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Original Article

Clinical characteristics of pyomyositis in children: 20-year experience in a medical center in Taiwan

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Background and purpose: Pyomyositis is an acute pyogenic infection of skeletal muscle. Because of its rarity, pyomyositis can be a diagnostic challenge. The clinical characteristics of pyomyositis were delineated in this study.
Methods: The medical records of patients younger than 18 years who were admitted to hospital from 1986 to 2005 and had a discharge diagnosis of pyomyositis were reviewed. The clinical presentations, laboratory data, and diagnostic tools were analyzed.
Results: Twenty four patients were enrolled. The mean ± standard deviation age was 5.3 ± 4.5 years. There were 13 boys and 11 girls. Eight patients (33.3%) had a preceding history of muscle trauma or local injection of the involved area. Five patients (20.8%), had underlying diseases identified. The most common presentations were fever (83.3%) and local swelling (33.3%). Ultrasound was done for 21 patients (87.5%) and provided a definite diagnosis for 20. Twenty patients (83.3%) had positive pus and/or blood culture results. The most common causative organism was *Staphylococcus aureus* (n = 14; 58.3%). Gram-negative organisms were isolated from 3 patients, all of whom had underlying diseases. Three patients (12.5%) received antibiotic therapy alone and 21 (87.5%) required aspiration or surgical incision and drainage. All patients recovered without sequelae.
Conclusions: Suspicion of pyomyositis is needed for children with previous trauma or injection when they have fever and local swelling of the muscles. Although *S. aureus* is the most common pathogen of childhood pyomyositis, Gram-negative organisms should be considered as possible pathogens in patients with underlying diseases.

Key words: Pyomyositis; *Staphylococcus aureus*; Ultrasonography

Introduction

Pyomyositis is the term used to denote spontaneous abscess of skeletal muscle [1]. Pyomyositis was initially recognized in tropical areas, but it has been increasingly recognized in temperate climates. Due to the non-specific presentation of pyomyositis and the obscure symptoms, this disease may be a diagnostic challenge for physicians working in temperate climates. Only a few children with pyomyositis have been reported in the literature [2-4]. Eight patients with staphylococcal pyomyositis treated between 1989 and 2001 have been reported in Taiwan [5]. As there is limited information about the condition in children, this retrospective study analyzed children with pyomyositis to clarify the clinical presentation.

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Methods

The medical records of patients younger than 18 years with a diagnosis of pyomyositis from January 1986 to December 2005 were reviewed. Diagnosis was based on compatible symptoms and signs, together with 2 or more of the following diagnostic features: pus aspirated from local lesions; isolation of bacterial pathogens from muscle or blood; compatible imaging results by ultrasound (US), computed tomography (CT), or magnetic resonance imaging (MRI).

The following data were obtained from the medical records: demographic characteristics, presentations,

and laboratory parameters, including initial complete blood cell count and differential count, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) level, serum creatinine kinase (CK), and culture results for pus or blood. Predisposing factors, including previous trauma, intramuscular injection, hospital admission history, and underlying medical conditions were recorded. Duration of symptoms before diagnosis, imaging findings, and treatment methods were also recorded. Parameters were compared between culture-positive and culture-negative groups, and between Gram-positive and Gram-negative groups.

Statistical analysis

Data were analyzed by using the Statistical Package for the Social Sciences for Windows (Version 12.0; SPSS, Inc., Chicago, IL, USA). Chi-squared and Mann-Whitney *U* tests were used for statistical analysis. A p value of <0.05 was considered to be significant.

Results

Twenty four children who met the study criteria were enrolled, including 13 boys and 11 girls. The mean age was 5.3 ± 4.5 years (range, 15 days to 15 years). There were 8 infants (33.3%), 7 toddlers (29.2%) aged from 1 to 5 years, 5 children (20.8%) aged from 6 to 10 years, and 4 adolescents (16.7%) older than 10 years.

There was no significant seasonal variation (Fig. 1). The most common predisposing factor was a history of muscle trauma of or local injection into the involved area, which was found in 8 patients (33.3%); 6 had a history of recent trauma and 2 had received an intramuscular injection prior to the onset of symptoms. Five patients had underlying conditions, as summarized in Table 1.

Fever was the most common presenting symptom (83.3%), followed by local swelling (33.3%), local pain (20.8%), limping gait (8.3%), and local erythema (8.3%). The most frequent sites of involvement were the muscles of the extremities, especially the lower extremities (n = 14; 58.3%) [Table 2].

The average ± standard deviation (SD) leukocyte count at admission was 17,304 ± 7864/mm^3 with 62.4 ± 19.3% neutrophils. The mean ± SD ESR at admission was 52.62 ± 32.31 mm/h and CRP was 14.42 ± 10.52 mg/dL. Serum CK was measured in 8 patients and was normal in 3.

Bacterial isolates were found in pus and/or blood in 20 patients (83.3%). The most common organism cultured from pus was *Staphylococcus aureus* (n = 12; 50.0%). Four patients had methicillin-resistant *S. aureus* (MRSA) and all were younger than 6 months. Positive blood cultures were found in 6 patients (25.0%), 5 of which were *S. aureus*, and 1 was group A *Streptococcus*. Two patients had *S. aureus* isolated from blood, but not from pus. Fourteen patients (58.3%) were infected by *S. aureus. S. aureus* was the leading causative pathogen

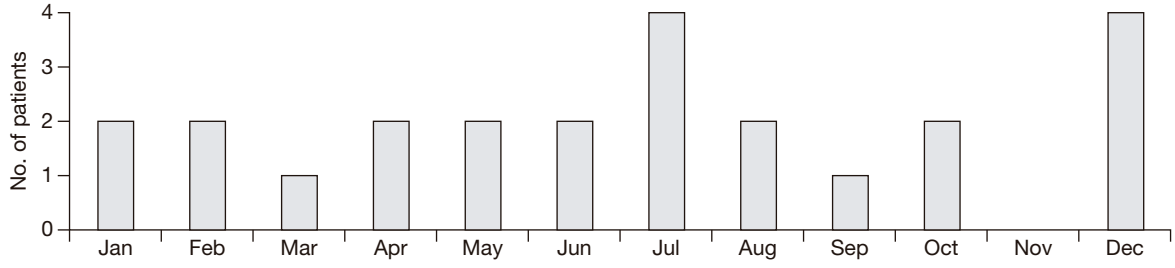

Fig. 1. Cumulative monthly incidence of pyomyositis.

Table 1. Demographic and clinical data of children with pyomyositis with cormorbid conditions (n = 5).

Patient no.	Sex/age (years)	Comorbidity	Presentation	Pus culture results
1	Male (0.1)	Prematurity	Right leg swelling	Methicillin-resistant *Staphylococcus aureus*
2	Male (3)	Acute myeloid leukemia	Neutropenic fever and right inguinal area tenderness	*Escherichia coli*
3	Male (4)	Necrotizing enterocolitis after operation; atopic dermatitis	Abdominal wall mass for 1 month	*Enterobacter cloacae*
4	Female (7)	Systemic lupus erythematosus	Fever and left thigh swelling	*Staphylococcus aureus*
5	Female (12)	Glycogen storage disease	Fever and left leg swelling	*Salmonella* group B

Table 2. Clinical manifestations and site of infection in children with pyomyositis (n = 24).

Variable	No. of patients (%)
Clinical manifestation	
Fever	20 (83.3)
Local edema	8 (33.3)
Local pain	5 (20.8)
Limping gait	2 (8.3)
Local erythema	2 (8.3)
Site	
Lower limbs	14 (58.3)
Abdominal wall	5 (20.8)
Upper limbs	2 (8.3)
Buttock	2 (8.3)
Chest	1 (4.2)
Back	1 (4.2)

identified in all age groups from both pus and blood (Table 3). Gram-negative organisms were isolated from 3 patients who all had underlying diseases.

The mean ± SD duration of time from onset of symptoms to diagnosis was 9.8 ± 7.9 days (range, 2 to 39 days). The mean ± SD duration from admission to confirmed diagnosis was 3.2 ± 3.2 days (range, 1 to 14 days). Imaging studies for diagnosis were performed for 21 patients (87.5%), as follows: US (n = 21; 87.5%), CT (n = 7; 29.2%), and MRI (n = 2; 8.3%). Of the 21 patients who underwent US, 20 (95.2%) had positive findings of infected muscles. The CT and MRI findings were all compatible with pyomyositis. Five patients with suspected complications of osteomyelitis or septic arthritis underwent 3-phase bone scan, 4 of whom had increased radiotracer uptake over a localized bony area.

All the patients received empiric intravenous antibiotic therapy with an antistaphylococcal agent, such as oxacillin, during the diagnostic period. Antibiotics were then adjusted according to the results of the antibiotic sensitivity tests. Three patients (12.5%) received antibiotic therapy alone, 7 (29.2%) had aspiration, and 14 (58.3%) underwent surgical incision and drainage. All the patients were cured or improved at discharge. Five patients had complications (4 had osteomyelitis and 1 had septic arthritis). There were no residual sequelae noted at follow-up.

Twenty patients (83.3%) had positive culture results and 4 (16.7%) had no culture-proved pathogens. Comparison of these 2 groups is shown in Table 4. There were no significant differences in age, initial total leukocyte count, or time from onset of symptoms to diagnosis between the 2 groups. All the patients with complications had positive culture (25% vs 0%). Culture-positive patients had longer hospital stay (26.8 ± 14.3 days vs 13.5 ± 4.5 days; $p = 0.015$) and longer duration of intravenous antibiotic therapy (25.8 ± 15.4 days vs 13.1 ± 5.3 days; $p = 0.023$).

Age distribution, duration of hospital stay, and laboratory data of patients with pyomyositis caused by Gram-positive and Gram-negative pathogens did not differ significantly between the 2 groups (Table 5). All the patients infected by Gram-negative organisms had underlying diseases, while only 2 of the patients infected by Gram-positive organisms had underlying conditions ($p = 0.009$). However, 5 patients (29.4%) with Gram-positive infection had complications of osteomyelitis or septic arthritis and 3 (17.6%) had septic shock. They were all cured without sequelae after treatment. None of these complications were detected in patients with Gram-negative infection.

Discussion

Pyomyositis affects all age groups in tropical climates, with a preponderance for children [6] and those aged

Table 3. Microorganisms isolated from pus and/or blood of patients with pyomyositis by age (n = 24).

Microorganism	Total No. (%)	Age (years) No. (%)			
		<1 (n = 8)	1-5 (n = 7)	6-10 (n = 5)	>10 (n = 4)
Methicillin-sensitive *Staphylococcus aureus*	10 (41.7)	3 (37.5)	4 (57.1)	1 (20.0)	2 (50.0)
Methicillin-resistant *Staphylococcus aureus*	4 (16.7)	4 (50.0)	0 (0)	0 (0)	0 (0)
Salmonella spp.	1 (4.2)	0 (0)	0 (0)	0 (0)	1 (25.0)
Streptococcus pneumoniae	1 (4.2)	0 (0)	1 (14.3)	0 (0)	0 (0)
Enterobacter cloacae	1 (4.2)	0 (0)	1 (14.3)	0 (0)	0 (0)
Group A *Streptococcus*	1 (4.2)	0 (0)	0 (0)	1 (20.0)	0 (0)
Escherichia coli	1 (4.2)	0 (0)	1 (14.3)	0 (0)	0 (0)
Staphylococcus hominis	1 (4.2)	1 (12.5)	0 (0)	0 (0)	0 (0)
No growth	4 (16.7)	0 (0)	0 (0)	3 (60.0)	1 (25.0)

Table 4. Comparison of children with positive and negative culture results for pyomyositis.

Variable	Culture positive (n = 20) Mean ± SD (range)	Culture negative (n = 4) Mean ± SD (range)	*p*
Age (years)	4.5 ± 4.8 (0.1-15.0)	4.5 ± 3.1 (0.1-7.0)	0.255
Time from onset to diagnosis (days)	8.9 ± 4.9 (3-21)	7.5 ± 4.4 (2.0-15.0)	0.379
White blood count (/μL)	16,618 ± 10,110	14,580 ± 4825	0.653
Duration of hospital stay (days)	26.8 ± 14.3 (8-49)	13.5 ± 4.5 (7-22)	0.015
Duration of antibiotic therapy (days)			
Intravenous	25.8 ± 15.4	13.1 ± 5.3	0.023
Oral	7.2 ± 8.4	6.3 ± 5.2	0.950
Total	31.7 ± 16.9	19.5 ± 4.9	0.142
Complications			
No. (%)	5 (25)	0 (0)	0.135

Table 5. Comparison of children with Gram-positive and Gram-negative pyomyositis infections.

Variable	Gram-positive (n = 17) Mean ± SD (range)	Gram-negative (n = 3) Mean ± SD (range)	*p*
Age (years)	4.2 ± 4.9 (0.1-15.0)	6.3 ± 4.9 (3.0-12.0)	0.221
Time from onset to diagnosis (days)	8.8 ± 5.0 (3-21)	9.3 ± 5.0 (4-14)	0.670
Underlying disease	2 (11.8)	3 (100)	0.009
White blood cell count (/μL)	17027 ± 9599	14300 ± 14980	0.711
Duration of hospital stay (days)	26.8 ± 13.9 (11-49)	26.3 ± 20.2 (8-48)	0.958
Complications	5 (29.4)	0 (0)	0.539
No. (%)			
Septic shock	3 (17.6)	0 (0)	0.430
No. (%)			

between 20 and 45 years [7]. A male predominance has been found in most studies [3,4,8-10]. However, in this study, there was no statistically significant sex difference. The Mackay Memorial Hospital, Taipei, Taiwan, has a large population of pediatric patients. One-third of patients in this study were younger than 1 year and 62.5% were younger than 5 years — this age distribution is younger than in previous reports [1,3,4]. Since daily activities for infants and toddlers are similar for both sexes, the male predominance starts at an older age. The young age distribution in this study may explain why there was no male predominance.

The pathogenesis of pyomyositis is not clearly understood. The disease may develop by hematogenous spread to susceptible muscle tissue during a period of transient bacteremia [11]. The suggestion that trauma is an important contributing factor is supported by a history of prior trauma in a large number of patients with pyomyositis (range, 25-50%) [3,6,7]. Trauma may facilitate hematogenous access to the muscles and provide critical bacterial nutrition, requirement for which is sequestered under normal conditions [12]. Formation of a small hematoma may provide a favorable site for the binding of bacteria, and the surrounding damaged and devitalized tissue might also impede the host immune response. Possible predisposing factors of immunodeficiency, nutritional deficiencies, and comorbidities, such as diabetes mellitus, virus infection, rheumatologic disease, renal insufficiency, and malignancy, have been considered [13]. In this study, 5 patients had underlying diseases.

The non-specific symptoms of pyomyositis make early diagnosis difficult, and often lead to misdiagnosis. The natural history of pyomyositis has been categorized into 3 stages. The initial invasive stage involves the insidious onset of dull cramping pain, with or without low-grade fever, that may progress over 10 to 21 days [8]. It is rare for patients to present at this stage. The second purulent or suppurative stage, during which most patients present, occurs when a deep collection of pus has developed in the muscle. The muscle is usually, but not always, tender, and the overlying skin may be mildly erythematous. Fever and chills is common at this stage. The third or late stage of generalized infection is characterized by high fever or septic shock. The overlying skin is severely erythematous and tender. Due to the vague initial presentation, diagnosis of pyomyositis is often delayed.

The mean delay from onset to correct diagnosis was about 12 days in a North American study [6] and, in a Hawaiian study, the diagnosis was made before admission in only 5 of 18 patients [2]. The mean duration of time from onset of symptoms to diagnosis was 8.8 days in this study, which is shorter than in previous reports.

The most frequently involved muscles are large ones such as the thigh, calf, buttock, upper extremities, and iliopsoas. The lower extremities are reported to be 4 times more likely to be involved than the upper extremities [13]. Consistent with the reported findings, the most common sites of involvement in this study were the muscles of the lower limbs.

Initial laboratory data of patients with pyomyositis may lack indicators of inflammation or infection. It has been reported that the white blood cell count is raised in 50% to 60% of patients [4]. Only 58% of the patients in this study presented with leukocytosis. The serum CK is often within normal limits [14,15], as it was for 3 of 8 patients in this study. This implies that in children who present early, the abscess is displacing muscle rather than invading it. In severe pyomyositis, particularly that for which the children present late, the CK value can be dramatically elevated, suggesting extensive destruction [16].

The most common causative organism of pyomyositis is *S. aureus,* with up to 90% of patients in tropical regions and 75% of those in temperate areas having *S. aureus* infection [12]. In immunocompromised patients, a range of other organisms has been described, including Gram-negative enteric organisms, anaerobic bacteria, and fungi [6]. The microbiologic profile in this study is similar to that for previous studies, which showed *S. aureus* as the leading organism in culture-positive disease. The Gram-negative pathogens in this study, including *Escherichia coli*, *Enterobacter cloacae,* and *Salmonella* group B were all causative organisms in children with underlying disease. Although the lack of an identified pathogen affects the choice of antibiotics, this may indicate a less complicated clinical course. In this study, anti-staphylococcal antibiotics resulted in a favorable outcome in children with culture-negative pyomyositis.

Owing to the lack of specificity of laboratory testing, imaging is the most useful method for diagnosing pyomyositis. US should be used first as it is inexpensive and widely available [17]. US of the affected area may identify increased muscle volume with associated fluid collections, and hypoechogenicity of fibroadipose septa [18,19]. Previous studies have shown that early use of US can help to establish early diagnosis of pyomyositis [6,15]. When US is inconclusive and a high index of suspicion persists, MRI is recommended in preference to CT because it has greater resolution [20]. If occult muscle abscesses or multifocal lesions are suspected, nuclear scintigraphy can also be used to identify the lesions, and to localize the extent of the abscess [21]. In this study, US was the most frequently used imaging tool for the diagnosis of pyomyositis. CT and MRI were also helpful, but were not necessary for all patients. Three-phase bone scan is indicated for patients suspected to have concurrent osteoarticular problems, such as osteomyelitis or septic arthritis.

Intravenous antimicrobial therapy has been recommended for at least 7 to 10 days, followed by a variable period of oral antibiotic therapy for 4 to 6 weeks, depending on the severity of the condition and the presence of complications such as osteomyelitis [9]. Surgical incision and drainage is also important for most patients. The outcome for pyomyositis is generally good. All the patients in this study recovered without sequelae, although some had associated osteomyelitis or arthritis.

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