that, other uncommon pathogens include Treponema pallidum, Mycobacterium spp., Campylobacter Jejuni, Listeria monocytogenes and others [2, 14-15]. Fungal arterial infections are extremely rare, but they can cause MAAs too. Fungal IAAA may occur in patients with immunosuppression,

diabetes mellitus and disseminated fungal infection.

These pathogens include Candida, Cryptococcus, Aspergillus and other species [2]. Table 1 lists the possible pathogens causing MAA described in literature.

Table 1. Pathogens causing MAAs

Common pathogens	Rare pathogens
Staphylococcus spp.	Mycobacterium spp.
Salmonella spp.	Campylobacter spp.
Streptococcus spp.*	Clostridium spp.
	Klebsiella spp.
	Escherichia coli
	Pseudomona spp.
	Treponema pallidum
	Listeria spp.
	Candida, Cryptococcus, Aspergillus

*Streptococcus pneumoniae and Streptococcus pyogenes were common before the pre – antibiotic era, but now are rare.

4. Symptoms and Diagnostics

In the past 17 years, the main diagnostic criteria were: (1) clinical manifestation; (2) laboratory findings; (3) radiological findings; (4) intraoperative findings [16]. The manifestation of MAAs is always with non – specific and general symptoms. In almost all cases patients have fever with unknown cause. Also, clinical presentation may occur as abdominal, chest or back pain, shock symptoms, loss of consciousness and pulsatile mass. Other manifestations include IAAA rupture, expanding intraabdominal retroperitoneal hematoma, which usually cause hypovolemic shock. Infection of abdominal aorta may produce contiguous infection of the lumbar or thoracic vertebra, what leads to osteomyelitis. Acute ischemia of the lower limb, intraabdominal abscess, compression of nearby structures may occur too [1]. Laboratory findings include increased inflammatory findings (C – reactive protein, leucocytosis), elevated erythrocyte sedimentation and positive blood culture. Radiological examination consists of computed tomography (CT) or magnetic resonance (MR) imaging. Multifunctional CT angiography (CTA) remains the first – line diagnostic method, cause of it's sensitivity of 92 – 96% and a specificity of 93 – 100%. Magnetic resonance angiography (MRA) is an alternative method. However, it has hypersensitivity to motion artifact and takes much more time. It has 95 – 100% sensitivity and 82 – 96% specificity. Invasive aortography can be used for patients to

whom non – invasive examinations cannot reject mycotic aneurysm, because it can depict just the lumen of the artery. Mycotic peripheral arteries can be imaged by ultrasound, but it's significance for MAA is not described in the literature [16-17]. Radiological findings specific to MAAs may be rapid expansion, saccular or multilobular appearance, periaortic soft tissue mass and periaortic gas formation within the aneurysm thrombus [1,9,19]. Some authors have also suggested, that molecular diagnostics may be helpful too, especially in difficult cases. For example, 16S ribosomal ribonucleic acid (rRNA) testing determining Streptococcus pneumoniae [20]. The value of positron emission tomography (PET) and granulocyte scintigraphy in the diagnostic of mycotic aortic aneurysms have not been **widely i**nvestigated yet, but it is thought that these methods may help in diagnostics [18-19]. Though, individual literature sources describe leukocyte scintigraphy in an attempt to detect inflammatory processes in the arteries, but it lacks sensitivity and specificity. The distribution of sensitivity and specificity of radiological examination is shown in Table 2.

Table 2. Sensitivity and specificity of radiological examinations

Diagnostic method	Sensitivity	Specificity
CT angiography	92 – 96%	93 – 100%
MR angiography	95 – 100%	82 – 96%
F-FDG PET*	60 – 90%	88 – 100%

***** F – fluorodeoxyglucose positron emission tomography

5. Treatment

The management of MAAs can be divided into three categories: antibiotic therapy, surgery and endovascular repair. The literature review shows, that it is recommended to start empirical treatment with vancomycin and an anti – Gram – negative antibiotics, such as intravenous fluoroquinolone, ceftriaxone, and piperacillin-tazobactam. Antibiotic therapy should be reviewed after the identification of microorganism. Unfortunately, no specific algorithm has been developed to indicate how long antibiotic therapy should last. It is believed, that it depends on various factors, such as immune competence of patient, location of infection, specific bacteria, fever, hemodynamic stability and others. However, literature sources recommend continue treatment at least six or eight weeks with intravenous and oral antibiotics [1-2]. Open surgery repair is commonly referred as the gold standard in the treatment of MAAs. The aim of this type of treatment is to remove all infected and necrotic tissue. Also, management of the occurrence and spread of ischemia. Based on different literature sources surgical repair can be divided into aneurysm excision and ligation without arterial reconstruction, excision with immediate reconstruction, excision with interval reconstruction or extraanatomic bypass (EAB) and in situ graft placement [1,10]. EAB is most commonly applied to infrarenal aneurysms, while in situ graft is used for suprarenal MAAs. EAB is associated with complications such as aortic stump disruption, amputation, and reinfection. There are several different in situ grafts: silver-coated grafts, cryopreserved arterial allografts, rifampicin-impregnated grafts, and autogenous vein grafts [10]. Some authors

have also suggested that open repair with biological grafts shows better midterm results cause of its' no reinfection [21]. Another option to treat IAAAs is endovascular aneurysm repair (EVAR). It was reported in literature, that this treatment method is the most suitable for patients at high risk of mortality during open surgery. Also, it can be a great alternative as the primary method of treatment, then it is needed to wait to perform open reconstruction. However, EVAR have a risk of complications such as stent infection, malposition and endoleak, potential rupture [1-2,10]. All in all, a recent study by Karl Sörelius and co - authors concluded, that after EVAR survival at 30 days, 3 months and 1 year is actually better than after open surgery. Also, authors suggest, that there is no difference between these two treatment methods in survival at 5 and 10 year period [8]. A large number of existing studies in the broader literature have showed almost the same results too [3,22-26]. However, the newest systematic review showed, that early results after EVAR is better than after open surgery [27]. The distribution of long – term survival after open repair or endovascular treatment in different studies is shown in Table 3 and Table 4.

Table 3. Long – term survival after endovascular treatment

Reference	Study Period	Country	1 year survival	5 year survival
Chung-Dann Kan et al. 2007 [29]	1980 – 2007	Taiwan	94%	87%
Karl Sörelius et al. 2014 [22]	1999 – 2013	International	76%	55%
Karl Sörelius et al. 2016 [8]	1994 – 2014	Sweden	84%	58%
Ming – Yuan Liu et al. 2020 [33]	2001 – 2017	China	75%	41%
Joel S. Corvera et al. 2018 [31]	2006 - 2016	USA	84%	64%
C.-M. Luo et al. 2018 [24]	2009 – 2015	Taiwan	71%	53%

Table 4. Long – term survival after open repair

Reference	Study Period	Country	1 year survival	5 year survival
Karl Sörelius et al. 2016 [8]	1994 – 2014	Sweden	73%	60%
Guy Lesèche et al. 2001 [30]	1992 – 2000	France	78%	50%
Theodosios Bisdas et al. 2010 [32]	2000 – 2008	Germany	80%	64%
Ming – Yuan Liu et al. 2020 [33]	2001 – 2017	China	78%	69%
Ivika Heinola et al. 2018 [21]	2006 – 2016	International	83%	71%
Munetaka Hashimoto et al. 2019 [28]	2010 – 2017	Japan	96%	75,8%

6. Prognosis

The diagnosis of mycotic aortic aneurysms is always life - threatening, as MAAs are associated with 15–50% mortality [34]. Diagnosis and delayed treatment may be due to multifarious, non-specific symptoms, rapid enlargement and expansion of the aneurysm sac. Up to 24% of IAAA rupture spontaneously and are associated with 63% to 100% mortality [10]. Nevertheless, patients' with timely diagnosed and treated MAAs survival for 1 year reaches 71-96%, and 5 years - 41-83%.

7. Conclusions

MAA is one of the most dangerous health disorders due to its non-specific symptoms, laboratory tests. Therefore, CT or MR remain the main diagnostic method. Open repair is considered to be the gold standard treating IAAAs. However, new studies and literature sources suggest that survival after EVAR is the same as after open surgery. Unfortunately, due to the rarity of MAA and low statistical significance it is hard to do basic conclusions in diagnostics and treatment algorithms, so further studies must be conducted.

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