

Septic Arthritis and Acute Osteomyelitis in Early Infancy

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We retrospectively studied 10 cases of patients with septic arthritis with or without osteomyelitis who were admitted to Cathay General Hospital from November 1989 to November 1997. Most of the patients were infants younger than 2 months; they included three premature neonates and seven full-term infants. The female:male ratio was 7:3. Soft tissue swelling and decreased range of motion of the affected limbs were the clinical signs that attracted the attention of the medical personnel and that subsequently led to the right diagnosis. Among these 10 patients, two presented with signs of Erb's palsy initially, so true paralysis of the affected limb should alert all clinicians that paralysis may be the result of septic arthritis or osteomyelitis. In this study, 60% of the patients had septic arthritis concomitant with osteomyelitis. The right upper limb was the most commonly affected site (80%). This pattern of involvement may have been related to the fact that a high proportion of patients were cannulated on the right upper limb in our institution. Moreover, the focus of infection was closely related to the intravenous or intra-arterial catheterization in six patients (60%). The most common pathogen involved in this infection was Staphylococcus aureus with or without methicillin resistance. The three patients infected by methicillin-resistant Staphylococcus aureus (MRSA) were all premature neonates. Since septic arthritis and osteomyelitis are usually the result of hematogenous spread, the risk factors causing these diseases are the same as those causing bacteremia. The usual risk factors are femoral venipuncture, umbilical catheterization and prematurity, but we found that intravenous or intra-arterial catheterization were also important factors causing this ominous disease in early infancy.

Key words: Septic arthritis, Osteomyelitis, Intravenous catheterization, Intra-arterial catheterization

Acute osteomyelitis and septic arthritis in early infancy are rare diseases and are very different from those same infections in the older child [1, 2]. Due to the rarity of the diseases and the paucity of signs and symptoms, making an early diagnosis is difficult. The risk factors for this disease include prematurity, respiratory distress syndrome, low birth weight (<1,500 g), parenteral nutrition, invasive procedures such as femoral venipuncture, and umbilical catheterization [1, 3]. The aim of this study was to review the clinical features, pathogens and risk factors for these rare diseases in early infancy.

Materials and Methods

This study was a retrospective review of cases diagnosed as septic arthritis and/or osteomyelitis during the period from November 1989 to November 1997. Diagnostic criteria for septic arthritis in this study were: (1) clinical findings such as fever, involved joint swelling, tenderness,

local heat, and decreased range of motion. (2) a radiological finding of joint capsular swelling and/or a bone scan finding of increased tracer uptake of the affected joint; and (3) positive bacterial cultures from blood, joint fluid, or both. Diagnostic criteria for osteomyelitis in this study were: (1) clinical findings such as fever, local swelling, local erythematous change, local heat, and pseudoparalysis. (2) a radiological finding of osteolytic or osteosclerotic change and/or a bone scan finding of abnormal increased tracer uptake by the affected bone; and (3) positive bacterial cultures from blood, soft tissue and/or joint fluid. All the studied cases had to meet two or more of the above criteria in the diagnosis of septic arthritis and osteomyelitis.

Results (Table 1 and 2)

Ten cases met the criteria we set above. Seven patients were female and 3 were male. Most of the patients were

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Table 1. Data for 10 infants with acute osteomyelitis and septic arthritis

Joint	*GA (weeks)	Sex	Age at onset	Site of infection	Organism	Source of isolate	Drainage	X-ray	Duration from *S/S to X-ray	Bone scan (Duration from S/S)	Catheterization before onset	Disease on Admission	
	+BBW Kg			Bone									
1	40 2.6	F	9D	Lt hip	S. aureus	Joint	Arthrocentesis	Not performed	@CT scan on 8th D of s/s (+)	Not performed	Intravenous catheterization (6D)	Fever R/O sepsis	
2	41 3.56	F	30D	Rt shoulder	Humerus head	S. viridans. § CSF	Open Drainage	↓ density of humeral head	3 D	Rt shoulder ↑ uptake (20 D)	NIL	Rt shoulder arthritis	
3	40 3.35	F	14D	Rt shoulder	Humerus head	S. aureus	Open Drainage	↓ density of humeral head	3 D	Normal (3 D)	NIL	Rt shoulder arthritis	
4	40 2.7	F	23D	Rt elbow	Distal humerus	S. epidermidis	Arthrocentesis	Normal	2 D	↑ uptake of distal humerus (2 D)	Intravenous catheterization (3D)	Fever R/O sepsis	
5	28 0.98	M	4M	Rt elbow	Humerus head	± MRSA	Joint Soft tissue Blood	Irregular edge of rt humeral head	7 D	↑ uptake of rt elbow (7 D)	Intravenous & intra-arterial catheterization in rt antecubital space	Prematurity δ RDS	
6	41 3.41	M	7D	Lt ankle	Lt clavicle	S. aureus	Soft tissue Blood	Osteosclerotic change- clavicle	2 D	Normal (14 D)	Intravenous catheterization (2D)	Fever R/O Sepsis	
7	33 2.10	F	14D	Rt elbow	Humerus head	± MRSA	Soft tissue	Not performed	3 D	Not performed	Intravenous & intra-arterial catheterization in rt antecubital space	Prematurity δ RDS	
8	38 3.3	M	41D	Rt elbow	Distal humerus	K. pneumonia	Joint	Arthrocentesis	2 D	↑ uptake of distal humerus (5 D)	Intravenous & intra-arterial catheterization in rt antecubital space	Septic arthritis	
9	29 1.23	F	43D	Rt 3 rd middle Interphalangeal	Rt 3 rd Middle phalangeal bone	± MRSA	Soft tissue Blood	Not performed	Defect on Rt 3 rd middle phalanx	Not performed	Intravenous catheterization & Intra-arterial catheterization of rradial artery	Prematurity δ RDS	
10	40 2.75	F	30D	Rt shoulder	Humerus Head	S. viridans	Joint Blood	Open drainage	7 D	↓ density of humeral head	Rt shoulder ↑ uptake (30 D)	NIL	Septic arthritis

*GA: Gestational age
 + BBW : Birth body weight
 ± MRSA: Methicillin-resistant *Staphylococcus aureus*
 §CSF: Cerebral spinal fluid
^a S/S: Symptom and sign

@ CT: Computer tomography
 δ RDS: Respiratory distress syndrome

Table 2. Laboratory data for 10 infants with acute osteomyelitis and septic arthritis

Patient	*WBC(/mm ³) (pre-treatment)	WBC(/mm ³) (post-treatment)	+ESR(mm) (1 hr/2 hr) (pre-treatment)	ESR(mm) (1 hr/2 hr) (post-treatment)	Interval (days)
1	10420	16040	108/127	35/64	8
2	9460	1026	125/142	32/64	12
3	14480	5350	94/118	22/50	8
4	11420	10550	56/110	18/40	12
5	16180	6710	87/92	10/28	7
6	31840	10290	73/109	54/90	30
7	15860	17740	23/58	14/41	8
8	14870	13470	108/128	75/123	12
9	10890	7690	35/46	7/27	7
10	11760	9650	30/52	5/15	9

*WBC: White blood cells
 +ESR: Erythrocytes sedimentation rate

younger than 2 months old. There was only one premature infant (gestational age: 28 weeks) who was noted to have osteomyelitis and septic arthritis when he was 4 months old (corrected age: 8 weeks old) and was still hospitalized when the diagnoses were made. The birth weights of the studied patients ranged from 0.98 Kg to 3.5 Kg. There were seven cases involving full-term infants and three cases involving premature neonates.

Patients who acquired the infection during hospitalization for unrelated diseases or following invasive procedures in the hospital were considered to have hospital-acquired infection. Patients who were previously healthy at home before the onset of the infection were considered as having community-acquired infection. There were six cases of hospital-acquired infection (60%) and the remaining four cases were community-acquired infection (40%).

Nine patients (90%) showed decreased range of mo-

tion for the affected limbs. Patient 7 presented with pseudoparalysis of the affected limb with normal nerve conduction velocity (NCV). Patient 8 showed decreased range of motion of the right forearm and an NCV study showed ulnar nerve palsy. Patient 2 and 3 presented with progressive weakness of the right upper limb and the physical examination on admission showed the possibility of Erb's Palsy which was confirmed later by an electromyogram (EMG) and NCV studies. Roentgenograms of the bone performed for these two patients (patient 2 and 3) on admission showed osteolytic changes of the right humeral head.

In patients 1, 4, 5, 6, 7, 8 and 9 (70%), swelling of the involved joints and/or bones was the first sign that drew the attention of the medical personnel. For patient 1, the swelling was over the left hip joint. For patients 4,5,7 and 8, the swelling was over the right elbow joint. For patient 6, the swelling was in the left clavicular area. For patient 9, the swelling was in the right interphalangeal joint area.

For patients 5, 7, 8 and 9, it was the swollen area which led us to think that intravenous or the intra-arterial catheterization was closely related to the septic arthritis and osteomyelitis in these cases. For patient 5 and 7, the swelling was noted over the elbow joint where antecubital arterial catheterization was performed. For patient 8, swelling was also noted over the elbow joint where an intravenous line was inserted when the patient was admitted at another hospital under the diagnosis of fever of unknown origin. For patient 9, the swelling was over the right interphalangeal joint but intra-arterial catheterization had been performed on the right radial artery. For patient 1 and 4, the swollen area was not the site of intravenous catheterization, but these two patients had had intravenous catheterization 3 to 6 days before the onset of the septic arthritis and/or the osteomyelitis. So, among these 10 studied cases, 60 % of the cases of septic arthritis and/or osteomyelitis were associated with intravenous or intra-arterial catheterization.

Patient 1 was brought to our hospital because of irritability, poor feeding, and mild fever (38°C). These non-specific signs and symptoms of fever, irritability and poor feeding were also noted in other patients after complete and thorough history taking during a second interview with the parents. Six patients (60%) presented with mild fever (38°C to 38.5°C) at the onset of the disease. However, only patient 6 presented with high fever (39°C) and other toxic signs.

In this study, six patients (60%) had concomitant septic arthritis and osteomyelitis. In patients 2, 3 and 10, the septic arthritis occurred in the shoulder joint and the osteomyelitis was found in the adjacent humeral head. In patients 4 and 8, the septic arthritis occurred in the elbow joint and the osteomyelitis was found in the adjacent dis-

tal humerus. In patient 9, the septic arthritis occurred in the interphalangeal joint and the osteomyelitis was found in the adjacent proximal phalangeal bone. In this study, not all of the cases of septic arthritis occurred adjacent to the sites of osteomyelitis. In patient 6, the septic arthritis occurred in the left ankle joint while the osteomyelitis occurred in the right clavicle. In patients 5 and 7, the arthritis occurred in the right elbow joint while the osteomyelitis occurred in the head of right humerus. There was only one patient (patient 1) with septic arthritis alone without the involvement of osteomyelitis.

There were four cases of elbow joint arthritis, three of shoulder joint arthritis, one of interphalangeal joint arthritis, one of ankle joint arthritis, and one of hip joint arthritis in this study. In comparison, the bones involved in osteomyelitis included five cases in the humeral head, two cases in the distal humerus, one case in the clavicle and one case in the proximal phalangeal bone. The right upper limb was the most commonly affected site (80%) in this study.

Five patients (50%) (patients 2, 5, 6, 9, and 10) with septic arthritis and osteomyelitis were infected through the hematogenous route in this study. There were four cases of hematogenous spread with the proof of a positive bacterial culture from blood and synovial fluid or soft tissue. In contrast, there were no pathogens cultured from blood from patient 2, but both synovial fluid and cerebral spinal fluid (CSF) showed *Streptococcus viridans* in that case.

The infecting pathogen most often identified (60%) was *Staphylococcus aureus* with or without methicillin resistance in this study. Other pathogens were *Streptococcus viridans*, *Staphylococcus epidermidis* and *Klebsiella pneumoniae*.

Elevated peripheral white blood cell counts ($\geq 15,000/\text{mm}^3$) were noted in three cases (30%) (patients 5, 6, and 7). An elevated erythrocyte sedimentation rate (ESR) was noted in all patients at the time of admission. Follow-up serial ESR determination showed that the levels decreased after 7 to 30 days (mean, 10.3 days) of treatment.

Seven patients (70%) (patients 2, 3, 5, 6, 7, 9, and 10) showed osteolytic or osteosclerotic change of the affected bones on X-ray within 2 to 7 days of the onset of symptoms (mean, 3.8 days). For patient 4, both an X-ray and a bone scan were performed 2 days after the onset of signs and symptoms. The X-ray was normal but increased tracer uptake was noted in the bone scan. For patient 8, an X-ray was normal 2 days after the onset of signs and symptoms and a bone scan showed increased tracer uptake 5 days after the onset of signs and symptoms. For patient 1, a computer tomography (CT) scan was done after 8 days of signs and symptoms and the result showed

left hip joint arthritis.

A bone scan was performed for seven patients (patients 2, 3, 4, 5, 6, 8, and 10) within 5 to 30 days of the onset of signs and symptoms (mean, 14.4 days). Bone scans of patient 3 and patient 6 done 3 days after the onset of symptoms, respectively, were normal, whereas the rest of the patients showed abnormal increased tracer uptake in their bone scans.

Antibiotics were given in all cases for 4 to 6 weeks. Arthrotomy and debridement were performed in three cases (patients 2, 3 and 10). Patient 9 showed right middle finger deviation on Outpatient Department (OPD) follow-up 5 months later. For patient 3, a follow-up examination at 6 months of age showed almost normal range of motion except for mild limitation of the right upper arm. Three patients were lost to follow-up and the remaining patients were normal and did not have any sequelae.

Discussion

Septic arthritis and Osteomyelitis in early infancy are very uncommon and are distinct from those diseases occurring in older children. During infancy, the bone is weak, the cortex is soft, the periosteum is loose and the epiphysis has not been developed. A developing abscess can therefore easily rupture into the surrounding tissues or invade directly into the joint space, so concomitant septic arthritis is usually noted with infantile osteomyelitis. In septic arthritis, growth plate disruption usually leads to permanent disability and deformities. Early recognition, decompression, and antibiotic treatment are imperative measures to minimize the sequelae [1, 2, 4].

In general, the clinical signs and symptoms of septic arthritis and osteomyelitis are nonspecific and insidious. Most infants are not brought for medical attention until local signs such as swelling, local erythematous change, and decreased range of motion of the extremity become apparent. Fever may be observed but the body temperature is seldom high [4-6]. In this study, only one patient was noted to have a high fever (39°C). Decreased range of motion of the affected limbs was noted in nine cases (90%) and soft tissue swelling was noted in seven cases (70%) in this study. In four cases, the swollen area of the involved joint was the site of an intravenous or intra-arterial line inserted during a period of hospitalization. In this study, soft tissue swelling and decreased range of motion were the most useful clinical signs leading to the diagnosis of the diseases. Frederiksen et al also found in their study that soft tissue swelling and pseudoparalysis were the most useful clinical signs in the diagnosis of septic arthritis and osteomyelitis [1]. In our study, two patients showed signs of Erb's palsy because of the os-

teomyelitis and arthritis. Pseudoparalysis of extremities owing to pain or muscle spasm from infection of articular space is common. However, though rare true paralysis of the affected extremities secondary to arthritis and osteomyelitis occurs. Therefore paralysis associated with septic arthritis and/or osteomyelitis in some patients may not be "pseudoparalysis" and that septic arthritis and/or osteomyelitis should be differentiated from true brachial plexus neuropathy [7, 8].

Septic arthritis Osteomyelitis and in the early infancy are usually the result of hematogenous spread of infection, and so their risk factors are closely related to the risk factors of bacteremia [1]. Invasive procedures, prematurity and respiratory distress syndrome have been noted to be the significant risk factors [1, 2]. In one study, it was proven that an intravascular device was the most common portal of entry of the infection [3]. In the present study, the infection in six cases was obviously related to the intravenous or intra-arterial cannulation.

The long bones (femur, humerus, tibia, radius and ulna) are the most frequently affected sites in many studies [1-3, 5]. The reason for the predilection of infection for long bones is that the metaphyseal areas of these long bones are very vascular and the blood flow through the sinusoidal loops is slow [2, 4]. In this review, almost all the affected sites were on the right humerus (80%). This pattern of involvement may have been related to the high proportion of patients with intravenous or intra-arterial cannulation in the right upper limbs in our hospital. If the infection occurs in a bone that has an intra-articular metaphysis, a concomitant septic arthritis can occur as the abscess ruptures from the subperiosteal space into the joint. This occurs commonly in the hip joint, but also may occur in the shoulder, ankle, and elbow [2, 4]. In our study, 60% of the patients had concomitant septic arthritis and osteomyelitis. Concomitant septic arthritis and osteomyelitis occurred in the right shoulder joint in three patients and in the right elbow joint in three patients in this study.

In Taiwan, the most common pathogen of this infection in all age groups is *Staphylococcus aureus* [5]. Several groups have reported an etiologic shift toward *Group B Streptococcus* [9, 10]. But in 1995, Wong et al [2] found in their study that staphylococci remained the predominant pathogen in their institution. In this study, six patients (60%) were infected by *Staphylococcus aureus* with or without methicillin resistance. The three patients infected by MRSA were all premature neonates. A study performed in an Australian tertiary neonatal unit showed that all the cases of osteomyelitis and/or septic arthritis due to MRSA involved sick premature infants requiring intensive support [3].

Broad spectrum antibiotics should be started as soon

as possible after a blood culture and after a joint has been aspirated to obtain fluid for culture. The recommended initial therapeutic regimen is a combination of intravenous methicillin and gentamicin. In general, isolated septic arthritis should be treated for at least 2 to 3 weeks, but septic arthritis due to *Staphylococcus aureus* usually requires 4 to 6 weeks of antibiotic therapy [11]. If septic arthritis is associated with concomitant osteomyelitis, the duration of antibiotic therapy should be 4 to 6 weeks. In hospitals where methicillin-resistant organisms are prevalent, one of the glycopeptides must be considered as the drug of first choice. Subsequent antibiotics therapy is based on culture results [4, 5, 12]. In this study all the patients were treated with antibiotics for 4 to 6 weeks.

Immediate open drainage is recommended for any patient who has a septic hip or shoulder [5, 12]. The widely accepted indications for surgery in the patient with septic arthritis include: (1) arthritis of the hip joint, with some specialists maintaining that infection of the shoulder joint is also an indication; (2) the presence of large amounts of fibrin, debris or loculation within the joint space; and (3) arthritis not improving with medical treatment within 3 days [12, 13, 15]. The indications for surgery in the patient with osteomyelitis are: (1) abscess formation in the bone, subperiosteum or adjacent soft tissue; (2) bacteremia persisting beyond 48 to 72 hours after initiation of antibiotic treatment; (3) persistent fever, pain or swelling after 72 hours of therapy; (4) development of a sinus tract; and (5) the presence of sequestra [12, 13, 15]. Arthrotomy and debridement were performed in three cases in this study. All three of these patients had infection in the right shoulder joint and the humeral heads. Arthrocentesis was performed in four cases for the diagnosis and treatment.

In conclusion, the infection of bones and joints in infants is usually due to hematogenous spread, and intravenous and intra-arterial access are important ports of infection in the hospitalized patients especially high risk premature neonates in the Neonatal Intensive Care Unit. Therefore, it is very important that all invasive procedures be done using strict sterile techniques. In this study, soft tissue swelling and decreased range of motion were the most useful signs attracting the attention of the medical personnel who made the right diagnosis. The two patients presenting with signs of Erb's palsy should alert all clinicians and pediatricians to the possibility that weakness of the upper extremities in the neonates may be a result of the bone and/or joint infection.

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