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Extensive Subcutaneous Abscess due to Panton-Valentine Leucocidin-Positive Community-Associated Methicillin-Resistant *Staphylococcus aureus* in an Infant

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Community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA) infections have increased worldwide in people without underlying diseases. CA-MRSA can often cause serious bacterial infections, especially skin and soft tissue infections (SSTI). Here, we describe a case of severe subcutaneous abscess due to Panton-Valentine leucocidin (PVL)-positive CA-MRSA in an infant without underlying diseases. A 4-month-old girl presented with a 4-day history of fever, with extensive redness and swelling of the lumbar region and buttocks. She was diagnosed with extensive subcutaneous abscess of the lumbar region and buttocks. Surgical drainage was performed, and a substantial volume of pus was drained. MRSA was detected in the pus on culture. Antibiotic therapy that covered MRSA was also administered for 3 weeks, and the abscess healed. As it was a severe SSTI due to MRSA, analysis of MRSA revealed PVL-positive MRSA. This patient had no underlying disease or history of antibiotic administration, and as MRSA was present in the nasopharyngeal cavity, it was considered a case of CA-MRSA. Furthermore, the prevalence of PVL-positive CA-MRSA in MRSA isolated from patients with SSTI has also increased in Japan. The Infectious Diseases Society of America recommends surgical intervention and empirical antibiotic therapy for MRSA-complicated SSTI cases in an era of CA-MRSA. Pediatricians must strongly consider the possibility of MRSA in children with severe SSTIs.

Keywords: abscess; anal fistula; infant; methicillin-resistant *Staphylococcus aureus*; Panton-Valentine leucocidin
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Introduction

Staphylococcus aureus (S. aureus) is one of the indigenous bacteria that mainly resides on the skin, but sometimes causes bacterial infections, such as skin and soft tissue infections (SSTI). Whether *Staphylococcus aureus* is methicillin-resistant *Staphylococcus aureus* (MRSA) is mandatory when considering the possibility of *Staphylococcus aureus* as a causative bacterium. MRSA has traditionally been a problem in hospitalized individuals with some underlying diseases, which is called hospital-acquired MRSA (HA-MRSA). However, in recent years, community-associated MRSA (CA-MRSA), which causes serious infections in people in the community without underlying disease, has increased worldwide (Tong et al. 2015). Here, we describe a case of severe subcutaneous abscess due to Panton-Valentine leucocidin (PVL)-positive CA-MRSA in an infant without underlying diseases.

Case Presentation

A 4-month-old girl presented with a 4-day history of fever with no other signs. She was admitted to a previous hospital because of a high C-reactive protein (CRP) level when examined by her home doctor. She had no relevant perinatal, medical, or family history. She had been administered antibiotics in the past. On physical examination, she

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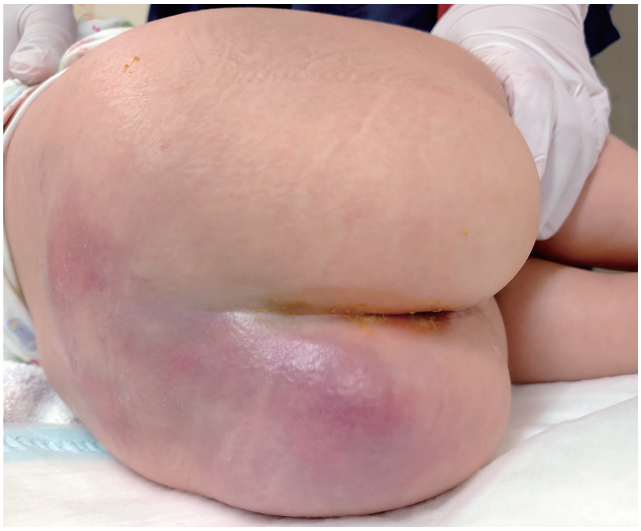

Fig. 1. Clinical appearance of the subcutaneous abscess. The image shows extensive redness and swelling of the lumbar region and the left buttock.

had extensive redness and swelling of the lumbar region and buttocks (Fig. 1). Blood test results showed a white blood cell count of 10,300/μL (neutrophils, 45.0%; lymphocytes, 33.0%), an albumin level of 2.7 g/dL, a C-reactive protein level of 16.3 mg/dL, and a procalcitonin level of 0.32 ng/mL (Table 1). Her urine and cerebrospinal fluid results were unremarkable. Cefotaxime was administered intravenously in consideration of her cellulitis and after collecting blood, urine, and cerebrospinal fluid samples and nasopharyngeal swabs for culture. On the following day, she was afebrile. However, the skin on the lumbar region and buttocks had not improved. On day 5 after admission, a contrast-enhanced computed tomography scan showed extensive subcutaneous fluid collection, indicating an abscess. (Fig. 2). The patient was transferred to our hospital because of the possibility of surgical intervention.

Magnetic resonance imaging (MRI) showed an extensive, high signal in the subcutaneous lesion located in the lumbar region and buttocks. This indicated an abscess, and a "bubble" appeared within the abscess (Fig. 3). This "bubble" suggested the possibility of external communication such as a perianal fistula. We also collected her feces for culture. Surgical aspiration and drain placement were performed, and a substantial volume of purulent fluid was drained. Gram staining showed Gram-positive cocci. Although the local findings did not improve, cefotaxime was continued because she became afebrile. After 4 days, MRSA was detected in the drainage fluid (Table 2). MRSA was also detected in the patient's feces when admitted to our hospital and on the nasopharyngeal swab collected by the previous hospital. Pathogenic bacteria were not detected in the blood, urine, or cerebrospinal fluid collected by the previous hospital. Cefotaxime was changed to intravenous vancomycin (trough concentration, 16.6 μg/mL). After 5 days, vancomycin was discontinued and switched to oral sulfamethoxazole-trimethoprim because drainage from the drain was almost non-existent and local skin findings improved. Sulfamethoxazole-trimethoprim was administered for 16 days. After completion of treatment, MRI examination findings showed a reduction in the volume of the subcutaneous abscess and the existence of a perianal

Table 1. Laboratory data at the time of hospitalization.

Hematology		Urine	
White blood cells	10,300 /μL	White blood cells	1-4 /HPF
Neutrophils	45%	Red blood cells	< 1 /HPF
Lymphocytes	33%	Protein	-
Hemoglobin	10.3 g/dL	Glucose	-
Platelets	44.2 ×10^4/μL	Nitrite	-
Biochemistry		Cerebrospinal fluid	
AST	13 U/L	Cell count	4 /μL
ALT	13 U/L	Protein	29.4 mg/dL
LDH	209 U/L	Glucose	70 mg/dL
Total protein	5.5 g/dL		
Albumin	2.7 g/dL		
Blood urea nitrogen	5.5 mg/dL		
Creatinine	0.17 mg/dL		
Sodium	134 mmol/L		
Potassium	4.5 mmol/L		
C-reactive protein	16.3 mg/dL		
Procalcitonin	0.32 ng/mL		

AST, aspartate aminotransferase; ALT, alanine aminotransferase; LDH, lactate dehydrogenase; HPF, high power field.

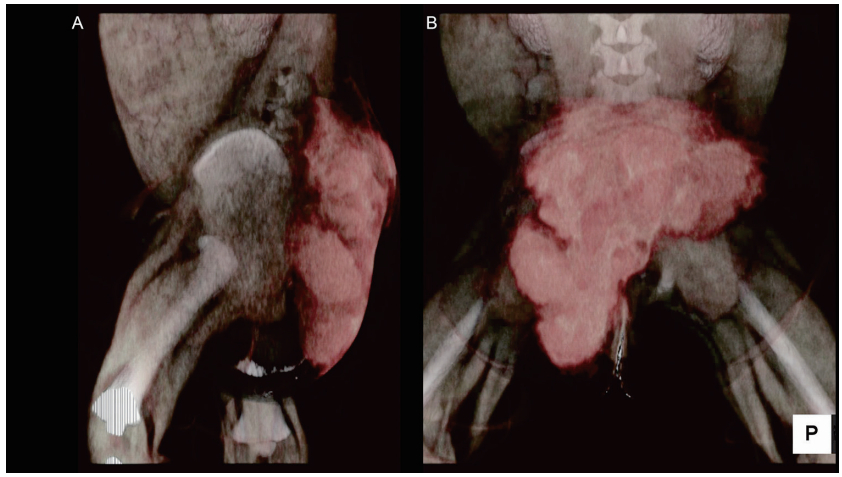

Fig. 2. Computed tomography findings of the subcutaneous abscess.
Three-dimensional, contrast-enhanced computed tomography shows an extensive subcutaneous fluid collection, indicating an abscess. (A) Sagittal. (B) Coronal.
P, posterior.

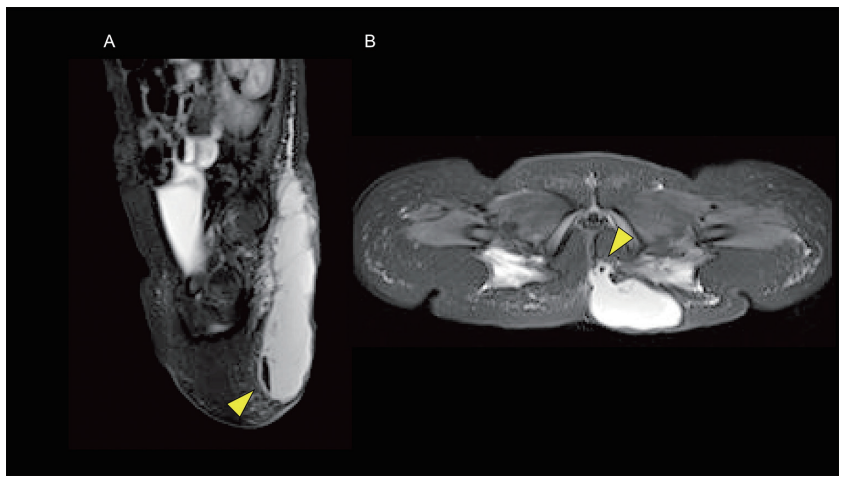

Fig. 3. Magnetic resonance imaging before surgical drainage.
Magnetic resonance imaging of short tau inversion recovery shows a bubble (yellow arrowhead) in the abscess. (A) Sagittal. (B) Axial.

fistula adjacent to the patient's left buttock (Fig. 4). In this case, the subcutaneous abscess was thought to be attributable to MRSA in the stools that passed through the perianal fistula. Surgical treatment for the perianal fistula was not performed.

It was a serious bacterial infection in an infant, and an immunological examination was implemented as we considered the possibility of primary immunodeficiency. The results of the immunological tests revealed normal immunoglobulin levels, lymphocyte subsets, and neutrophil function. As it was a severe SSTI due to MRSA, analysis of MRSA revealed PVL-positive MRSA. Multilocus sequence typing and Staphylococcal Cassette Chromosome (SCC) *mec* typing were performed to identify the strain isolated from the pus culture (MRSA from the nasopharyngeal sample could not be analyzed). These tests revealed that the sequence type was 8, and the SCC*mec* type was of type IV. This patient had no underlying disease or history of antibiotic administration, and MRSA was present in the nasopharyngeal cavity at the time of admission to the previous hospital; hence, a case of CA-MRSA was considered. One year later, follow-up revealed no recurrence of the subcutaneous abscess, and her growth and development were normal.

Written informed consent for publication was obtained from the patient's parents.

Discussion

CA-MRSA often causes more severe infections than HA-MRSA by carrying a leukolytic toxin such as PVL. PVL is one of the extremely pathogenic toxins produced by *S. aureus*. The prevalence of PVL is reportedly higher in MRSA strains than in methicillin-susceptible *S. aureus* strains (MSSA) (Ritz and Curtis 2012). PVL-positivity is

Table 2. Susceptibility results of MRSA.

Antibiotics	MIC	Category
Aminobenzylpenicillin	> 8	R
Penicillin-G	> 8	R
Aminobenzylpenicillin/sulbactam	16	R
Cefazolin	16	R
Imipenem	≤ 1	R
Arbekacin	4	S
Gentamicin	> 8	R
Erythromycin	> 4	R
Clindamycin	≤ 0.25	S
Minocycline	≤ 1	S
Levofloxacin	> 4	R
Vancomycin	1	S
Sulfamethoxazole-trimethoprim	≤ 0.5	S
Teicoplanin	≤ 1	S
Linezolid	2	S
Rifampin	≤ 0.5	S
Daptomycin	≤ 0.25	S
Mupirocin	≤ 256	S

MIC, minimum inhibitory concentration; MRSA, methicillin-resistant *Staphylococcus aureus*; R, resistant; S, susceptible.

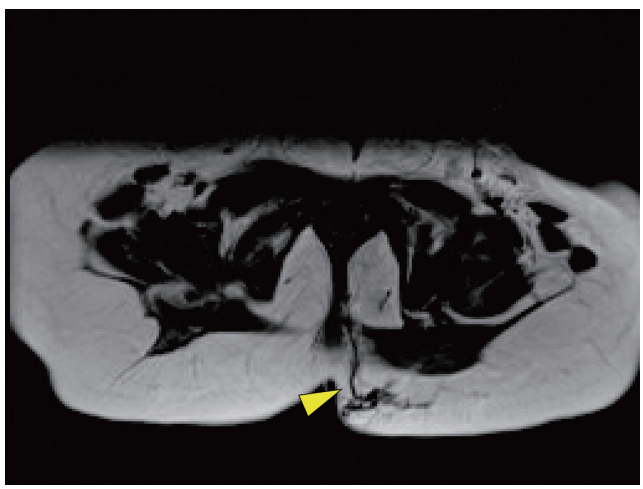

Fig. 4. Magnetic resonance imaging after surgical drainage and antibiotic therapy.
Magnetic resonance imaging after surgical drainage and antibiotic therapy reveals a perianal fistula (yellow arrowhead) adjacent to the patient's left hip.

higher in the USA300 clones, with the incidence of disease complications being higher in ST8 clones (Tenover and Goering 2009; Nakaminami et al. 2017; Takadama et al. 2018). PVL-positive CA-MRSA often causes severe deep-seated skin infections, such as furuncles and cellulitis (Takadama et al. 2017). In one study, CA-MRSA and MSSA was the causative pathogen in 63% and 15% of cases, respectively (Talan et al. 2011). The prevalence of PVL-positive CA-MRSA in MRSA isolated from patients with SSTI increased from 3.4% in 2013 to 12.0% in Japan in 2017 (Nakaminami et al. 2020). PVL-positive CA-MRSA also increased in children (Hoppe et al. 2019; Selb et al. 2022). We pediatricians must recognize that PVL-positive CA-MRSA is more likely to be the cause of SSTI and consider empirical antibiotics covering MRSA especially in severe cases, than previously thought.

The Infectious Diseases Society of America management recommendations of SSTI in the era of CA-MRSA are publicized in their clinical practice guidelines (Liu et al. 2011). The guidelines for hospitalized patients with complicated SSTI, such as deep soft-tissue infections, recommend surgical debridement and initiating empirical antibiotics for MRSA without waiting for the culture results. It is unclear whether the same management is recommended for all ages of children. Some reports have indicated that SSTI in younger children are more likely to be caused by *S. aureus,* especially MRSA, than SSTI in older children (Salazar-Ospina and Jiménez 2018; Yueh et al. 2022). Aggressive surgical intervention and empirical antibiotic therapy for MRSA may be recommended, not only in severe SSTI cases, but also in younger children, especially as SSTI due to CA-MRSA is also on the rise in Japan. We continued the intravenous cefotaxime administration, which was commenced at the previous hospital, until the results of the bacterial culture of the surgically drained pus were available. Our case was resolved satisfactorily, but in the case of an extensive subcutaneous abscess like this, CA-MRSA could have been considered, and MRSA could be covered by antibiotic therapy after surgical drainage. It would be useful to conduct further studies to investigate the epidemiology of CA-MRSA infections in children in Japan.

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Author Contributions

Dr. Fujita collected and analyzed the data and wrote and revised the initial manuscript. Dr. Matsudera, Dr. Watanabe, Dr. Yamaguchi, Dr. Suzuki, Dr. Ohkusu, Dr. Ishiwada, and Prof. Yoshihara interpreted all the data and critically revised the manuscript for intellectual content. Dr. Ohkusu and Dr. Ishiwada characterized the methicillin-resistant *Staphylococcus aureus* isolate, interpreted the data, and critically revised the manuscript for intellectual content. All authors approved the final manuscript and agreed to be accountable for all aspects of the work.

Conflict of Interest

The authors declare no conflict of interest.

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