

# Pediatric Calcaneal Osteomyelitis

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**Background:** Osteomyelitis continues to be a common problem amongst the pediatric population. Osteomyelitis of the calcaneus is an uncommon problem that still poses a problem to the treating physician. The purpose of this article is to retrospectively review a large series of pediatric patients with calcaneal osteomyelitis. We compare our experience with that in the literature to determine any factors that may aid earlier diagnosis and or improve treatment outcomes.

**Methods:** A 10-year retrospective review was performed of clinical records of all cases of pediatric calcaneal osteomyelitis managed at the 2 children's orthopaedic departments in the Auckland region. The Osteomyelitis Database was used to identify all cases between 1997 and 2007, at Starship Children's Hospital, and 1998 and 2008 at Middlemore's Kids First Hospital.

**Results:** Sixty patients fulfilled the inclusion criteria, and had a review of clinical notes and relevant investigations. The average duration of symptoms before presentation to hospital was 6.8 days. About 40% of patients had a recent episode of trauma. About 82% of patients could not bear weight on admission. Only 22% of patients had a temperature above 38°C. Erythrocyte sedimentation rate was elevated in 81% and the C-reactive protein was elevated in 77% of patients. About 27% of patients had positive blood cultures with *Staphylococcus aureus* being the most commonly cultured organism. X-rays, bone scans, and magnetic resonance imaging were all used to aid the diagnosis. About 20% of patients had surgery with an average of 1.3 surgeries for those who progressed to surgery. Treatment length was an average of 2 weeks 6 days of intravenous antibiotics followed by 3 weeks 2 days of oral treatment. There were no postsurgical complications and 10 readmissions: 3 for relapse, 3 for peripherally inserted central catheter line problems, and 4 for antibiotic-associated complications.

**Conclusions:** Although sometimes more difficult to diagnose, calcaneal osteomyelitis can be diagnosed with an appropriate history, clinical examination, and investigations. Treatment with intravenous and oral antibiotics and surgical debridement if indicated can lead to a good clinical outcome with minimal complications.

**Key Words:** calcaneal, radiology, treatment outcomes, osteomyelitis

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Osteomyelitis continues to be a common problem amongst the pediatric population. The most frequent sites are within the long bones for example the femur and tibia, whereas the calcaneus is an uncommon site. Rates of calcaneal osteomyelitis are quoted as between 3% and 10% of all cases of pediatric osteomyelitis, and the literature contains case reports and several small series.<sup>1–3</sup>

Osteomyelitis can result from hematologic spread or from direct inoculation, usually from an overlying open wound or foreign body penetration. Calcaneal osteomyelitis has a less dramatic presentation than long bone osteomyelitis, and subsequently the diagnosis is often delayed. Complications of calcaneal osteomyelitis include chronic infection, growth arrest, leg length discrepancy, and spontaneous arthrodesis of surrounding joints.<sup>1,2</sup>

The aim of this article is to retrospectively review a large series of pediatric patients with calcaneal osteomyelitis. We compare our experience with that in the literature to determine any factors that may aid earlier diagnosis and or improve treatment outcomes.

## METHODS

A 10-year retrospective review was performed of clinical records of all cases of pediatric calcaneal osteomyelitis managed at the 2 children's orthopaedic departments in the Auckland region. The Osteomyelitis Database was used to identify all cases between 1997 and 2007, at Starship Children's Hospital, and 1998 and 2008 at Middlemore's Kidz First Hospital. Patients presenting with preexisting chronic osteomyelitis, or osteomyelitis secondary to heel prick blood sampling or compound fracture were excluded. This left 60 patients for review.

Review of the presentation focused on the history, including symptom duration, the presence of concurrent illness, and weight-bearing status; the clinical signs, including temperature, heart rate, local swelling, warmth, and erythema; and the diagnostic tests performed, including hematology, microbiology, and radiology. The time until final diagnosis and the management performed, including the prescribed antibiotic regimen and surgical procedures, was recorded. Finally, latest follow-up appointments and secondary complications were considered.

**RESULTS**

Sixty patients fulfilled the inclusion criteria: 40 males and 20 females, with an average age of 6 years 8 months (range: 11 mo to 13 y 1 mo). Twenty-five (42%) patients identified themselves at New Zealand Europeans, 11 (18%) as New Zealand Maori, 17 (28%) as Pacific Island, 4 (7%) as Chinese, and 3(5%) as another ethnicity.

Symptom duration averaged 6.8 days (range: 1 to 34 d). Sixteen (27%) patients had a concurrent illness at presentation, including an upper respiratory tract infection, infected eczema, and a heart murmur. Twenty-four patients (40%) related some episode of recent trauma: 15 sustained a bruise or twisting injury to the leg, 5 had superficial puncture wounds in the heel, 2 had blisters on the same foot, 1 had a laceration further up the same leg, and 1 had a scratch on the same foot. There were 2 concurrent foot fractures but no pathologic fractures of the calcaneus.

On admission, 46 (82%) could not bear weight on the affected foot, 9 (16%) were partial weight bearing or crawling, 1 was able to bear weight on the affected foot, and 4 (6%) patients did not have weight-bearing status recorded.

The average temperature on admission was 37.2°C (range: 36 to 39.4°C), and 13 (22%) patients had a temperature greater than 38°C. The average heart rate on admission was 107 beats per minutes (range: 60 to 160 beats/min), and 25 patients (42%) had a heart rate above 110 beats per minutes.

Local swelling was recording in 56 patients. Thirty-four (61%) of these patients had swelling. Twenty-five (48%) patients, from 52 recordings, had local warmth and 19 (38%) patients, from 50 recordings, had local erythema.

All children had a venous white blood cell count (WCC) performed upon admission. The average WCC was 10.6 (range: 5.0 to 21.6) and 23 patients (38%) had a WCC above 11. The C-reactive protein (CRP) was measured in 45 patients (75%), with an average of 48.3 (range: <1 to 360). Erythrocyte sedimentation rate (ESR) was measured in 58 patients (97%), with an average of 41.5 (range: 1 to 147).

Blood cultures were performed on 59 patients upon admission and 16 patients (27%) had positive findings. *Staphylococcus aureus* was cultured in 10, *Streptococcus pyogenes* in 3, Coagulase-negative *Streptococcus* in 1, micrococcus in 1, and an undifferentiated Gram-positive

organism in 1. There were no cases of methicillin-resistant *Staphylococcus aureus* (MRSA)-positive cultures (Table 1).

A plain radiograph was performed during the admission of 59 (98%) patients, and 14 (24%) patients had a positive finding. Seventeen (28%) patients proceeded to bone scan, and 15 (87.5%) of these patients demonstrated a positive change within the calcaneus. Twenty-two (37%) patients were referred for a magnetic resonance imaging (MRI) scan and all had signal abnormality consistent with an imaging diagnosis of osteomyelitis. Two patients had an ultrasound scan, both with positive findings, but no patients in this series underwent computerized tomography scanning. Long-term follow-up radiographs were performed in 37 patients, with 13 (35%) showing lasting radiographic abnormalities consistent with previous osteomyelitis (Fig. 1).

The diagnosis of osteomyelitis was made in 38 patients (63%) at the time of admission. The remaining patients required more sophisticated diagnostic studies and the average time delay until a final diagnosis was reached was 2.9 days. Fifty-eight (97%) cases were restricted to the calcaneus, 1 case involved the calcaneus and the talus, and 1 multifocal case involved the calcaneus and the ulna.

Surgery was performed for 12 patients (20%). Eight of these patients had 1 operation, 3 had 2 operations, and 1 had 3 operations, giving an average of 1.3 procedures for all patients that were surgically managed. Aspiration alone was performed for 2 patients; and aspiration, debridement, and washout for 9 patients. Decision for the location of the incision was based on the location of the abscess. (4 had lateral incisions, 3 medial, 1 posterolateral, and 1 cannula port washout.) There was 1 lost operation note. Of these 12 patients, 10 had tissue cultures performed with 9 patients positive results. Seven colonized *Staphylococcus aureus*, 1 *Streptococcus pyogenes*, and 1 *Staphylococcus aureus* and Gp B *Streptococcus*.

From admission to the start of antibiotic treatment, the average delay was 0.92 days (range: 0 to 6 d), and 52 patients (87%) were started on intravenous (IV) treatment within 24 hours of admission to hospital. Augmentin (amoxicillin + clavulanic acid) was prescribed in 34 (57%) patients, flucloxacillin in 28 (47%), a cephalosporin in 8 (13%), clindamycin in 5 (8%), and penicillin in 4 (7%). In 19 patients (32%), the antibiotic regimen was altered during the course of treatment, which explains the

**TABLE 1.** Clinical and Radiographic Findings

Clinical	Radiographic		
	X-ray	Bone Scan	Magnetic Resonance Imaging
Nonweight bearing/limping affected leg	Normal	Increased uptake of tracer	Soft tissue edema
Pain localized to calcaneus	Soft tissue swelling		Low-density changes T1
Erythema	Joint effusion		Hyperintensity and enhancement T2
Swelling	Sclerosis or lysis		Enhancement postgadolinium
Warmth	Diffuse changes		Ankle/subtalar effusions
			Abscess formation

percentages above. The average duration of IV antibiotic treatment was 2 weeks and 6 days (range: 0 to 7 wk), and this was followed by a course of oral antibiotics for an average of 3 weeks and 2 days (range: 0 to 9 wk).

The average hospital admission was for 12.6 days (range: 0 to 42 d), and follow-up management averaged 16.6 weeks (range: 0 to 118 wk).

Over the 10-year period, there were 10 readmissions (17% of cases). Three readmissions were for recurrence of osteomyelitis. All 3 settled on repeat prolonged courses of antibiotics. There were no particular findings that predicted these 3 recurrences. Three patients were admitted for peripherally inserted central catheter (PICC) line complications requiring line removal, and 4 for antibiotic-related problems. Overall 8 patients (13%) developed an adverse reaction to an antibiotic; 6 a rash and 2 neutropenia. Six percent of the patients treated with augmentin, and 21% of the patients treated with flucloxacillin, sustained an adverse reaction. There were no postsurgical complications.

### DISCUSSION

Osteomyelitis continues to be a common problem amongst the pediatric population. The common sites are the long bones (eg, femur and tibia). The calcaneus is an uncommon site with rates in the literature quoted as between 3% and 10%.<sup>1-3</sup> Susceptibility of the calcaneus to infection may be because of the “metaphyseal equivalent” region that borders the apophysis.<sup>4</sup>

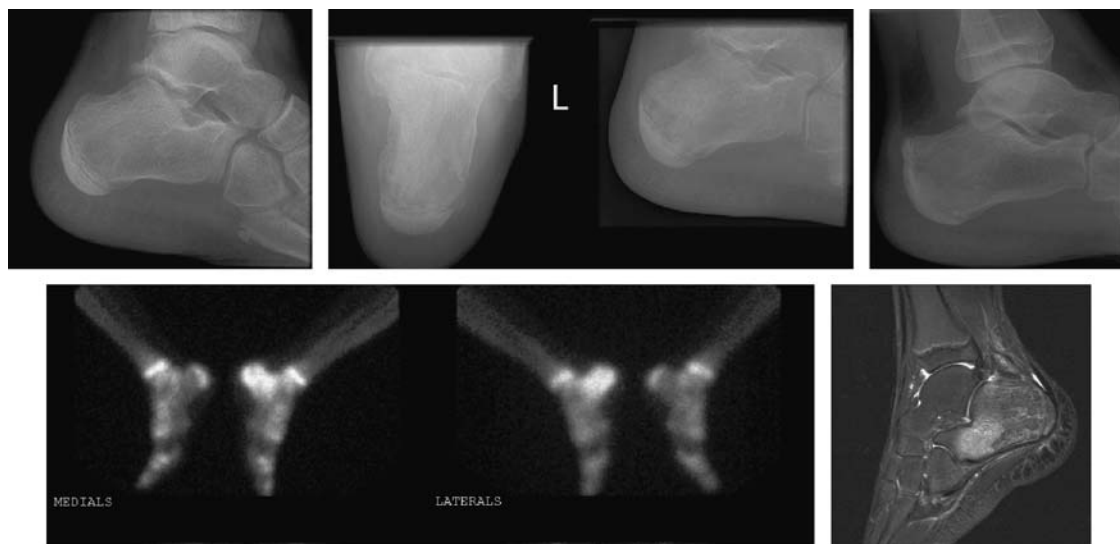
In populations with high rates of osteomyelitis, a history of bone pain, fever, and a limp should suggest osteomyelitis until proved otherwise. Age, a history of

trauma, location of symptoms, and sex should all be considered. The differential diagnosis includes calcaneal stress fracture, calcaneal apophysitis, and Achilles tendinopathy.

Dormans and Drummond<sup>5</sup> stated that there was no consistent peak of age of incidence for acute osteomyelitis of the calcaneus. However, Morrissy<sup>6</sup> reported a peak late in the first decade of life. Most series report that calcaneal osteomyelitis occurs in much younger patients; for example Winiker and Scharli,<sup>7</sup> average age 6.5 years, and Jaakkola and Kehl,<sup>8</sup> average age 2.9 years with 53% below the age of 2 years. Rasool<sup>9</sup> reported an older average age of 9 years. By comparison, the average age of presentation in our series was 6 years 8 months.

Although some studies show similar rates of infection in males and females, most show male predominance,<sup>10-12</sup> perhaps because of the role of trauma in the development of osteomyelitis. In our study, 67% of patients were male and 40% of patients reported a history of trauma. Jaakkola and Kehl<sup>8</sup> report 19% with a history of trauma.

All of the studies quoted shows that calcaneal osteomyelitis is slow to present, with symptoms existing some time before medical advice is sought and then further delays until treatment is commenced. On average, our patients had symptoms for 6.8 days before medical consultation, followed by an average of 2.9 days until final diagnosis, usually aided by imaging studies. Winiker and Scharli reported that patients waited an average of 3 days after initial symptoms before seeking medical review and that treatment was not commenced until day 7. Wang et al<sup>13</sup> reported a delay to diagnosis of 5 days, in 17 patients, and 2 weeks, in 8 patients. Jaakkola and Kehl<sup>8</sup> reported that patients presented after 13.1 days, but this



**FIGURE 1.** Thirteen-year-old boy presented with 5 day history of nonweight bearing on left leg. Top right: X-ray on admission showing soft tissue swelling, early rarefaction of the proximal apophysis. Top middle: X-ray at 2 months showing patchy lysis and sclerosis of the posterior portion of the calcaneus. Top left: X-ray at 18 months showing almost complete resolution posteriorly with residual lucency centrally. Bottom right: Bone scan during admission showing increased uptake in left calcaneus. Bottom left: Magnetic resonance imaging showing extensive abnormal high signal throughout the calcaneus.

was influenced by 4 of their cases presenting at follow up 2 to 4 weeks after an inappropriate diagnosis was made.

The clinical diagnosis of osteomyelitis is supported by appropriate laboratory findings of elevated WCC, and raised inflammatory markers, however, such tests may not be as elevated especially in the diagnosis of calcaneal osteomyelitis. In their series of 116 children with osteomyelitis, Scott et al<sup>14</sup> showed that 36% had admission temperatures less than 37.5°C and 41% had WCC less than 10,500/mm<sup>3</sup>. In our series, only 22% recorded a temperature greater than 38°C, and only 38% had a WCC greater than 11,000/mm<sup>3</sup>. Elevated WCC were reported in fewer than 20% of patients by Wang et al<sup>13</sup> and Puffinbarger et al,<sup>15</sup> and in 45% by Winiker and Scharli,<sup>7</sup> and 24% by Jaakkola and Kehl,<sup>8</sup> Rasool<sup>9</sup> noted higher WCC in their series.

Unkila-Kallio et al<sup>16</sup> showed an elevated admission CRP in 98% of cases and that the level peaked after 2 days. Other studies, including our own, failed to show such consistent elevation. About 77% of our patients and 47% of those in the Jaakkola and Kehl study,<sup>8</sup> recorded an elevated CRP. Winiker and Scharli<sup>7</sup> found that 80% had a normal CRP.

Other markers of inflammation, in particular the ESR may be more reliable. The ESR was measured in 97% of our patients and elevated in 81%. Jaakkola and Kehl<sup>8</sup> similarly found that 95% of their patients showed an elevated ESR. This may be because of the delay in seeking medical advice and the more indolent course of calcaneal osteomyelitis.

Positive blood cultures are recorded in 40% to 50% of most series.<sup>6</sup> Our results are significantly different as only 27% of the blood culture samples were positive despite testing 98% of patients. *Staphylococcus aureus* is the most common causative organism, accounting for 60% to 90% of infections.<sup>6,17</sup> In our study, 56% of positive blood cultures and 78% of tissue samples grew *Staphylococcus aureus*. There were no cases of MRSA despite a high incidence of MRSA soft tissue infection in the Auckland region.<sup>18</sup>

Plain radiographs do not show diagnostic bone changes until 1 week,<sup>7,9</sup> and because of relatively prompt treatment, increasing numbers of radiographs obtained after 2 weeks do not show radiographic abnormalities.<sup>10</sup> In patients with normal radiographs, Technetium-99m bone scintigraphy is a useful diagnostic aid. It is usually positive within 24 to 48 hours of symptoms onset, and with a sensitivity of 84% to 100% and a specificity of 70% to 96%, it is a useful diagnostic tool.<sup>10</sup> MRI is also useful, with a sensitivity of 88% to 100% and a specificity of 75% to 100% for detection of osteomyelitic changes. Ultrasound is a low cost, readily available, non-invasive, and a nonirradiating test; however, its use is limited because of lack of specificity, operator dependence, and inability to show cortical or bone marrow detail.

The imaging algorithm used in our center begins with a plain radiograph, and if this is normal, a bone scan is performed to localize a lesion and detect multifocality, with subsequent MRI for improved local visualization.

Treatment of calcaneal osteomyelitis is similar to that for long bone osteomyelitis with rest, elevation, and empiric antibiotics the mainstay. Antibiotic treatment is subsequently directed by blood culture and organism sensitivity results. The duration of antibiotic treatment and role of IV and oral antibiotics is not well defined in the literature. Winiker and Scharli treated patients with IV antibiotics for a mean of 9 days IV followed by a 6-week course of oral antibiotics. Wang et al treated patients for 3 weeks in total IV or oral.

Rasool used IV antibiotics for 4 to 6 weeks. In our series, patients received an average of 3 weeks of IV antibiotics and 3 weeks oral treatment. Most patients were changed from IV to oral antibiotics once their inflammatory markers had normalized.

The literature is small regarding complications secondary to calcaneal osteomyelitis, however, growth disturbance and chronic osteomyelitis is most frequently described as well spread to adjacent joints and foot bones. Although Puffinbarger et al's<sup>15</sup> series included growth disturbance and scar sensitivity, there were no chronic infections. Jaakkola and Kehl<sup>8</sup> reported 3 cases of growth disturbance, 1 equinus deformity and 2 osteomyelitic recurrences. Wang et al<sup>13</sup> found 10 chronic infections, 2 growth disturbances, and 1 subtalar septic arthritis, and had an overall complication rate of 21%. Rasool in his series of 14 cases had 10 late diagnoses all of which required repeat<sup>2-5</sup> visits to the operating room. Three patients required removal of the calcaneus, 2 also of the talus, 1 of the distal tibial epiphysis, and 1 underwent partial calcaneotomy. Late complications included scarring of the foot, growth arrest, avascular necrosis of the talus, limb length discrepancy, calcaneal and equinus deformity, fusion of ankle, subtalar and calcaneal-cuboid joints, plantar fusion, phalangeal loss, and brodie's abscess.<sup>9</sup>

By comparison, in our series, there were no postsurgical complications. There was a 17% overall readmission rate. The majority of readmissions were for antibiotic or PICC line complications, including 3 PICC line problems requiring PICC line removal, and 8 antibiotic reactions. The recurrence rate was 5% and these cases settled with further antibiotic courses with no long-term complications.

Osteomyelitis of the calcaneus is an uncommon problem that still poses a problem to the treating physician. Our series confirms that patients tend to seek medical intervention in a delayed fashion when suffering from calcaneal infections. The clinical and laboratory findings are typically less pronounced than those of long bone osteomyelitis. The inflammatory markers of ESR and CRP were more sensitive than WCC, blood cultures, and elevated temperatures. Plain film x-rays were not helpful in the diagnosis in the early setting but both bone scans and MRI were helpful in confirming the diagnosis. Treatment with prolonged courses of IV and oral antibiotics resulted in 13% having antibiotic related problems with flucloxacillin having the highest rate of adverse reactions. But unlike other series, there were not the same prevalence of long-term complications.

Although sometimes more difficult to diagnose, calcaneal osteomyelitis can be diagnosed with an appropriate history, clinical examination, and investigations. Treatment with IV and oral antibiotics and surgical debridement if indicated can lead to a good clinical outcome with minimal complications.

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