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Mycotic Aneurysm of Native Aorta and Prosthetic Grafts

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Abstract

Mycotic aneurysms are infective aneurysms of native aorta. Pathogenesis is by septicaemic seeding of distant site infection to susceptible atherosclerotic aortic wall. *Staphylococcus aureus* is the most common causative organism in Western countries, whereas non-typhoid *Salmonella* species are more common in Asian countries. Mycotic aneurysms are usually diagnosed by infective clinical picture, with or without positive blood cultures, imaging techniques and intraoperative findings. Current standard treatment is open surgical repair, while newer modalities such as endovascular repair are being examined. Lack of randomised, controlled trials highlights the requirement of national and international registry for mycotic aneurysms.

Keywords: Mycotic aneurysm; Aortic aneurysm; Infective aneurysm; Prosthetic graft

Introduction

William Osler introduced the term "mycotic aneurysm" in 1885 to describe infective aortic aneurysms, which were associated with endocarditis. Although there was no relation with fungal infections, the term "mycotic aneurysm" was later widely used for the infections of aorta regardless of the kind of infection. Mycotic aneurysm of native aorta is the infection of aortic aneurysms by infective seeding of septic emboli originated from another site of infection, by definition, excluding those resulting from aortic trauma, contiguous infection or after aortic surgery.

Mycotic aneurysms are extremely rare. Despite being only 0.85% of all aortic aneurysms, mycotic aneurysms are life-threatening with significant mortality and morbidity [1]. Without surgical intervention, mortality rates could be 57% with medical management alone, while aneurysm-related mortality rate for surgical intervention was 28% [2]. Currently, there is no randomised controlled trial to guide the management of mycotic aneurysms. The main stay of treatment is surgical intervention combined with antimicrobial therapy.

Infection of Native Aorta

Infection of native aorta is predisposed by atherosclerotic segments of aorta or already existing intraluminal clot of previously formed aortic aneurysms. Aortic intima is highly resistant to infections, but atherosclerosis could lead to intima tear or rupture. Following septicaemic seeding from distant sites, combined with predisposing factors, formation of mycotic aneurysms results.

Primary distant site of infection could be determined by blood culture or culture of aneurysmal content, or usually both, although results could be negative [1]. Blood cultures are positive in about 62% to 75% of the cases [3,4]. Positive cultures from aneurysm wall or surrounding tissues are also positive in 85% of patients [4].

Infection of native aorta occurs predominantly in males with a mean age of above 60 [1,2,4-10]. The most common pathogen in Europe is *Staphylococcus aureus*, whereas the most common one in Asian countries is non-typhoid *Salmonella* species [5-9]. Atypical microorganisms such as *Campylobacter fetus*, *Listeria monocytogenes*, *Coxiella burnetii* and *Aspergillius* species are also reported to be the cause of mycotic aneurysms [4].

Mycotic aneurysm due to *Mycobacterium tuberculosis* are highly unusual, but there were reported cases [2,7]. MRSA and fungal infections of aorta are associated with worse outcomes with higher mortality and morbidity [11].

Diagnosis and Investigations

Diagnosis is usually confirmed by the presence of febrile illness, leucocytosis, acute or chronic infection, and positive culture results. Nearly 90% of patients are febrile, and have leucocytosis at the time of presentation, and up to 80% of patients have localized pain [7].

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Positive culture alone does not justify the diagnosis of mycotic aneurysm, since routine cultures of abdominal aortic aneurysm surgery could be up to 15% positive without any signs of infection [12]. About 14% to 40% of patients with mycotic aneurysms have negative culture results, and it could partly be due to special requirement of enriched cultures to detect atypical organisms, such as Campylobacter and Listeria species [4].

The diagnosis could further be confirmed by the presence of frank pus or suppurative inflammation intraoperatively [2,8]. Specimens of aneurysms usually reveal presence of lymphocytes and neutrophils, while plasma cells invade aortic tissue in the mycotic aneurysm [13].

Mycotic aneurysms are ruptured up to 59% at the time of diagnosis preoperatively [4-6]. Imaging techniques such as computed tomography or magnetic resonance imaging could be used to demonstrate periaortic soft tissue infiltration. It is recommended that careful imaging of whole of thoracic and abdominal aorta, since mycotic aneurysms are usually multiple and there could be silent pathology of aorta which could be missed on the initial scan [14]. Recently, F-^{18} Fluorodeoxyglucose (FDG) PET-CT scan has been used for diagnosing mycotic aneurysms showing by visualizing high metabolic rates within the wall of the aneurysm [11,15].

Currently, there is no preoperative scoring system for patients with thoracic or thoracoabdominal aortic aneurysms to stratify risk factors for open versus endovascular repair [16]. Meantime, it is the decision of individual treating physician to determine whether the patient is fit or unwell for open surgical repair.

Treatment

Mycotic aneurysms are highly lethal, and prompt diagnosis with combination of surgical and antimicrobial therapy is essential. Timely surgical intervention with long-term antibiotics therapy provides good outcomes [2].

In early cases, surgical intervention was delayed until identification of responsible pathogen, and antibiotic sensitivities were determined. Patients were managed medically until sepsis was well controlled. However, it often led to rupture of aneurysm in many cases, and sepsis was rarely controlled. As a result, practice has changed to early surgery, i.e., within 24 hrs of admission, regardless of state of infection if there are signs of rupture [1].

In stable patients, broad spectrum antibiotics were administered to control infection preoperatively. Usually, duration of antibiotic therapy lasts about 8-10 days before surgery [2,4,8]. Appropriate broad-spectrum prophylactic antibiotics should be started as soon as the diagnosis is established. The antibiotics could then be changed later according to intraoperative Gram staining, blood cultures and sensitivity results. *Salmonella* species infections are usually treated with ceftriaxone (1000 gram to 2000 gram every 12 hours), whereas *non-Salmonella* infections were treated according to culture and sensitivity results [2,7,8].

There usually is 4 weeks to 6 weeks of intravenous antibiotics course postoperatively until laboratory parameters, such as temperature, white blood cell count, and C-reactive protein levels are normalised, followed by oral antibiotics of varying lengths from 2 months to 6 months to lifelong therapy [1,3,5,7,8,17]. Occurrence of infection could be monitored by regular white blood cells and C-reactive protein levels postoperatively.

Later, lifelong antibiotics therapy was seen unnecessary because graft flow surface coverage was sufficient enough at 6 months and lifelong antibiotics therapy was rather unpleasant for patients [17].

There were two main open surgical repairs for mycotic aneurysms; conventional extra anatomical bypass and *in situ* graft placement. Initially extra anatomical bypass was regarded as treatment of choice because of concern of graft infection [6]. It includes extra anatomical bypass in combination with debridement of infective tissues and over-sewing of aortic stump.

However, the role of extra anatomical bypass became unfavourable with technical difficulties, especially in aneurysms adjacent to major blood vessels, and frequent association with complications, such as late graft thrombosis and second operation, compared to good results with in situ graft placement [1,7].

In situ graft placement consists of wide local debridement of necrotic tissue, copious saline irrigation, and *in situ* repair with Dacron graft [7,8]. Aggressive local debridement of aneurysmal wall and infective surroundings are very important to minimise postoperative infection [5]. In addition, placement of pedicled vascular tissue such as omentum or muscle flaps to separate the graft from infective tissue bed, use of antibiotic-boned grafts, autogenous grafts, or cryopreserved grafts could improve outcome of surgical intervention [2,10,11].

Certain grafts, such as rifampicin-soaked grafts could also be used, but they have been shown to be ineffective in *Salmonella* or methicillin-resistant *Staphylococcus aureus* [18]. However, the role of rifampicin bonded grafts for *in situ* repair is still debatable, with about 25% graft failure rate [4]. Cryopreserved allografts could be used for mycotic aneurysms with very low rate of recurrent infection, but limited availability deters the widespread use of it as standard graft [11].

Silver-coated grafts may be superior to rifampicin bonded grafts or standard grafts according to experimental and clinical data, but it is difficult to assess their role due to patients not limited to native aortic infection with about 40% graft failure rate [4]. Other choice of grafts includes autologous superficial femoral vein graft and bovine pericardial conduits [11]. It is recommended to use autologous vein or allogenic grafts over synthetic grafts whenever possible because of the benefit of low complication rate [4].

Infection of aortic arch is extremely uncommon, and it is technically challenging. Median sternotomy is preferred for proximal and arch aneurysm repair, whereas left posterolateral thoracotomy could be used for distal arch repairs. Reconstruction of aortic arch and main arch branches could be done under deep hypothermic circulatory arrest, with or without the help of brain protection such as retrograde cerebral perfusion and selective antegrade cerebral perfusion [2,8]. Despite protective mechanisms, the rate of postoperative hypoxic encephalopathy remains high, up to 40% of patients contributing to deep hypothermic circulatory arrest usually longer than 60 min in majority of patients [8]. For abdominal aortic repair, the celiac, superior mesenteric and renal arteries could be implanted as an island flap if necessary [9].

In-hospital mortality rate of *in situ* surgical repair ranges from 5% to 44% [2,5,7-10]. Overall, 1 year and 5 year survival rates were 62% and 36% respectively [5].

Endovascular repair of mycotic aneurysms has emerged as an alternative in surgically high-risk patients, particularly in patients

with previously normal aortic tissue. However, initial studies include only small number of patients with short term follow ups, and more data is needed to recommend this treatment modality. Moreover, this approach remains controversial because stents are directly placed in an infected field without debridement [14].

The early and late outcomes of endovascular repair are mixed, and late mortality could exceed 40% [9]. Therefore, endovascular repair could either be reserved to patients with multiple comorbidities, who not suitable for open repair, combined with long-term suppressive antibiotics therapy, or as a bridge to open repair with acceptable results [4,10,19,20].

Latest form of treatment is hybrid endovascular repair, which includes hand-made Dacron graft with multiple branches to extra anatomical bypass renal arteries, superior mesenteric arteries, an common hepatic artery with inflow from single proximal anastomosis from iliac artery, and stenting of the aneurysm from median arteriotomy of femoral artery [9]. Despite benefits of hybrid repair such as, avoiding aortic cross-clamping, it is time consuming and technically difficult with highly associated complications including renal failure and intestinal ischaemia or paraplegia. It is, therefore, currently recommended to be reserved to patients considered too high risk for open surgical repair [21].

In situ graft replacement of aorta, and omental or muscle flap installation provides better patient survival with lower recurrent or reintervention rate compared to extra anatomical bypass or endovascular repair [10].

Infection of Prosthetic Grafts

Graft infection accounts for approximately 0.5% to 2.0% of cases, and *Staphylococcus aureus* is the most common causative organism in early infection and coagulase-negative *Staphylococcus* species such as *Staphylococcus epidermidis* being common in late infection. Early infection (<4 months) is caused by virulent organisms introduced during surgery and is accompanied by severe clinical picture with high fever. Late infection (>4 months) is usually caused by indolent microbes with chronic, mild clinical course [22]. However, in daily practice, it is difficult to distinguish the two. Any bacteraemia, irrespective of the source, within 4 weeks of graft implantation is regarded as haematogenous seeding to prosthetic surface since endothelialisation is assumed incomplete within that time frame.

Currently, there is no universal definition for cases of aortic surgical graft infections. Local guidelines, clinical managements and outcomes largely vary. Lack of diagnostic criteria has led to formation of Management of Aortic Graft Infection Collaboration (MAGIC). The group has established the standard for diagnosis of aortic graft infection [23].

CT scan is the choice of imaging to diagnose the infection of grafts; however, it is usually difficult to differentiate the infection itself from postoperative changes. MRI is being examined as an alternative. Diagnosis is greatly improved by the use of ^{18}F-FDG-PET/CT scan with on-going research, and it could also be used to monitor the response to treatment [24].

Management of aortic graft infection is the removal of infected graft, revascularisation, and antimicrobial therapy [22]. If infected grafts are left *in situ*, despite long duration of antimicrobial therapy, mortality could reach to 100% within two years [25]. There is not enough evidence to formulate standard antimicrobial therapy to treat graft infection, and it is usually initial 6 weeks of IV antibiotics, followed by 6 months of oral antibiotics therapy. The antimicrobial therapy should be guided by culture results wherever possible.

Conclusion

Open surgical repair of mycotic aneurysms remains standard treatment of choice while other modalities are currently being explored. There are mostly case reports and case series for mycotic aneurysms due to rarity of disease. The lack of randomised, controlled trials highlights the urgent need for establishment of national and international registry of mycotic aneurysms for better understanding and management of the disease.

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