THE ASEAN JOURNAL OF RADIOLOGY 2012: 18(1): 41-56 41

Original Article

# Infected Aneurysms in Thai Patients: Computed Tomography Findings

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## Abstract

**Objectives:** To determine the CT characteristics of infected aortic and visceral aneurysms and evaluate the difference between Salmonella and non-Salmonella infections by radiography.

**Materials and Methods:** Records of patients with surgical and/or pathological/microbiologic proof of infected aortic aneurysm collected over a 5-year period were reviewed. Computed tomography (CT), demographics and clinical data were studied. Twenty-eight aneurysms were found in 24 patients including 18 men and 6 women between the age of 35-78 years (mean = 63.29 years). The size, shape and location of aneurysm, aortic wall calcification, gas, and periaortic findings were evaluated.

**Results:** Aneurysms were located in the thoracoabdominal aorta (n=1; 4.2%), juxtarenal aorta (n=7; 29.2%), infrarenal aorta (n=13; 54.2%), superior mesenteric artery (n=1; 4.2%), and Iliac arteries (n=2; 8.3%). One patient had 2 infected aortic aneurysms and one patient had 4 infected aortic aneurysms. All 28 aneurysms were saccular with a mean diameter of 4.2 ± 2.4 cm (range, 0.6-10.4 cm). Paraaortic stranding, and/or fluid retention was present in 28 aneurysms (100%), paraaortic soft tissue mass in 21 aneurysms (75%), enhancing irregular wall thickening in 19 aneurysms (67.9%), disruption of calcification in the aortic wall in 13 aneurysms (46.4%), and perianeurysmal gas in 5 aneurysms (20.8%). Other findings included ruptured/ concealed ruptured aneurysm (n=9, 32.1%), adjacent vertebral body erosion/osteomyelitis (n=5, 20.8%), renal abscess (n=1, 4.8%) and psoas abscess (n=3, 14.3%).

**Conclusion:** Saccular aneurysms especially those with adjacent stranding,/fluid, and mass were highly suspicious of infection. Perianeurysmal gas and patients with relatively older age were found more common in salmonella infection than those with non-salmonella infection. Whereas, multiple aneurysms were more common in non-salmonella infection.

***Keywords:*** infected aneurysms, mycotic aneurysms, computed tomography

## Introduction

Infected aneurysm (or mycotic aneurysm) was first described by Osler in 1885. It is defined as an infectious break in the wall of an artery with the formation of blind, saccular outpouching that is contiguous with the arterial lumen. It is currently estimated that 0.7% to 2.6% of all aortic aneurysms are complicated by infection[3]. In addition to being a rare occurrence, it can be fetal if not diagnosed and treated early. Patients commonly present nonspecific symptoms, and the diagnosis is usually delayed until aneurysm has ruptured or until fulminant sepsis. Infected aneurysms are prone to rupture, with reported rupture rates of 53% to 75%. Prompt recognition and early detection are important for the timely treatment with antibiotics and surgical intervention. Still, the reported clinical experiences are limited to a few small series and case reports.

*Staphylococcus aureus* and *Streptococcus spp.* are the most common causative pathogens associated with infected aneurysm in Western countries[5], whereas non-typhoidal *Salmonella spp.* and *S. aureus* are more commonly responsible for cases that occur in East and Southeast Asian countries[3]. *Burkholderia pseudomallei* causing infective endarteritis in areas in which melioidosis is endemic has been documented in Northeast Thailand[4].

Computed tomography (CT) is widely available and routinely accessible to all patients with aortic aneurysms as it is noninvasive and safe with few contraindications. This method is useful for patients who cannot undergo magnetic resonance imaging (MRI). Multislice CT scans can be displayed as axial, multiplanar reconstructed, reformatted, or surface-rendered images. Furthermore, CT angiography is also possible.

The purpose of this study is to determine the radiographic characteristics of infected aneurysms of aorta and its branches obtained with CT scan or CT angiography and assess whether radiographic findings of Salmonella infection are different from non-Salmonella infection.

## Material and Methods

### Patients

This retrospective study was conducted at Siriraj hospital (Bangkok Thailand). The medical records of patients who received a diagnosis of infected (mycotic) aneurysm of aorta and its branches from January 2005 through December 2011 were reviewed.

Patients were enrolled in the study if they received a diagnosis of infected aneurysm, which was defined by the presence of the followings: (a) clinical evidence of infection (fever and/or leukocytosis), (b) bacteremia with radiographic findings that were compatible with infected aneurysm, (c) intraoperative findings suggestive of infected aneurysm, such as inflammation or pus collection around the aneurysm, or (d) pathological evidence of infected aneurysm or septic arteritis from the resected aneurysm, such as acute or chronic inflammation, acute suppurative inflammation, abscess formation, and/or bacterial clumps from the excised aneurysm.

We excluded patients with iatrogenic or traumatic aneurysms.

### Record and Image Review

Demographics, clinical characteristics, surgical, microbiological and pathological findings were collected from the patient records by one resident. CT studies were reviewed by a vascular radiologist

with 27 years of experience and a senior resident in radiology.

The patients in our study included 18 men and 6 women between the ages of 35 and 78 years (mean = 63.29 years). The demographic information of patients: age, sex, underlying diseases, clinical features, operative findings, causative organisms, site of vascular involvement, and complications was recorded. Computed tomographic (CT) scans were performed by Definition; Siemens and Light Speed VCT; GE Medical Systems. Twenty-four CT studies (all patients underwent CT once) were available for review. In all 24 patients, CT examinations were performed before and after the administration of intravenous contrast material, with a section thickness of 1.25 to 5 mm. We evaluated CT scans for the location, shape (saccular or fusiform), size and number of the aneurysms. Additionally, we examined images for additional findings including adjacent soft tissue masses, stranding/fluid, enhancing irregular wall thickening, gas, calcification in the adjacent or involved aortic wall and its complications such as bony erosion/ osteomyelitis, abscess and ruptured aneurysms.

The microbiological findings of infected aneurysms were correlated with the presence of gas, vertebral body erosion, abscess, ruptured aneurysm, multiplicity of aneurysms, paraaortic soft tissue masses, stranding, and fluid accumulation observed on CT scans.

A comparison of these characteristics between patients with infected aneurysm caused by *Salmonella* and patients with infected aneurysm caused by other pathogens was performed to evaluate clinical and radiolographic differences between groups.

Data analysis was performed using SPSS software, version 17 (SPSS). Comparison was performed using Fisher's exact test, as appropriate. Two-tailed tests of significance were used to assess statistical significance at $p < 0.05$.

## Result

During the 7-year study period, 30 cases were registered as mycotic aneurysm of aorta and its branches. Of these, 24 patients had medical records that were available for review.

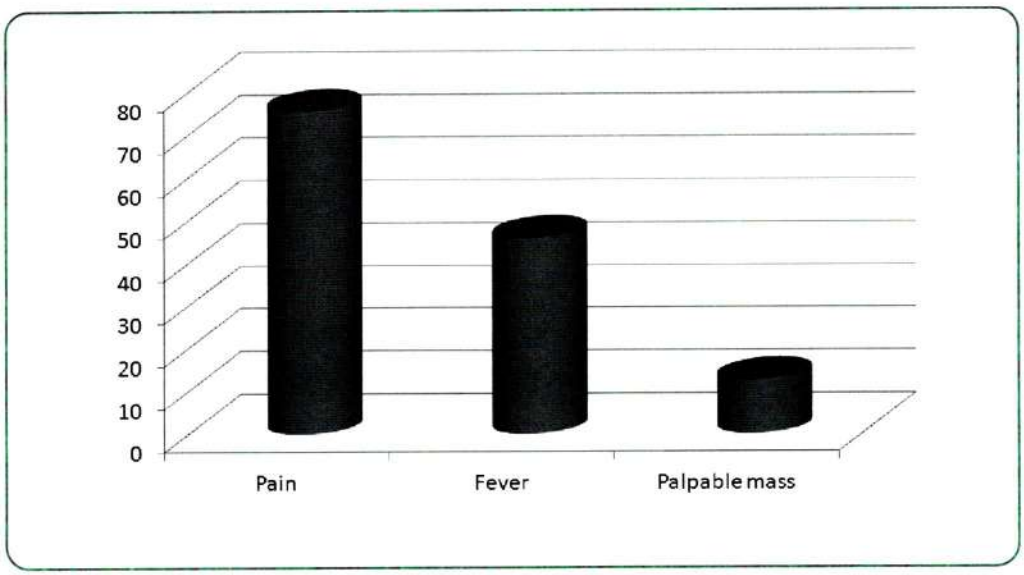
### Demographics

The majority of the patients were male (19 cases; 79%) and elderly (mean age, 63.29 years). Nineteen patients (79.1%) had preexisting diseases, of which the two most common were hypertension (13 patients; 54.1%), and diabetes mellitus (9 patients; 37.5%). The remaining preexisting diseases included gout, cerebrovascular disease, ischemic heart disease, chronic obstructive pulmonary disease, and SLE.

### Clinical Characteristics

Most of the patients presented with localized pain at the site of the aneurysm (abdominal and/or back pain) (18 cases; 75.5%). Fever (11 cases; 45.8%) and palpable, pulsatile mass (3 cases; 12.5%) were common clinical features. (Fig.1)

Demographics, clinical characteristics, microbiological and pathologic findings in 24 patients with infected aneurysm are shown in Table 1.




## CT Scan Findings

The abdominal aorta was involved in 21 cases (87.5%); infrarenal aorta (13 cases; 54.2%), juxtarenal aorta (7 cases; 29.2%), and thoracoabdominal aorta (1 case; 4.2%). The minority of cases involved common/ external iliac arteries (2 cases; 8.3%), and superior mesenteric artery (SMA) (1 case; 4.2%).

We found multiple aneurysms in 2 patients: one patient had 4 infrarenal aneurysms (Figure 1) and the another one had 2 infrarenal aneurysms.

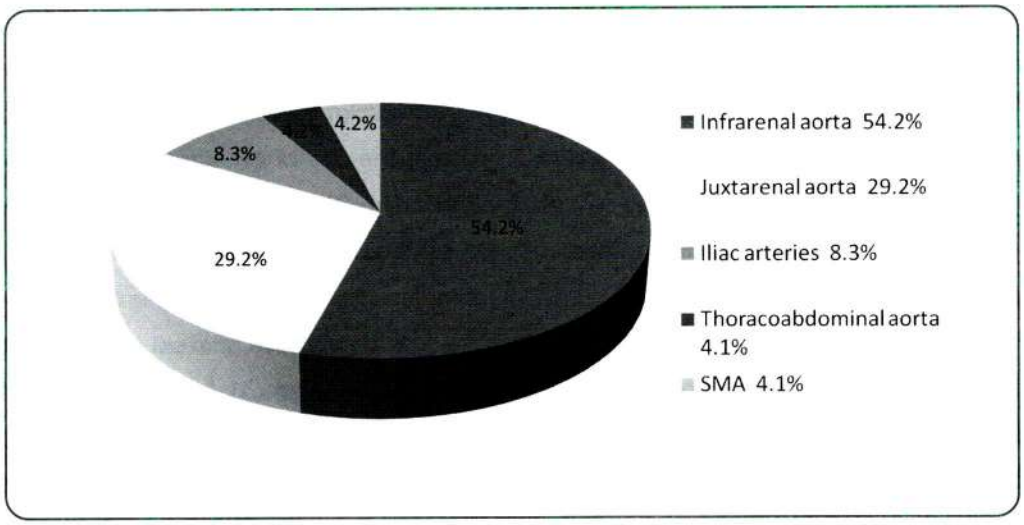


**Table 1** Demographics, clinical characteristics, microbiological and pathologic findings in 24 patients with infected aneurysm

| Age/sex | Clinical presentation | Aneurysm location | Underlying disease/ Predisposing factor | Primary source | Microbiology and pathology |
|---|---|---|---|---|---|
| M/70 | Fever | Infrarenal aorta | HT, renal insufficiency, old CVA | UTI | Blood: *Salmonella spp.* |
| M/69 | Fever | Infrarenal aorta | HT, History of aneurysmorrhaphy 1 year ago | Septic arthritis | Left knee effusion, blood: *Burkholderia pseudomallei* |
| M/62 | Acute fever, abdominal distension, left hip pain | Left CIA | HT, DM, mild MR | - | Blood: negative (aneurysm wall: chronic inflammatory cells) |
| M/70 | Acute fever | Juxtarenal aorta, right CIA | HT, DM | - | Blood: *Salmonella* group D (organize thrombus, dissecting aneurysm) |
| M/73 | Abdominal pain, palpable mass | Juxtarenal aorta, renal pedicle involvement | DM | - | Blood: *Salmonella* group C1 |
| M/67 | Acute fever, abdominal pain | Infrarenal aorta | HT, CAD | - | Blood: negative, Melioid titer 1: 80 |
| M/68 | Abdominal pain | Infrarenal aorta, both CIA | HT | - | Thrombus, pus: *Streptococcus agalactiae* |
| M/59 | Abdominal pain | Juxtarenal aorta, both CIA | HT, DM | - | Pus: *Shewanella spp.* (Thrombus: acute inflammation, necrotic debris) |
| F/73 | Abdominal pain | Thoracoabdominal aorta above celiac trunk | - | - | H/C: *Streptococcus agalactiae* |
| M/78 | Chronic fever | Infrarenal aorta | HT, DM, CAD, old CVA | - | Wall aorta, blood: *Salmonella* group C1 |
| M/55 | Acute fever, back pain | Juxtarenal aorta | HT | - | Blood: *Staphylococcus hemolyticus* |
| M/35 | Palpable mass | Right EIA,CFA | Thalassemia trait | Chronic wound at right groin | Hematoma at aneurysm wall: *Pythium insidiosum* (active arteritis of femoral a, chronic arteritis obliterans of ATA,PTA, peroneal a., infected thrombus, fungal hyphae) |

**Table 1** Demographics, clinical characteristics, microbiological and pathologic findings in 24 patients with infected aneurysm *(cont.)*

| Age/sex | Clinical presentation | Aneurysm location | Underlying disease/ Predisposing factor | Primary source | Microbiology and pathology |
|---|---|---|---|---|---|
| M/70 | Chronic abdominal pain, acute fever | Infrarenal aorta | DLP, gout | - | Blood: negative, melioid titer<1:160 |
| F/50 | Abdominal pain, chronic fever | Infrarenal aorta | HT, erythema nodosum | - | Blood: negative (aortic wall: acute necrotizing inflammation of aortic wall) |
| M/57 | Chronic abdominal pain | Infrarenal aorta, left CIA | DM, HT, COPD | - | Thrombus at aortic wall: *Burkholderia pseudomallei* (Blood clot: chronic, acute inflammation, aortic wall: chronic inflammation, necrosis) |
| M/45 | Chronic abdominal pain | Infrarenal aorta | DM, TB | - | Wall of aneurysm: *Burkholderia pseudomallei* |
| M/61 | Leg pain | Juxtarenal aorta | DM, HT, DLP, CAD, gout | - | Blood: negative (focal necrosis of wall, acute suppurative inflammation) |
| F/61 | Abdominal pain | Juxtarenal aorta | DM, HT, epidermolysis bullosa acquiritica on prednisolone, cyclophosphamide | - | Blood: *Salmonella* group D |
| M/69 | Acute fever | Infrarenal aorta | - | - | Pus, L4: *Salmonella* group D (aorta: focal necrosis, acute suppurative inflammation, L4: chronic osteomyelitis) |
| M/78 | Abdominal pain, fever, palpable mass | Juxtarenal aorta, Left CIA | - | | Blood clot G/S: gram positive cocci in pair (aortic wall: focal necrosis, acute inflammation) |
| F/58 | Chronic abdominal pain | Infrarenal aorta | SLE, CAD S/P PCI, chronic AF | Septicemia | Blood, aortic wall: *Salmonella* group D |
| F/51 | Abdominal pain, chronic anorexia | Superior mesenteric artery | HT | - | Blood: *Streptococcus alpha hemolyticus* (Focal acute inflammation) |
| M/75 | Abdominal pain, chronic fever | Infrarenal aorta | Gout, BPH | - | Blood: *Salmonella* group C2 (blood clot: mixed many RBC, some WBC) |
| M/65 | Chronic left hip pain, fever | Infrarenal aorta | - | - | Blood: *Salmonella* group D |

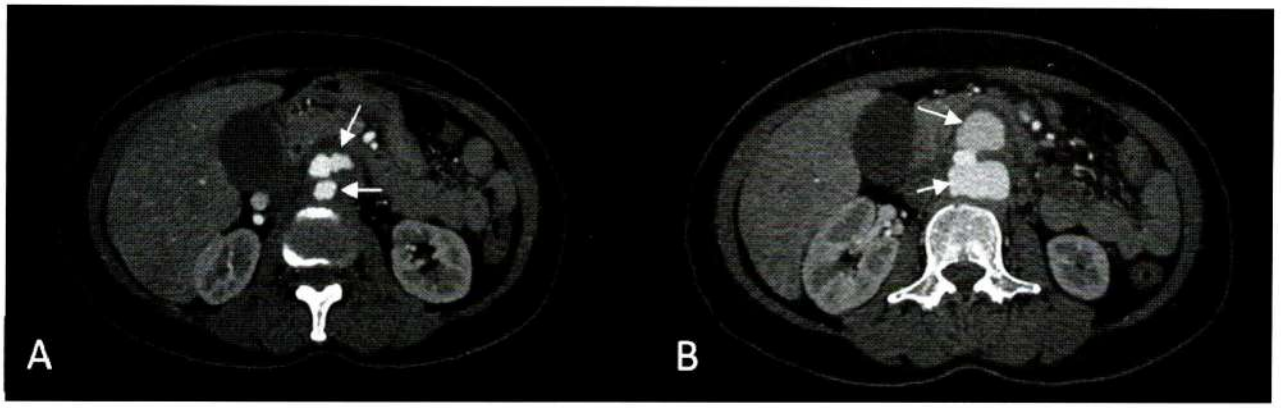


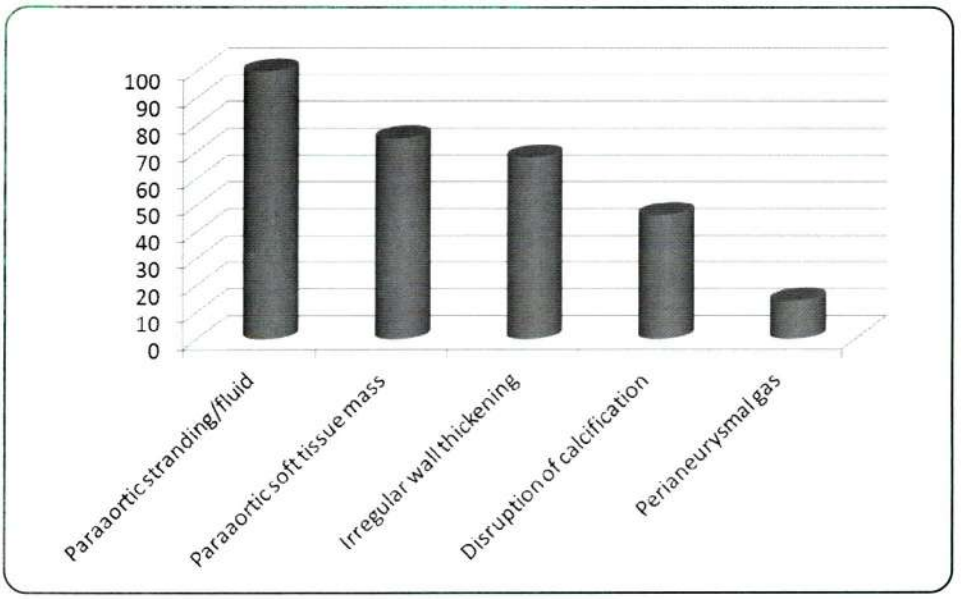

**Fig.1** A 50-year-old female with non-*Salmonella* infected aneurysm presented with intermittent fever, radiating pain to the back and pulsatile mass at abdomen. A. and B. Multiple irregular saccular dilatation (arrows) with surrounding fat stranding and soft tissue thickening of infrarenal abdominal aorta

Maximal diameters were greater than 10 cm in 1 aneurysm (3.6%), 5 to 10 cm in 9 aneurysms (32.1%), and less than 5 cm in 18 aneurysms (64.3%). The mean average diameter of the infected aneurysms were 4.2 ± 2.4 cm. (range, 0.6 -10.4 cm.).

Aneurysm shape was saccular in all 28 aneurysms and no aneurysm was with fusiform shape.

Paraaortic stranding, and/or fluid retention was presented in 28 aneurysms (100%), paraaortic soft tissue mass in 21 aneurysms (75%), irregular wall thickening in 19 aneurysms (67.9%), disruption of calcification in the aortic wall in 13 aneurysms (46.4%), and perianeurysmal gas in 5 aneurysms (20.8%) (Figure 2).

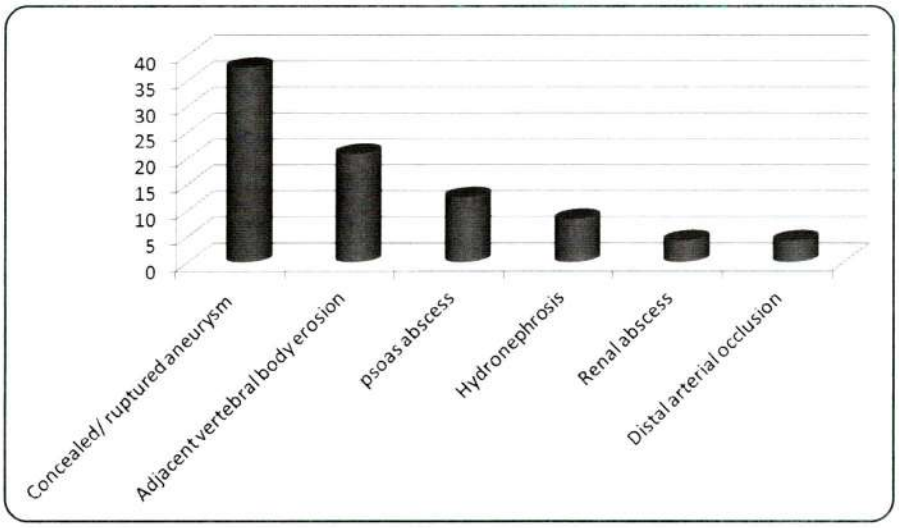
In addition, we found groups of reactive small intraabdominal lymph nodes around the infected aneurysm in 15 cases (62.5%). Twelve cases (50%) had evidence of associated atherosclerotic change of the aorta.



### Complications related to infected aneurysms

The majority of infected aneurysms in this study were located at the abdominal aorta. Their complications were identified on CT scan in 10 out of 24 cases. These included rupture/concealed ruptured in 9 cases (37.5%) (Figure 3), adjacent vertebral body erosion/ osteomyelitis in 5 cases (20.8%) (Figure 4), secondary ureteral involvement in the inflammatory process or compression by hematoma with resultant hydronephrosis (Figure 5) in 2 cases (8.3 %), psoas abscess (Figure 6) in 3 cases (12.5%), and renal abscess in 1 case (4.2%). In our study, there was no coexistent aortic dissection, kidney infarct and aortoenteric fistula that were found in the prior literature[1-3].

Isolated inflammatory iliac artery aneurysms were found in 2 cases with negative culture and Pythium insidiosum, whereas isolated inflammatory superior mesenteric artery aneurysm (Figure 7) was found in 1 case with *Streptococcal* infection. In a patient with Pythiosis, we found a severe occlusion of distal arteries which was caused by invasion of the organism, resulting in gangrene (4.2%) (Figure 8). Therefore, the patient underwent amputation of the affected extremities and the pathology showed acute arteritis of the aneurysm with chronic arteritis obiterans of the distal arteries.



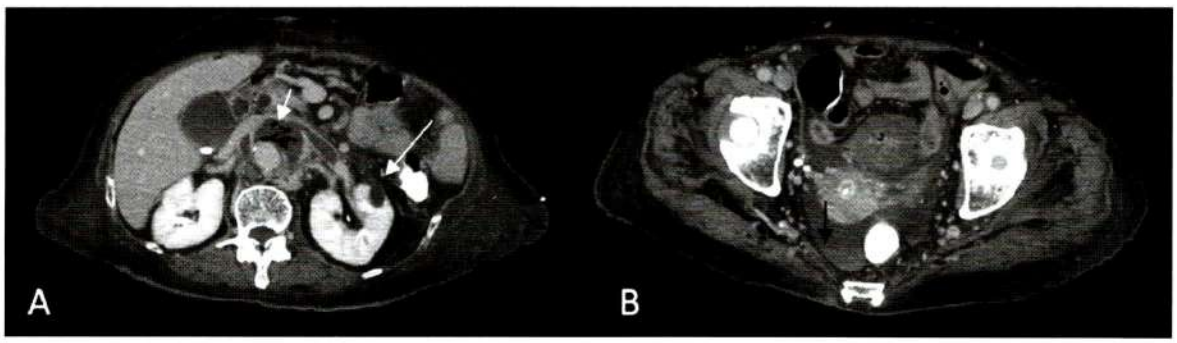




**Fig.2** A 73-year-old woman with Salmonella infected aneurysm presented abdominal pain and palpable mass. A. Saccular aneurysm at juxtarenal aorta surrounding by enhancing periaortic hypodensity rim with large amount of periaortic gas (short white arrow). B. Hemoperitoneum (black arrow) All these finding are consistent with ruptured infected aortic aneurysm with periaortic and left renal abscess formation (long white arrow).

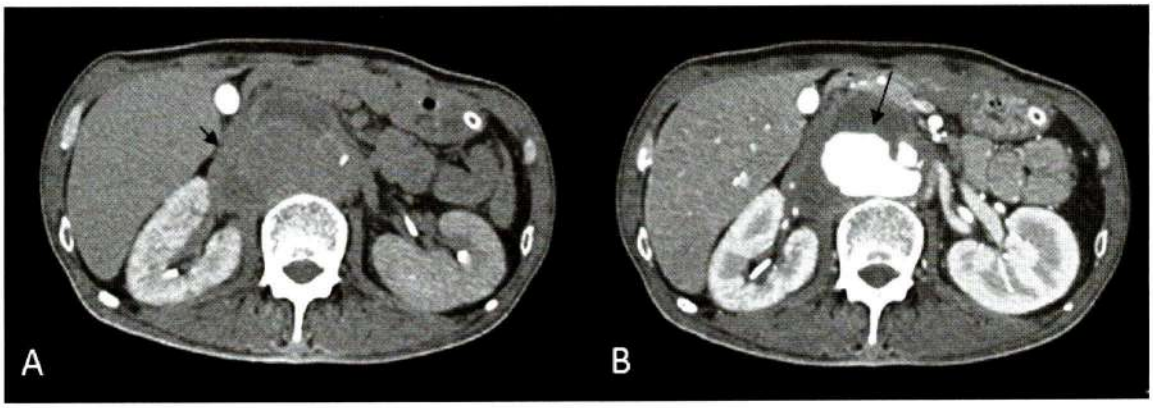



Fig.3 A 59 year old male with non-*Salmonella* concealed ruptured infected aneurysm (*Shewanella spp.*) presented with abdominal pain. A. Crescents shaped hyperdensity intramural thrombus in precontrast phase (short arrow). B. Diffuse periaortic soft tissue thickening and stranding surround the aneurysm (long arroow).

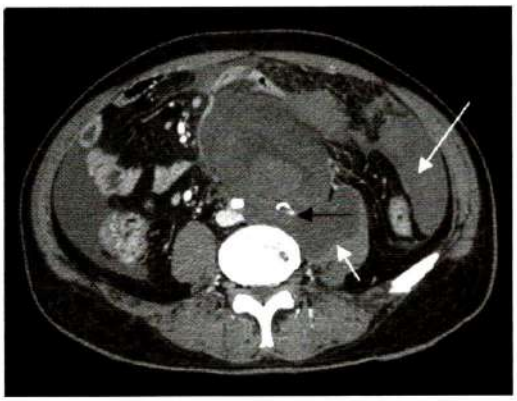


Fig.4 A 57-year-old male with ruptured Melioidosis infected aneurysm presented with acute alteration of consciousness and hypotension. There is a large irregular mixed hypo-hyperdensity lesions with peripheral enhancement surrounding infrarenal abdominal aorta. Disrupted wall of left common iliac artery associated markedly obliterated its lumen (black arrow). This hematoma at left iliopsoas muscle (arrow) and hemoperitoneum (long arrow) are visualized.

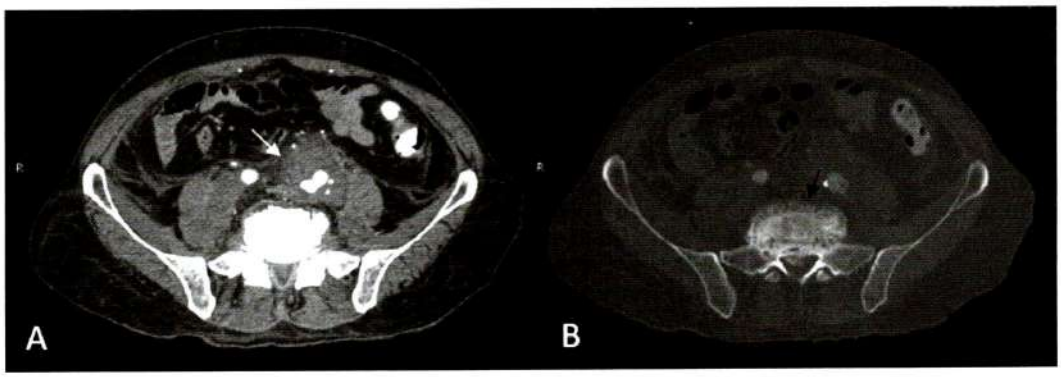



Fig.5 A 62-year-old man with culture-negative infected aneurysm presented with left lower abdominal pain with fever. A. An outpouching of contrast medium at left common iliac artery surrounding with irregular thickened soft tissue and perilesional stranding (white arrow). B. Minimal bony erosion at L5 and S1 vertebral body (balck arrow).

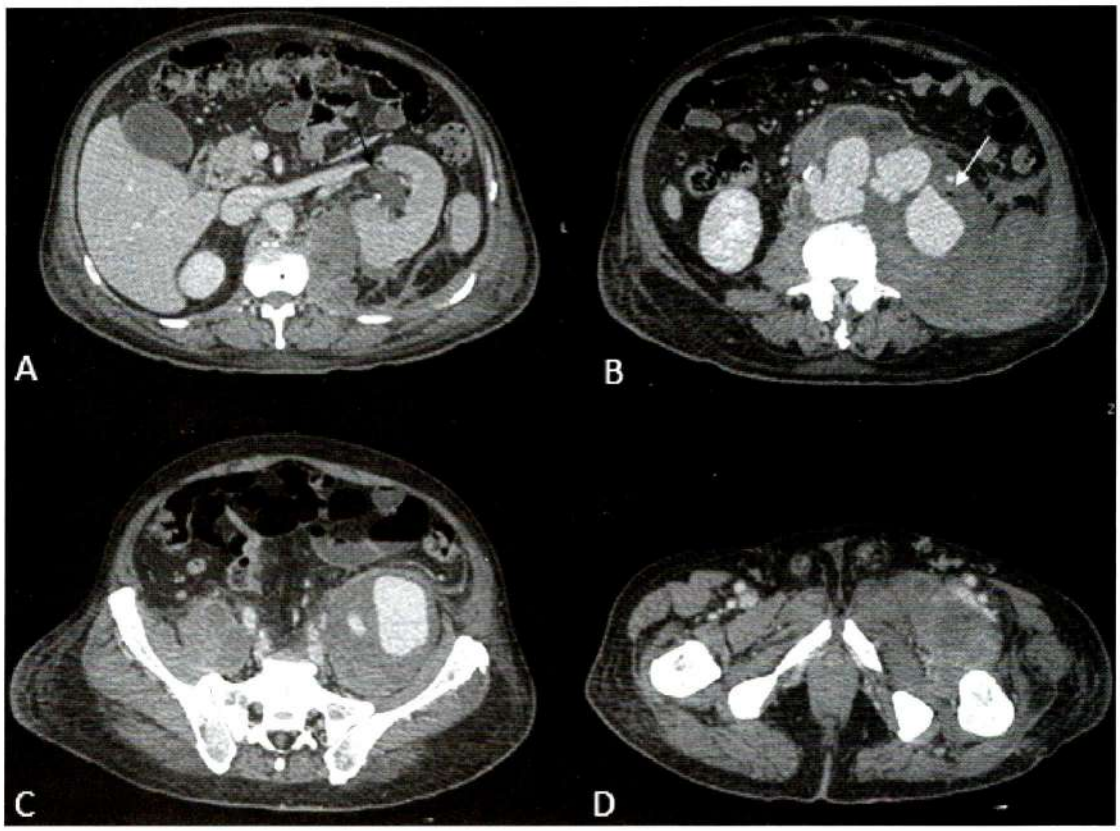



**Fig.6** A 65-year-old man with ruptured *Salmonella* infected aneurysm presented with fever with chronic left hip pain. B. Saccular aneurysm with enhancing periaortic soft tissue thickening. B., C., D. Large left retroperitoneal hematoma with internal air bubbles (white arrow) extending along bilateral psoas, iliopsoas, and muscles of left upper thigh, compatible with infected hematoma. A. The aneurysm and hematoma have pressure effect and cause left kidney anterolaterally with abrupt narrowing at left proximal ureter, causing mild left hydronephrosis (black arrow).

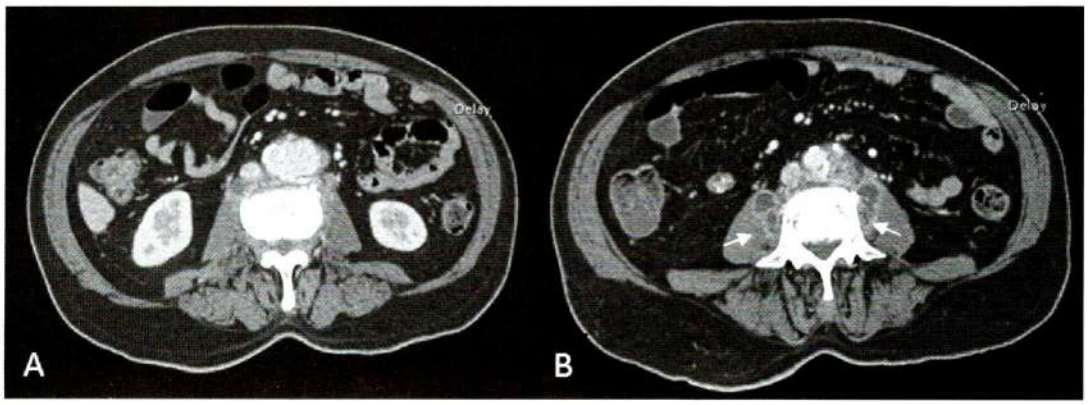



**Fig.7** A 69-year-old man with *Salmonella* infected aneurysm presented with acute fever. A. An irregular shape saccular aneurysm at left side of abdominal aorta with soft tissue thickening. B. Multiple rim enhancing hypodensity lesions in both psoas muscles, compatible with bilateral multiple psoas abscesses (arrow).

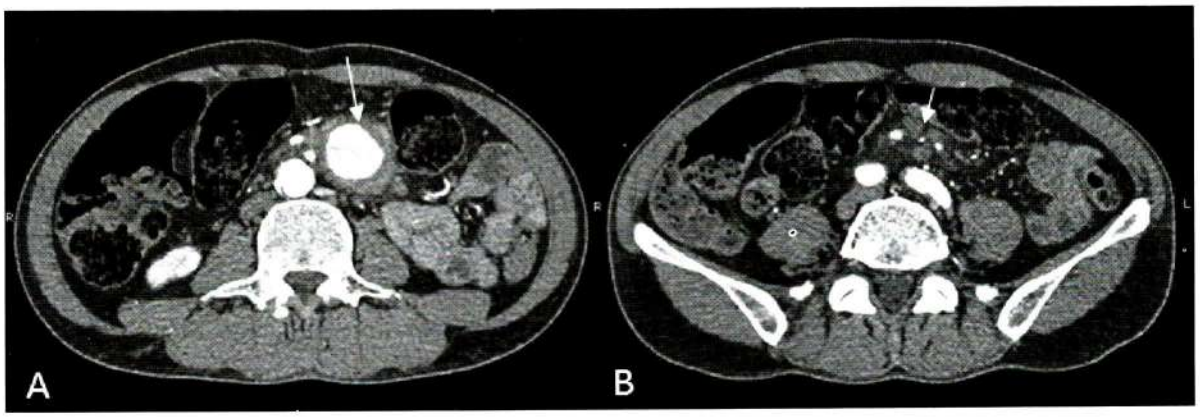



Fig 8 A 51-year-old man with non-*Salmonella* infected aneurysm (*Streptococcus* spp.) presented with abdominal pain. A. A saccular outpounching lesion at intestinal branch of superior mesenteric artery with soft tissue thickening and fat stranding (long arrow) B. Adjacent multiple lymphadenopathies are pathological proven of reactive lymph nodes (short arrow). All of these findings are suggestive of mycotic aneurysm of SMA.


**Fig. 9** A 35-year-old male Pythiosis infected aneurysm presented with chronic wound at right groin. A. Large irregular shaped outpouching lesion at right external iliac artery (EIA) and right superficial femoral artery (SFA) with enhancement soft tissue thickening and surrounding stranding. B. Total occlusions of right SFA (arrow).

## Pathogens

Eighteen cases (75%) were culture-proven infected aneurysms (from aneurysm or blood). The most common etiological pathogens were non-typhoidal *Salmonella spp.* (9 cases; 37.5%) and *Streptococcus spp.* (3 cases; 12.5%), Burkholderia pseudomallei (3 cases; 12.5%). *Staphylococcus spp.*, *Shewanella spp.*, and *Pythium insidiosum* were found once each.

Only 16 aneurysms were excised. These pathogens were isolated from blood (16 cases; 66.7%) and excised aneurysms (11 cases; 45.8%). The remaining isolates of the pathogens were from samples obtained from intraabdominal (psoas and renal) abscesses (4 cases; 16.7%) and another disseminated site of infection such as joint effusion (1 cases; 4.2%).

The rest of the 6 cases (25%) were culture-negative. Therefore, the diagnosis of infected aneurysm was convincing by surgical and pathological findings.

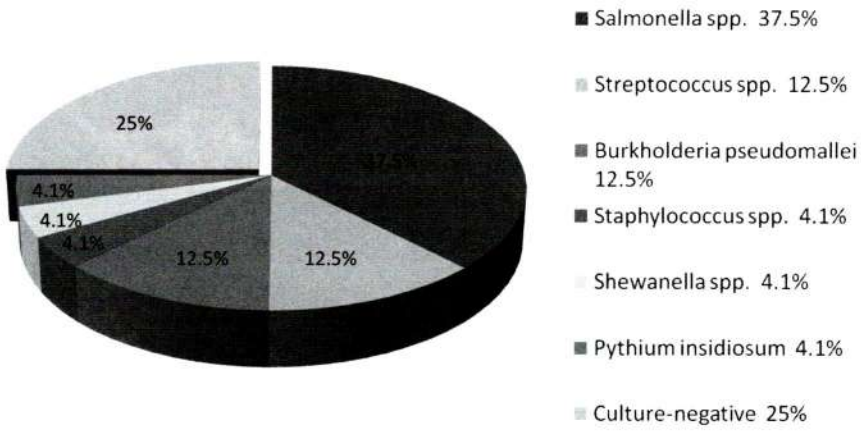



**Table 2** Correlation of Infected Aortic Aneurysms causing by various pathogens with Imaging Findings

| | Microbiologic Finding | | | | | | |
|---|---|---|---|---|---|---|---|
| **Imaging Characteristics** | ***Salmonella*** **(n=9pt)** | ***Staphylococcus*** **(n=1pt)** | ***Burkholderia*** **(n=3pt)** | ***Streptococcus*** **(n=4an,3pt)** | ***Pythium*** **(n=1pt)** | ***Shewanella*** **(n=1pt)** | **Negative (n=9an,6pt)** |
| Periaortic soft-tissue mass (n=20pt) | 8 | 1 | 2 | 3 (4an) | 1 | 1 | 3 (3an) |
| Periaortic stranding, and/or fluid (n=28pt) | 9 | 1 | 3 | 4 | 1 | 1 | 9 |
| Multiple aneurysms (n=2pt) | 0 | 0 | 0 | 1 (2an) | 0 | 0 | 1 (4an) |
| Gas (n=5pt) | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bony erosion (n=5pt) | 2 | 1 | 0 | 1 | 0 | 0 | 1 |
| Abscess (n=4pt) | 3 | 0 | 1 | 0 | 0 | 0 | 0 |
| Rupture (n=9pt) | 3 | 0 | 1 | 1 | 0 | 1 | 3 |

an= aneurysms, pt= patients

### *Salmonella versus non-Salmonella*

Of the 18 cases of culture-proven infected aneurysm, 9 were associated with *Salmonella spp.*, and 9 were associated with other pathogens. Six cases of infected aneurysms were culture-negative. There were no statistically significant difference with respect to sex, underlying diseases, clinical presentations, site of aneurysm or positive-culture sample site between patients with infected aneurysm caused by *Salmonella* and patients with infected aneurysm caused by non-*Salmonella*.

We found that *Salmonella* infected aneurysm were significantly related with older age (mean age 68.8 ± 6.5 year in *Salmonella* vs. 60.0 ± 11.5 year in non-*Salmonella*; $p = 0.049$) and perianeurysmal gas was significantly more common among patients with *Salmonella* infected aneurysm (56% in *Salmonella* vs. 0% in non-*Salmonella* group) ($p = 0.003$).

**Table 3** Comparison between causes of mycotic aneurysms due to Salmonella and non-Salmonella

| Variable | Patients with mycotic aneurysm | | P-value |
|---|---|---|---|
| | ***Salmonella*** **(n=9 pt)** | **non-*Salmonella*** **(n=15 pt)** | |
| Age, mean years ± SD | 68.8 ± 6.5 | 60.0 ± 11.5 | 0.049 |
| Male sex | 7/9 (78%) | 12/15 (80%) | 1 |
| Underlying disease | | | |
| Any | 7/9 (78%) | 12/15 (80%) | 1 |
| DM | 4/9 (44%) | 5/15 (33%) | 0.678 |
| HT | 4/9 (44%) | 9/15 (60%) | 0.675 |
| Clinical feature | | | |
| Localized pain | 6/9 (77%) | 12/15 (80%) | 0.635 |
| Palpable mass | 1/9 (11%) | 2/15 (13%) | 1 |
| Fever | 5/9 (56%) | 6/15 (40%) | 0.675 |
| Site of aneurysm | | | |
| Abdominal aorta | 9/9 (100%) | 12/15 (80%) | 0.266 |
| other site | 0/9 (0%) | 3/15 (20%) | |
| Site of positive culture sample | | | |
| Aneurysm | 2/4 (50%) | 9/12 (75%) | 0.547 |
| blood | 6/9 (67%) | 10/15 (67%) | |
| Radiological findings | | | |
| Infra/juxtarenal aortic aneurysm | 9/9 (100%) | 11/15 (73%) | 0.259 |
| Periaortic soft-tissue mass | 8/9 (89%) | 12/15 (80%) | 1 |
| Periaortic stranding and/or fluid | 9/9 (100%) | 15/15 (100%) | 1 |
| Multiple aneurysms | 0/9 (0%) | 2/15 (13%) | < 0.001 |
| Gas | 5/9 (56%) | 0/15 (0%) | 0.003 |
| Bony change | 2/9 (22%) | 3/15 (20%) | 1 |
| Abscess | 3/9 (33%) | 1/15 (7%) | 0.130 |
| Rupture | 3/9 (33%) | 6/15 (40%) | 1 |

Pt= patients

Intraabdominal (renal or psoas) abscess was found more common in *Salmonella* group (33% in Salmonella vs 7% in non-*Salmonella* group), though, there is no statistically significant difference ($p$ = 0.130).

Multiple aneurysms were significantly more common in non-*Salmonella* group (0% in Salmonella and 13% in non-*Salmonella* group, p <0.001).

## Discussion

Because of an infected aortic aneurysm is not always aneurysmal by conventional criteria (more than 50% luminal diameter dilatation), therefore, we use the term infected aortic aneurysm to include any aortic dilatation of infectious origin, regardless of size and pathogens.

In practice, the infected aortic aneurysm is often not suspected during clinical evaluation because of non-specific symptoms and inconclusive laboratory data. If diagnosed, however, the common treatment usually consists of antibiotics and urgent surgical intervention. With the treatment, the overall mortality rate is 16-40%[9,10].

Our study shows that *Salmonella spp.* are the most common causative pathogen found in infected aneurysms of aorta and its branches accounting for up to one-third of all cases (37.5%). As with infected aneurysm due to non-typhoidal *Salmonella spp.*, the major pathogenesis of other bacterial aneurysm is most likely to be a complication of bacteremia caused by hematogenous seeding in elderly patients with preexisting atherosclerotic diseases such as DM, HT and 50% of patient had evidence of associated atherosclerotic change of the aorta. This often leads to the formation of infected aneurysm. The demographics and clinical features of *Salmonella* infected aneurysm are not significant different from those caused by other pathogens.

In our study, up to 66.7% of infected aneurysms result in bacteremia and it must be noted that the primary source of the bacteremia is often unknown. Negative blood cultures have been reported in up to 47% of cases[8] and may be caused by antibiotic pretreatment and anaerobic organisms.

The most common location of aneurysm was different between atherosclerotic aneurysm and infected aortic aneurysm as reported in the literatures with infrarenal aorta (85%-87%) in atherosclerotic aneurysm[11] and descending aorta (47.6%) in infected aneurysm[3]. In our study, the distribution of infected aortic aneurysms were similar to the more common location of atherosclerotic aneurysm. About 54% of infected aneurysms located in infrarenal aorta and multiple aneurysms were uncommon.

Cross-sectional imaging is valuable to demonstrate the characteristic adjacent findings such as paraaortic soft tissue stranding and/or fluid, mass, and enhancing irregular wall thickening. Helpful findings such as gas, disruption of calcification and adjacent vertebral body change were seen less commonly. In the early stage, subtle paraaortic inflammatory changes may be overlooked.

The complications are dependent upon the location of infected aneurysm, branch/ adjacent organ involvement, and progression of the disease. The more common complications in the literature were hydronephrosis and coexistent aortic dissection[2]. The most common complication in our study is ruptured/ concealed rupture aneurysm.

Ming et al[3] reported 21 cases of infected aortic aneurysm. Periaortic gas was found in 7 cases (33.3%) in various bacterial pathogens. However, our study results that perianeurysmal gas found only in *Salmonella* infection.

Relatively old age and perianeurysmal gas were significantly more common among patients with *Salmonella* mycotic aneurysm than the non-*Salmonella* group. Renal/ psoas abscess are more common in *Salmonella* infected aneurysms rather than non-*Salmonella* group, though this was not statistically significant. Prior studies found that *Salmonella* infected aneurysm has a high fatality rate. Antibiotics alone are not sufficient, and complete excision of the affected aorta is the key to curative treatment[7].

The infected aneurysms caused by *Pythium insidiosum* (Pythiosis) is associated with chronic arterial inflammation and occlusion by invasion of the organism, which can result in gangrene, aneurysm formation and resection of affected arteries or amputation of the affected extremities. The disease is not uncommon in Thailand and Southeast Asia and predisposing factors are thalassemia and agricultural occupation[6].

There are a few limitations associated with this study. Firstly, the reviewer knew the diagnosis of infected aneurysm before evaluation of images, so we directly attended to the specific involved organs and findings Secondly, we had no control case to calculate sensitivity and specificity. Thirdly, this was a retrospective study of patients from a single institution and fourthly, infected aortic aneurysm was uncommon diagnosis. Therefore, the number of cases was small. The statistical significance of some findings cannot be predicted with this small number. The evaluation of causative organisms was based on an aerobic culture, so we could not explore the role of anaerobic bacteria or other uncommon organisms under this condition.

## Conclusion

Infected aneurysms of aorta are not uncommon but can be fatal if untreated. A high degree of clinical awareness followed by computed tomography allows early detection of infected aneurysm, adjacent organ involvement and its complications. The recognition of imaging findings associated with an infected aneurysm is critical for early diagnosis and adequate therapy. Saccular aneurysm with paraaortic stranding and/or fluid retention or mass constitutes the imaging findings that are highly suggestive of an infected aortic aneurysm. Perianeurysmal gas, disruption of calcification and adjacent vertebral change are other helpful features in the diagnosis of infected aortic aneurysm. In conclusion, *Salmonella* infected aneurysms might have a poorer prognosis than non-*Salmonella* group because of more common in perianeurysmal gas, abscess and relatively old age of the patients.

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