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ORIGINAL SCIENTIFIC REPORT

Paediatric Osteomyelitis in Fiji

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Abstract

Introduction Osteomyelitis can lead to significant morbidity and long-term disability if early treatment is not initiated in a timely manner. For developing countries this can lead to a significant burden on the healthcare system. This study aims to describe the demographic variables, aetiology and outcomes of treatment and to calculate the incidence of paediatric osteomyelitis in Fiji. The micro-organism profile and the outcomes for treatment were analysed.

Methods This is a retrospective review of medical records of all paediatric patients presenting to hospitals in Fiji over a 5-year period (2006–2010) with a diagnosis of osteomyelitis. Data were collected from the three divisional hospitals in Fiji (Colonial War Memorial Hospital, Lautoka Hospital and Labasa Hospital).

Results Two hundred and twenty patients were identified. An annual incidence of 18.1 cases/100,000 paediatric population was identified. The highest incidence was in the itaukei (ethnic Fijian) population (21 cases/100,000). Males were at a higher risk of developing osteomyelitis ($20.8/10^5$ vs. $10.7/10^5$). *Staphylococcus Aureus* was identified in 86% of all positive blood and 81% of all positive pus cultures, and it was sensitive to cloxacillin in 100% of cases. The most common factor identified preceding the development of osteomyelitis was trauma (55%) followed by skin sepsis (32%). Fifty-four per cent of the cases had chronic osteomyelitis, and the most common mode of presentation was in the form of an abscess (48%) followed by sinus/sequestrum (24%). The age group most commonly affected was between 5 and 9 years of age ($19.6/10^5$). Children with chronic osteomyelitis were more likely to require operative intervention in addition to antibiotics as compared to acute osteomyelitis (85 vs. 24%). The success rate of treating acute osteomyelitis was 92% compared to 61% for chronic osteomyelitis.

Conclusion Paediatric osteomyelitis poses a significant problem in Fiji, especially in the male, ethnic Fijian population between 5 and 9 years of age. The chance of complete resolution after treatment of acute osteomyelitis is very good. Therefore, interventions aimed at early diagnosis and treatments are required.

Introduction

Osteomyelitis is a serious condition for developing countries as it can lead to long-term morbidity if it progresses into chronic osteomyelitis. The source of the infection is bacterial. Although in children it is primarily haematogenous in aetiology, it can also be secondary to penetrating trauma, surgery or infection in a contiguous site [1]. If osteomyelitis is not managed appropriately, it can lead to

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amputation, sepsis or death [2, 3]. The treatment provided and outcomes are influenced by the stage of the presentation.

Developing countries, such as the Pacific Islands, have a high prevalence of paediatric osteomyelitis [4–6]. Environmental factors such as the tropical climate, low socioeconomic status, use of traditional medicine and genetic factors have been identified as contributing factors [5]. There have been no reports of the disease burden in Fiji, and only a handful of studies in the Pacific nations have attempted to quantify the disease burden [4–6].

There is a growing concern within Fiji that a treatable condition in the acute stage has become such a significant disease burden within the paediatric population. This retrospective review therefore aims to establish the burden of osteomyelitis within the paediatric population admitted to the three divisional hospitals in Fiji. This review should reflect the burden of acute and chronic osteomyelitis in other developing countries. This study will also ascertain the demographic variables and average length of stay, as well as calculate the incidence of paediatric osteomyelitis in Fiji.

Methodology

The Fiji secondary healthcare system includes the three main hospitals. The Colonial War Memorial Hospital (CWM) in Suva primarily caters for the Central-Eastern Division, but it also is a referral centre for all medical centres in Fiji and occasionally from other Pacific Island countries. The Lautoka Hospital caters for the Western Division, while the Labasa Hospital caters for the Northern Division. The paediatric population for the Central-Eastern Division, Western Division and Northern Division during the study period was 111,425, 88,476 and 43,223, respectively [7].

A retrospective study of paediatric osteomyelitis was conducted between 1 January 2006 and 31 December 2010. All children under the age of 16 years that were admitted to any of the three divisional hospitals with osteomyelitis were included in this study. Patients were identified from the patient information system (PATIS) coding system, inpatient records and the operating theatre records. Ethical approval was obtained from the Ministry of health prior to the collection of data.

All patients' folders, microbiological records, histological records and X-rays were then reviewed to confirm the correct diagnosis. Data were collected using a standardized data entry sheet prior to being analysed. Any child with pre-existing osteomyelitis, hospital-acquired osteomyelitis and readmission with osteomyelitis was excluded from the study.

Published criteria for osteomyelitis were used for this study. This involved any child with a positive pus culture from bone or histology compatible with osteomyelitis; or any child with clinical signs suggestive of osteomyelitis with a concurrent positive blood culture; or any child with clinical signs suggestive of osteomyelitis with a compatible radiological study [8]. The success of treating acute osteomyelitis was defined as no residual clinical or radiological evidence of disease 6 months after treatment.

The analyses utilized the entire population data, and statistical analysis was performed for the demographic variables. The annual incidence of osteomyelitis for the study period was calculated using the following formula: $I = [total\ cases]/population\ at\ risk \times 10^5$. P values were considered significant if they were <0.05.

Results

Over the 5-year period, there were 220 cases of paediatric osteomyelitis admitted to the three divisional hospitals in Fiji. Table 1 shows the distribution of demographic features of paediatric osteomyelitis in Fiji from 2006 to 2010.

Table 1 Distribution of demographic variables of paediatric osteomyelitis in Fiji from 2006 to 2010

Variable	Population (<16 years)	Osteomyelitis *n* (population %)	Cumulative incidence (per 100,00)	[a]*p* value	Rate ratio
Gender					
Male	125,645	151 (0.12)	120.1	$p < 0.01$	2.04
Female	117,479	69 (0.05)	58.7	($p = 0.000$)	
Ethnicity					
itaukei	156,079	123 (0.07)	78.8	$p < 0.01$	5.29
Non I-T	87,045	13 (0.01)	14.9	($p = 0.000$)	
Age group					
≤9 years	189,547	151 (0.001)	79.7	$p < 0.01$	2.26
≥10 years	196,050	69 (0.0003)	35.2	($p = 0.00$)	

[a]*p* value from *z* test of proportions

The incidence was calculated at 18.1/100,000 paediatric population. Table 2 shows the annual incidence of osteomyelitis by age group.

In terms of gender and race, the highest incidence was in males (20.8 cases/100,000) and in the itaukei (indigenous Fijian) population (21.3/100,000). Females had an incidence of 10.7/10,000, and the incidence in Fijians of Indian origin was 6.5/100,000 and in Fijians of other origins was 7.1/100,000.

The mean duration of admission was 11.5 days with a range of 6–56 days.

A total of 102 cases (46%) were admitted with acute osteomyelitis, and 118 cases (54%) had chronic osteomyelitis. Factors identified which preceded the development of osteomyelitis included trauma in 120 patients (55%), skin sepsis in 70 patients (32%) and both trauma with skin sepsis in 16 patients (7%). All the trauma reported here was blunt force trauma. This study did not include any open fractures.

The clinical presentation of chronic osteomyelitis was most commonly in the form of an abscess (48%). The other modes in which patients presented with chronic osteomyelitis were with a sinus/sequestrum (24%), inflammation (17%) and as a pathological fracture (7%).

Mono-focal osteomyelitis was the most common mode of presentation in 94% of cases. Six per cent of cases presented with poly-focal osteomyelitis, and this was associated with severe sepsis or septicaemia. The tibia was the most commonly involved bone (124 cases). Other large bones involved were the femur (55 cases) and the humerus (21 cases). The frequency of other bones involved and whether this was in a setting of acute or chronic osteomyelitis is shown in Table 3. Of the 55 cases of osteomyelitis involving the femur, 43 cases involved the distal femur and 12 cases involved the proximal femur. All the 12 cases of proximal femur osteomyelitis were in infants, and as such they also had simultaneous septic arthritis of the ipsilateral hip joint. Treatment in this setting was more challenging as these infants all had to undergo arthrotomies as a part of treatment. None of these patients developed the dreaded complication of avascular necrosis of the femoral head.

Staphylococcus aureus was the predominant causative organism present in 86% of positive blood cultures and 81% of positive pus swab cultures. The frequency of organisms cultured in blood and pus swab is shown in Table 4. This table also highlights that the success of obtaining a positive yield was better when pus was cultured (93%) as compared to blood (48%).

The mean duration of antibiotic administration was 28 days with a range of 14–42 days. The most commonly used antibiotic was cloxacillin (96%) followed by gentamicin (76%) as this was often the empirical combination of choice. Where possible, the antibiotic administration was guided by the micro-organism sensitivity. The other antibiotics that were used were rifampicin (7%), chloramphenicol (2%), vancomycin (2%), cephalothin (1%) and erythromycin (1%).

Of the 102 cases of acute osteomyelitis, no radiological changes were detected on plain X-rays in 94% of patients. Many of the diagnoses were made clinically at the time of presentation due to the lack of bone scans and/or MRI as utilized in the diagnostic process in many developed countries [8–10]. All 118 cases of chronic osteomyelitis had X-ray changes on a plain radiograph.

Table 2 Annual incidence rates of osteomyelitis by age group

Age (years)	Incidence (per 10^{5})
<5	10.5
5–9	19.6
10–14	12.3
15–16	1.4

Table 3 Involved bones

Bones involved	Total number of cases	Bone involvement in the setting of acute osteomyelitis	Bone involvement in the setting of chronic osteomyelitis
Tibia	124	64	60
Femur	55	25	30
Humerus	21	11	10
Fibula	8	2	6
Radius	4	0	4
Calcaneus	3	0	3
Carpal bones	3	0	3
Ulna	2	0	2

Table 4 Micro-organisms cultured via blood and pus swabs

	Blood cultures	Pus swab cultures
Total no. of cultures	157	144
Positive yield	76 (48%)	134 (93%)
Frequency of micro-organisms cultured		
Staph aureus	86%	81%
Staph epidermidis	11%	3%
Streptococcus pyogenes	3%	3%
Acinetobacter bominii	–	3%
E. coli	–	3%
Klebsiella pneumoniae	–	3%
Moragnella morgagni	–	2%
Proteus vulgaris	–	2%

Table 5 Treatment options and outcomes of treatment for acute osteomyelitis

Treatment options and outcomes	Percentage
Conservative	76
Operative	24
Complete resolution	92
Relapse	5
Lost to follow-up	2

Seventy-six per cent (76%) of cases of acute osteomyelitis were treated with antibiotics alone, while twenty-four per cent (24%) underwent additional surgical intervention. Six months after treatment, complete resolution, both clinically and radiologically, was seen in 94 patients (92%). Six patients (6%) failed treatment and progressed to chronic osteomyelitis. Two patients (2%) were lost to follow-up, and their outcomes are not known. These figures are shown in Table 5.

This contrasted with chronic osteomyelitis, where 118 patients were diagnosed and 100 (85%) patients required surgical treatment with only 18 patients (15%) treated with antibiotics alone. Complete resolution was seen in 72 (61%) patients, while ongoing illness or recurrent infections were seen in 31 patients (26%); 15 patients (13%) were lost to follow-up, and their outcomes are not known.

There were no deaths reported during this study period.

Discussion

The rates of paediatric osteomyelitis in Fiji are high. The annual incidence of paediatric osteomyelitis was calculated as $18.1/10^5$. The highest rate of osteomyelitis was in children between 5 and 9 years of age ($19.1/10^5$). Out of the 220 patients, 46% of the cases admitted were classified as acute osteomyelitis, while 54% were classified as chronic osteomyelitis. The tibia was the commonest bone to be affected in 54% of cases.

When compared to recently published literature, the incidence in Fiji is one of the highest in the world [4–6, 9–13]. The reasons for the high incidence of osteomyelitis are multifactorial. It is suggested that there is a complex interaction between the host (genetic factors), agent (mainly the virulence of *Staphylococcus aureus*) and the environment which combined to be responsible for the high rates of disease. Majority of the cases seen were males, and this was comparable to Gillespie et al. [6] who reported a 2:1 male-to-female ratio and Labbe et al. [4] who reported a 62% male predominance. From this study, it was shown that trauma (blunt trauma) was a common precipitating factor in 54% of the cases of acute osteomyelitis and this may explain why males were more susceptible to osteomyelitis.

One contributing factor which has been identified in the Pacific region is more virulent strains of *S. aureus* which have the Panton–Valentine leukocidin (PVL) genes. PVL genes induce leukotoxic leukocidin production, causing acute locally aggressive infection and thus increasing the chances of developing acute osteomyelitis [14]. Studies have shown the greater prevalence of these organisms in the tropical Pacific region [4, 14]. Also, there may be individual genetic factors that make Pacific Island children more susceptible to developing osteomyelitis. This could be verified by looking at osteomyelitis rates of Pacific Island children living in New Zealand and Australia.

Globally, indigenous peoples suffer from poorer health outcomes [15]. The incidence of osteomyelitis was higher in itaukei (indigenous Fijians; $21.3/10^5$). The incidence in Fijians of Indian origin was lower at $6.5/10^5$ and in Fijians of other origins $7.1/10^5$. The racial distribution for acute osteomyelitis as reported by Labbe et al. [4] in New Caledonia showed an ethnic distribution of 60% Melanesians and 20% Polynesians for a total of 80% in Pacific Islander origin. These findings are comparable with other studies as well [5]. The United Nations have identified that "statistical and health data collection is the key challenge in addressing indigenous health disparities across the world" [15].

There were several limitations noted with our review. Data regarding paediatric osteomyelitis were limited to the three major hospitals, and data were not collected from subdivisional hospitals, health centres, nursing stations and private practitioners. Most paediatric osteomyelitis cases are treated at the divisional hospital level. Another limitation was the number of cases lost to follow-up, with 13% of all cases of chronic osteomyelitis being lost.

This study has revealed that osteomyelitis in children poses a significant burden of disease in Fiji. The incidence of paediatric osteomyelitis is one of the highest in the world. Itaukei male children between 6 and 19 years of age are most at risk for developing osteomyelitis. A history of trauma and concomitant skin sepsis were identified as common preceding factors to developing acute osteomyelitis, and *S. Aureus* was the most prevalent causative organism. The outcomes of treating acute osteomyelitis were very good with an over 90% success rate, while that of treating chronic osteomyelitis was 61%. It is recommended that strategies be developed to identify and treat the disease early to avoid long-term complications. Future research should investigate the risk factors that drive the disproportionate incidence of indigenous osteomyelitis.

Compliance with ethical standards

Conflict of interest No conflicts of interests or disclosures.

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