Intercostal Muscle Abscesses in Infective Endocarditis Associated With Migratory Deposition of Calcium Pyrophosphate

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Abstract

Infective endocarditis (IE) is caused by vegetations, consisting of platelets, fibrin, inflammatory cells, and microcolonies of bacteria, fungi, rickettsia, chlamydia, and viruses, that form in the heart valves, endocardium, and large vessel intima. Staphylococcus aureus endocarditis is highly tissue destructive, usually follows an acute course, and tends to become severe due to valve destruction, surrounding abscesses, and distant seeding. The main complications of IE due to S. aureus are heart failure due to destruction of tendon cords and valves, perivalvular abscesses and fistulas, and the dissemination of septic emboli to various organs including the brain, kidney, spleen, and lungs. The most common deep tissue abscess formed is an iliopsoas abscess; however, a few publications have described the formation of superficial muscle abscesses due to S. aureus bacteremia. For muscles near joints, deposition of calcium pyrophosphate crystals, as seen in pseudogout, can lead to pseudo-abscess formation and increase susceptibility to infection. This has been previously recognized in the iliopsoas muscle, in particular. We report a case of IE and intercostal muscle abscesses caused by S. aureus bacteremia in an 86-year-old man. Careful follow-up is required in patients with IE, due to the possibility of abscess formation. Furthermore, calcium pyrophosphate deposition in muscles around joints can trigger abscess formation when there is concurrent bloodstream infection.

Introduction

Infective endocarditis (IE) is caused by vegetations, consisting of platelets, fibrin, inflammatory cells, and microcolonies of microorganisms such as bacteria, fungi, rickettsia, chlamydia, and viruses, that form in the heart valves, endocardium, and large vessel intima [1]. IE is a systemic septic disease and has various clinical presentations, including bacteremia, vascular embolization, and heart disorders [2]. It rapidly damages the endocardium or heart valve membranes and leads to death within a few weeks if not treated [2,3].

Although many bacteria and fungi sporadically cause endocarditis, streptococci from the oral cavity and staphylococci from the skin are the predominant cause of endocarditis that occurs in native heart valves [4,5]. Staphylococci are the most common cause of IE in developed countries [2]. In particular, Staphylococcus aureus infection is highly tissue destructive, usually follows an acute course, and causes severe illness, due to the development of valve destruction, surrounding abscesses, and distant seedings [4]. IE due to S. aureus has a higher probability of stroke, systemic embolism, persistent bloodstream infection, and death than IE caused by other pathogens, and four to eight weeks of antibiotic treatment is recommended [6,7].

The main complications of S. aureus IE are heart failure due to destruction of the heart tendon cords and valves, perivalvular abscess and fistula formation, embolic events, and spread of infection to peripheral organs including the brain, spleen, kidney, and lung [2]. Abscess formation is commonly associated with aortic or artificial valves. IE and deep tissue abscesses are reported to occur in 59% and 18%, respectively, of cases of S. aureus bacteremia [8]. In a retrospective cohort study of Methicillin-sensitive S. aureus (MSSA) bacteremia, metastatic infections occurred in 19% of patients, including IE, septic pulmonary abscess, spondylitis, lumbar abscess, epidural abscess, and septic arthritis [9].

The most common deep tissue abscess is an iliopsoas abscess. In one study, the causative bacteria were S. aureus (MSSA, 27%) and Escherichia coli (18%) [2]. There are a few reports on the formation of superficial muscle abscesses due to S. aureus bacteremia [10,11]; however, there are no reports of intercostal muscle abscess formation as a result of metastatic infection. Rather, most intercostal muscle abscesses are due to direct infiltration from tuberculosis or lung abscesses [10,11].

Furthermore, the pseudo-abscess formation can occur in muscles near joints. Susceptibility to infection may be enhanced by the deposition of calcium pyrophosphate. This occurs most frequently in the iliopsoas...
To our knowledge, there have been no previous reports of abscess formation in the intercostal muscles as a complication of IE. We report a case of IE and intercostal muscle abscess caused by *S. aureus* bacteremia in an older man. The unique characteristics of this case highlight the need to raise awareness of the possibility of intercostal muscle abscess formation.

### Case Presentation

An 86-year-old man, who lived with his eldest son, was independent in activities of daily living. Seven weeks before presentation, he was hospitalized elsewhere with a burn on the medial condyle of his right foot, caused by hot water. He developed a bruise on his left anterior chest wall three days before presentation. On the day of admission, he experienced left anterior chest pain, which worsened with coughing, and he had difficulty raising his left hand. His medical history was unremarkable. He was not taking any medications.

Initial vital signs were a body temperature of 37.7°C, blood pressure of 150/67 mmHg, the pulse of 72 beats/min, respiratory rate of 20 times/min, and saturation of percutaneous oxygen (SpO\(_2\)) of 98%. Physical findings showed no obvious erosions in the oral cavity, no enlargement of the cervical lymph nodes, and no cardiac murmurs. There was mild redness extending from the left side of the neck to the chest wall and redness and tenderness extending from the left clavicle to the fifth intercostal space. The patient had a burn scar on the medial condyle of his right foot, but there was no apparent redness or tenderness. The initial laboratory data were shown in Table 1.

| Marker                      | Level  | Reference range          |
|-----------------------------|--------|--------------------------|
| White blood cells           | 13.6   | 3.5–9.1 × 10\(^3\)μL    |
| Neutrophils                 | 86.9   | 44.0%–72.0%              |
| Lymphocytes                 | 5.2    | 18.0%–59.0%              |
| Monocytes                   | 7.4    | 0.0%–12.0%               |
| Eosinophils                 | 0.4    | 0.0%–10.0%               |
| Basophils                   | 0.1    | 0.0%–3.0%                |
| Red blood cells             | 4.41   | 3.76–5.50 × 10\(^3\)μL  |
| Hemoglobin                  | 12.3   | 11.3–15.2 g/dL           |
| Hematocrit                  | 38.8   | 33.4%–44.9%              |
| Mean corpuscular volume     | 88.0   | 79.0–100.0 fL            |
| Platelets                   | 16.9   | 13.0–36.9 × 10\(^3\)μL  |
| Total protein               | 7.4    | 6.5–8.3 g/dL             |
| Albumin                     | 3.8    | 3.8–5.3 g/dL             |
| Total bilirubin             | 1.7    | 0.2–1.2 mg/dL            |
| Aspartate aminotransferase  | 31     | 8–38 IU/L                |
| Alanine aminotransferase    | 33     | 4–43 IU/L                |
| Lactate dehydrogenase       | 296    | 121–245 U/L              |
| Blood urea nitrogen         | 14.8   | 8–20 mg/dL               |
| Creatinine                  | 0.76   | 0.40–1.10 mg/dL          |
| Estimated glomerular filtration rate | 72.9 | >60.0 mL/min/L               |
| Serum Na\(^+\)              | 136    | 135–150 mEq/L            |
| Serum K\(^+\)               | 3.2    | 3.5–5.3 mEq/L            |
| Serum Cl\(^−\)              | 97     | 98–110 mEq/L             |
| Creatinine kinase           | 238    | 56–244 U/L               |
| C-reactive protein          | 16.3   | <0.30 mg/dL              |
We performed soft-tissue ultrasonography of the left anterior chest and found low space in the left intercostal muscle and pectoralis minor muscle and fine flow around it (Figures 1A, 1B).

**FIGURE 1: Soft-tissue ultrasonography**

Soft-tissue ultrasonography of the left anterior chest wall showing (A) fluid retention in the left intercostal muscle (white arrow) and (B) the increase in vascular flow (white arrow; color spotting).

Contrast-enhanced computed tomography from the neck to the pelvis revealed gas within collections of fluid in the first and second intercostal muscles (Figures 2A, 2B).
FIGURE 2: Contrast-enhanced computed tomography

Contrast-enhanced computed tomography from the neck to the pelvis showing (A) fluid collection with gas (white arrow) in the first and second intercostal muscles and (B) calcification of the costosternal joint (white arrow).

We diagnosed multiple abscesses in the left anterior chest muscles and performed aspiration. Gram staining of the pus revealed many leukocytes and Gram-positive cocci, suggesting Staphylococcus and anaerobic bacterial infections. The patient was treated with intravenous ampicillin (ABPC) 6 g, sulbactam (SBT) 9 g, and vancomycin 1 g, covering Methicillin-resistant S. aureus and anaerobic bacteria. MSSA was grown from the admission blood culture, so all other antibiotics were stopped, and intravenous cephazolin (CEZ) 4 g was commenced on the third day of hospitalization, following the collection of repeat blood cultures. For the pain in his left chest wall, oral acetaminophen 1,500 mg was started on admission. Transthoracic echocardiography (TTE) on the fourth day of hospitalization revealed a 4-5 mm vegetation on the anterior mitral leaflet (Figure 3).

FIGURE 3: Transthoracic echocardiography on the fourth day of hospitalization revealing a 4–5 mm vegetation on the anterior mitral leaflet (white arrows pointing to the vegetation shown by + +)

The diagnosis of IE was made by satisfying two major items of the modified Duke Diagnostic Criteria: two blood cultures that tested positive for S. aureus and a valve vegetation seen on TTE. On the fourth day of hospitalization, the patient was referred to the Dental and Oral Surgery Department to rule out an oral source of S. aureus infection. He was reported to have good oral hygiene and no dental disease.

On the fifth day of hospitalization, the patient developed swelling of the left anterior chest wall, low-grade
fever, and his left-sided chest pain continued despite taking regular doses of acetaminophen. The abscess in
the left second intercostal muscle was drained, and a small amount of cream-colored pus was aspirated. We
suspected the involvement of anaerobic bacteria and changed the antibacterial drugs from CEZ back
to ABPC/SBT. We found numerous polynuclear leukocytes and Gram-positive cocci scattered in the pus Gram
stain, as well as crystals of calcium pyrophosphate (Figures 4A, 4B).

FIGURE 4: Gram stain
Gram stain of pus from the intercostal muscle abscess showing (A) numerous polynuclear leukocytes and Gram-
positive cocci (white arrow) and (B) crystals of calcium pyrophosphate (white arrow).

Considering the possibility of intramuscular pseudogout, pain control was changed from acetaminophen to
diclofenac from the seventh day of hospitalization. After this change in treatment, the patient’s pain
improved, and his fever resolved. Repeat blood cultures on days 4 and 9 were tested negative. When a TTE
was repeated on day 11, the valve vegetation on the anterior mitral leaflet had disappeared, and no evidence
of valve destruction was observed. On day 14, diclofenac administration was stopped because the pain in the
left anterior chest had dissipated. As there was no valve destruction and the patient’s symptoms were stable,
the ABPC/SBT infusion was stopped after two weeks and switched to oral trimethoprim-sulfamethoxazole on discharge from the hospital on the 15th day of hospitalization. He was followed up in
the outpatient department four weeks later, with no reoccurrence of IE or intercostal abscesses.

Discussion
This case shows that IE can occur with intercostal muscle abscesses triggered by the deposition of calcium
pyrophosphate crystals. Abscess formation in muscles can be triggered by calcium pyrophosphate
deposition. In general, most intercostal muscle abscesses are caused by direct invasion [11,14]. However, in
this case, no lung lesions were observed, and IE was suspected because S. aureus was cultured from the
intercostal muscle abscess and the blood. In addition, as calcium pyrophosphate was present
simultaneously, nonsteroidal anti-inflammatory drugs (NSAIDs) and drainage and antibacterial agents were
effective treatments.

In this case, there were concurrent intercostal muscle abscesses seeded from the bloodstream and IE.
Calcium pyrophosphate may enhance susceptibility to infection and make treatment difficult [13].
Treatment of pseudogout may be effective in the treatment of abscesses associated with calcium
pyrophosphate [15].

For a diagnosis of IE, identification of the bacterial entry point is important in terms of infection control.
There is a high possibility of the infective source being the oral cavity or skin [2]. In the present case, there
was no skin damage around the intercostal muscles and no lung lesions; therefore, it was unlikely that the
intercostal muscle was an entry point. There were no abnormalities with the oral mucosa and neck, and as
there was no swelling of the lymph nodes, the possibility of infection from the oral cavity was low. However,
as there was a history of a burn seven weeks before this admission, the bloodstream infection could have
been caused by S. aureus, which is part of the skin microbiota, from the burn site, followed by IE [3].

The standard treatment for IE due to MSSA bacteremia is CEZ, depending on the clinical course, as in this
case [2,7]. CEZ was selected based on the antibiotic sensitivity results of the blood and abscess cultures.
However, because of the exacerbation of the symptoms, the patient was recommenced on ABPC/SBT
antibiotics for four weeks, and repeat echocardiography was performed. As calcium pyrophosphate was observed microscopically in the pus aspirated from the intercostal muscle abscesses, it is possible that inflammation was also induced by the intramuscular accumulation of calcium pyrophosphate [15,16]. NSAIDs may have contributed to a reduction in pain and swelling.

Accumulation of calcium pyrophosphate in muscles can cause abscess formation. In this case, the origin of the intercostal muscle abscess was near the sternoclavicular and sternocostal joints, and calcium pyrophosphate could have been deposited in the muscle at those sites [17]. Previous studies have shown that calcium pyrophosphate deposition can trigger inflammation and abscess formation [15,16,18,19]. Calcium pyrophosphate has been observed in an iliopsoas abscess associated with intervertebral discitis, suggesting the possibility of migratory pseudogout [13]. As far as we are aware, there are no previous reports on calcium pyrophosphate deposition in intercostal muscle abscesses. As the relationship between the deposition of calcium pyrophosphate and infection has not been clearly investigated, it is necessary to study future cases.

Conclusions
IE can form an abscess in the intercostal muscles. Careful follow-up is required in patients with IE, due to the possibility for abscess formation. Furthermore, calcium pyrophosphate deposition in muscles around joints can trigger abscess formation when bloodstream infections are present.

Additional Information
Disclosures

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References

1. Sandre RM, Shafran SD: Infective endocarditis: review of 135 cases over 9 years. Clin Infect Dis. 1996, 22:276-86. 10.1093/clinids/22.2.276
2. Wang A, Gaca IG, Chu VH: Management considerations in infective endocarditis: a review. JAMA. 2018, 320:72-83. 10.1001/jama.2018.7576
3. Skipcek L, Codolona IN, Davila CD, Romero-Corcal A, Yun J, Pressman GS, Figueroed VM: Infective endocarditis epidemiology over five decades: a systematic review. PLoS One. 2015, 8:e82665. 10.1371/journal.pone.0082665
4. Remadi JP, Habib G, Nadji G, et al.: Predictors of death and impact of surgery in Staphylococcus aureus infective endocarditis. Ann Thorac Surg. 2007, 83:1295-302. 10.1016/j.athoracsur.2006.09.095
5. Liu PY, Huang YF, Targ CW, et al.: Staphylococcus lugdunensis infective endocarditis: a literature review and analysis of risk factors. J Microbiol Immunol Infect. 2010, 43:478-84. 10.1016/S1684-1182(10)60074-6
6. Hart RG, Foster JW, Luther MF, Kanter MC: Stroke in infective endocarditis. Stroke. 1990, 21:695-700. 10.1161/str.21.5.695
7. Luque Paz D, Lakkar I, Tattievin P: A review of current treatment strategies for infective endocarditis. Expert Rev Anti Infect Ther. 2021, 19:297-307. 10.1080/14787210.2020.1822165
8. Fowler VG Jr, Olsen MK, Corey GR, et al.: Clinical identifiers of complicated Staphylococcus aureus bacteremia. Arch Intern Med. 2005, 165:2066-72. 10.1001/archinte.165.17.2066
9. Horino T, Sato F, Hosaka Y, et al.: Predictive factors for metastatic infection in patients with bacteremia caused by methicillin-sensitive Staphylococcus aureus. Am J Med Sci. 2015, 349:24-8. 10.1097/MAJ.0000000000000530
10. Bansal M, Dalal P, Kadian Y, Malik N: Tubercular liver abscess rupturing into the pleural cavity: a rare complication. Trop Doct. 2019, 49:520-2. 10.1177/0049475519864749
11. Spoto S, Cicciozzi M, Angeletti S: A case of rare cutaneous abscess with intercostal muscles involvement by pleural tuberculosis in a Malagasy young traveller. J Travel Med. 2017, 24:10.1093/jtm/txz035
12. Bridges KJ, Bullis CL, Wanchu A, Than KD: Predictive markers of the cervical and thoracic spine mimicking infection after lumbar fusion: case report. J Neurosurg Spine. 2017, 27:145-9. 10.3171/2016.12.SPINE16979
13. Al-Khodairy AT, Gobelet C, Nanzo R, De Preux J: Iliopsoas bursitis and pseudogout involving the knee mimicking L2-L3 radiculopathy: case report and review of the literature. Eur Spine J. 1997, 6:356-41. 10.1007/s005860050282
14. Arai N, Usabe Y: Acute empyema with intractable pneumothorax associated with ruptured lung abscess caused by Mycobacterium avium. Gen Thorac Cardiovasc Surg. 2011, 59:445-6. 10.1007/s11748-010-0687-7
15. Chesterton T, Miller CS: Infective endocarditis initially manifesting as pseudogout. Proc Bayl Univ Med Cent. 2021, 34:496-7. 10.1080/10898992.2021.1888652
16. Ungprasert P, Kaewpoowat Q, Ratapano S, Srivali N, Bischof EF Jr: Presence of crystals is not an evidence of absence of infection. Am J Emerg Med. 2013, 31:455-e1-2. 10.1016/j.ajem.2012.07.020
17. Macmullan P, McCarthy G: Treatment and management of pseudogout: insights for the clinician. Ther Adv Musculoskelet Dis. 2012, 4:121-31. 10.1177/1759770811432559
18. Santos-Ocampo AS, Tupasi TE, Villanueva F, Roxas FK, Ramos CP: Mycobacterium tuberculosis infection of
19. Ohta R, Kaneko M, Hattori S: Diseases with extremely elevated erythrocyte sedimentation rates in a secondary healthcare facility: retrospective cohort study. Shimane J. Med. Sci. 2017, 34:27-33.