T.O. Alonge · S.O. Ogunlade · A.B. Omololu

The Belfast technique for the treatment of chronic osteomyelitis in a tropical teaching hospital

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Abstract From September 1995 to August 2001, we treated 25 patients with chronic osteomyelitis of long bones by a two-stage technique. This consisted of the radical removal of all infected bone and soft tissue and immediate provision of soft-tissue cover. This was supplemented when necessary with delayed autogenous bone grafting. The average follow-up was 46 months (range: 19–80 months). One patient with haemoglobin sickle cell disease (HbSS) died after the second stage of surgery. There were four recurrences, one of which followed a myocutaneous flap that became necrotic. Ankylosis occurred in five patients.

Résumé De septembre 1995 à août 2001 nous avons traité 25 malades avec une ostéomyélite chronique des os longs par une technique en deux temps, comprenant un nettoyage radical de l'os et des parties molles infectés avec les dispositions nécessaires pour assurer la couverture cutanée, et une greffe osseuse autologue retardée si nécessaire. Le suivi moyen était 46 mois (19–80 mois). Un patient porteur d'hémoglobine HbSS est mort après le deuxième temps chirurgical. Il y avait quatre récurrences dont une suite à la nécrose d'un lambeau myocutané. L'ankylose s'est produite chez cinq malades.

Introduction

Chronic osteomyelitis is a debilitating disease of bone characterised by the persistence of discharging pus and infected granulation tissue. It is nearly always associated with sequestration of a part of the affected bone [6]. The systemic symptoms of infection have usually already subsided unless there is further abscess formation, and this usually results from spontaneous but premature closure of a discharging sinus. This pus and infected granu-

lation tissue, by the release of bacterial toxins and enzymes, probably results in the further death and devascularisation of the healthy bone surrounding the area of infection, and this effect may be increased by any local rise in intra-osseous pressure [14]. The surrounding soft tissue envelope (muscles and periosteum) becomes fibrosed, thickened and relatively avascular. These changes result from chronic ischaemia [6, 7, 8, 14]. Therefore, the bacteria that are trapped by fibrin clot within the dead bone become inaccessible to the body's defence mechanisms as well as to chemotherapeutic agents [8].

Thus, systemic antibiotics, which require tissue perfusion for their distribution, are only of very limited value in the management of chronic osteomyelitis [6]. Previous reports have already shown that the use of systemic antibiotics in the management of chronic osteomyelitis is expensive, prone to complications and often unsuccessful [19, 20]. There is no doubt that adequate surgery offers the best option in the management of this distressing disease, although there is no consensus as to the most appropriate surgical technique [13].

Several operative techniques have been described but with only varied reports of a successful outcome. These methods include simple saucerization and curettage [6], radical debridement and reconstruction with a pedicle muscle flap [18], the Papineau technique [16], continuous wound irrigation with antibiotic following sequestrectomy [5], bone resection and callotasis using the Ilizarov's frame [11] and recently the two-stage Belfast operation [13]. It has been shown that even the most radical surgical debridement fails to eradicate all the organisms hidden in the infected bone [8] and therefore that there is a need to develop a method of eliminating the organisms remaining after thorough sequestrectomy and debridement. We report here our experience and results of the Belfast technique in the management of chronic osteomyelitis. Our only modification of the original procedure was that we used ceftriaxone-PMMA beads in place of the commercially available gentamycin beads (Septopal) [1].

T.O. Alonge (✉) · S.O. Ogunlade · A.B. Omololu
Division of Orthopaedics and Trauma, Department of Surgery,
College of Medicine, University of Ibadan, Ibadan, Nigeria
e-mail: alonget@skannet.com
Tel.: +234-2-8106016, Fax: +234-2-2411768

Table 1 Details of 25 patients with chronic osteomyelitis treated by the two-stage Belfast technique

Case	Age	Gender	Bone affected	Infecting organism	Previous no. or surgery	Sickle cell anemia	Infection duration	Skin over	Antibiotic bead	Time of 1st stage	Time of 2nd stage	Complication	Follow-up	Outcome
1	29	F	Tibia	No growth	Acute osteomyelitis	No	16 yrs	Direct closure	Ceftriaxone PMMA	26/1/00	Retained bead	None	31 mo	Knee arthrodesis Cured
2	13	M	Tibia	No growth	Acute osteomyelitis	Yes (HbSS)	7 mo	Direct closure	Ceftriaxone PMMA	26/2/96	06/05/96	None	74 mo	
3	26	M	Femur	Staph. aureus	Previous close fracture	No	8 yrs	Direct closure	Ceftriaxone PMMA	31/7/96	10/02/96	Discharge after 12 mo	70 mo	Recurrence
4	19	F	Femur	Staph. aureus	Previous bone surgery	No	1 yr	Direct closure	Ceftriaxone PMMA	24/4/96	07/03/96	None	73 mo	Cured
5	37	F	Femur	No growth	Previous bone surgery	No	2 1/2 yrs	Direct closure	Gentamycin	18/9/95	25/12/95	None	80 mo	Cured
6	22	M	Humerus	Staph. aureus	Acute osteomyelitis	Yes (HbSS)	2 yrs	Direct closure	Gentamycin	18/01/96	23/5/96	None	75 mo	Cured
7	19	M	Femur	Staph. aureus	Septic arthritis of the knee	No	14 yrs	Direct closure	Ceftriaxone PMMA	22/5/96	24/7/96	None	73 mo	Knee Arthrodesis
8	26	M	Femur	No growth	Septic arthritis of the knee	No	18 yrs	Direct closure	Ceftriaxone PMMA	06.09.99	08/09/99	None	36 mo	Knee arthrodesis
9	14	M	Humerus	No growth	Previous open fracture	No	6 yrs	Direct closure	Ceftriaxone PMMA	08.12.99	22/9/99	Discharge after 6 mo	35 mo	Recurrence
10	25	F	Tibia	Staph. aureus	Acute osteomyelitis	Yes (HbSC)	2 yrs	Direct closure	Ceftriaxone PMMA	31/05/00	Retained bead	None	27 mo	Cured
11	10	F	Femur	No growth	Acute osteomyelitis	Yes (HbSS)	4 yrs	Direct closure	Ceftriaxone PMMA	26/1/00	21/6/00	Died of sequestration crisis	26 mo	Cured
12	12	F	Tibia	No growth	Previous bone surgery	No	2 yrs	Direct closure	Ceftriaxone PMMA	29/11/99	05/10/00	None	27 mo	Cured
13	21	M	Tibia	No growth	Acute osteomyelitis	No	10 yrs	Direct closure	Ceftriaxone PMMA	22/11/99	16/2/00	None	30 mo	Cured
14	24	M	Femur (neck)	No growth	Acute osteomyelitis	Yes (HbSS)	6 mo	Direct closure	Ceftriaxone PMMA	13/10/99	Retained bead	None	34 mo	Hip arthrodesis
15	39	M	Ulna	Staph. aureus	Previous bone surgery	No	7 mo	Direct closure	Ceftriaxone PMMA	16/10/99	07/05/00	None	25 mo	Cured
16	24	F	Femur	No growth	Previous bone surgery	Yes (HbSS)	6 yrs	Direct closure	Ceftriaxone PMMA	22/9/99	31/07/00	None	25 mo	Cured
17	27	M	Tibia	No growth	Acute osteomyelitis	No	14 yrs	Direct closure	Ceftriaxone PMMA	23/7/99	13/9/99	None	35 mo	Cured
18	22	M	Femur	No growth	Acute osteomyelitis	Yes (HbSS)	12 mo	Direct closure	Ceftriaxone PMMA	22/1/97	26/3/97	None	65 mo	Cured
19	19	F	Femur (neck)	Staph. aureus	Acute osteomyelitis	Yes (HbSS)	6 mo	Direct closure	Ceftriaxone PMMA	28/8/00	29/01/01	None	19 mo	Hip arthrodesis
20	44	M	Tibia	Proteus Sp	Previous open fracture	No	24 yrs	Cross leg flap	Ceftriaxone PMMA	29/3/00	28/8/00	Persistent discharge	24 mo	Recurrence
21	9	F	Femur	Staph. aureus	Acute osteomyelitis	Yes (HbSS)	5 yrs	Direct closure	Ceftriaxone PMMA	26/03/97	19/5/97	None	63 mo	Cured
22	16	M	Tibia	Proteus Sp	Previous close trauma	No	3 yrs	Ponstien flap	Ceftriaxone PMMA	09.09.96	11/11/96	None	69 mo	Cured
23	21	M	Tibia	No growth	Acute osteomyelitis	No	3 yrs	Fascio-Cutaneous flap	Ceftriaxone PMMA	07.01.98	Beads fell out	Flap necrosis	49 mo	Recurrence
24	40	M	Femur	No growth	Previous bone surgery	No	4 yrs	Direct closure	Ceftriaxone PMMA	21/9/98	12/07/98	None	44 mo	Cured
25	23	M	Ulna	Staph. aureus	Previous open fracture	No	5 yrs	Direct closure	Ceftriaxone PMMA	02.08.99	05/05/99	None	39 mo	Cured

Material and methods

Between September 1995 and August 2001, we treated 25 patients with chronic osteomyelitis of one or more long bones by using the two-stage Belfast technique. There were 16 men and nine women. Twelve cases were classed as primary chronic osteomyelitis while 13 were secondary [6]. Eight patients with primary chronic osteomyelitis also had sickle cell anaemia (homozygous SS disease). In three of the patients with secondary chronic osteomyelitis, this had complicated an open fracture, in six it followed previous bone surgery and two occurred after septic arthritis of a knee joint. *Staphylococcus aureus* was the most common organism isolated by culture. Ceftriaxone had a higher sensitivity profile for the organisms isolated from the discharging sinuses in chronic osteomyelitis in our environment [3], and this was why we used ceftriaxone-PMMA beads in place of the commercially available gentamycin beads. The "mass production" of these beads makes the cost more affordable to most Nigerian patients, and moreover these locally produced beads have been shown to "elute" the antibiotic effectively [2].

Patients had the two-staged Belfast procedure, which includes radical debridement followed by immediate provision of soft-tissue cover. In addition, and when indicated, delayed autogenous bone grafting was also performed at the second stage. Three patients did not have the second-stage surgery and thus retained their beads, and only two of the 25 patients actually required bone grafting at the second stage.

Results

Average follow-up was 46 months (range: 19–80 months). There was no mortality as a result of the first stage surgery, but one patient with sickle cell haemoglobin disease (HbSS) died of a sequestration crisis within 24 h after the second stage. There were four recurrences, one of which followed necrosis of a myocutaneous flap. The average hospital stay was 2 weeks after the first stage and 10 days following the second stage. The average blood loss in both stages was 400 ml. Ankylosis occurred in five patients. In three of these, septic arthritis of the knee joint had preceded the bone infection and in two cases of chronic osteomyelitis of the femoral neck spontaneous ankylosis of the hip joint followed extensive debridement of the infected cavity (Table 1). New bone formation followed surgery in most cases and was demonstrated by cortical thickening. Restoration of a distinct cortico-medullary differentiation indicated eradication of the infection.

Discussion

Parenteral administration of antibiotics is an inherently inefficient method for achieving high local tissue concentration of drugs [10]. Conversely, the use of various drug delivery systems, e.g. polymethylmethacrylate [1, 21], biodegradable polylactic-coglycolic acid copolymer (PLGA) [9], collagen [4], fibrinogen [22], gentamycin impregnated xenografts [17], and porous apatite-wollastonite glass ceramic [12], ensures a *high local* tissue concentration and *low systemic* levels of antibiotics. The two-stage Belfast operation ensures removal of all

necrotic bone and delivery of a high local tissue concentration of antibiotic from the beads. This technique therefore aids the eradication of any residual viable microorganisms in the "saucerized" bone bed. The major modification of the original technique in our Institution was the use of ceftriaxone-PMMA antibiotic beads [1] instead of gentamycin beads. This was primarily due to the inability of the patients to purchase the commercially available gentamycin beads (Septopal) due to their cost. Also, more than 90% of organisms isolated from the chronic discharging sinuses in our patients with chronic osteomyelitis (mainly *S. aureus*) were sensitive to ceftriaxone. In our hands, the Belfast technique was associated with minimal blood loss when compared to saucerization and curettage [6], and the wounds healed by primary intention (within 2 weeks). This is far superior to the Papineau technique, which has a healing time ranging from 3 to 4 1/2 months in the series reported by Panda et al. [15]. Only the patient with recurrence of infection required more surgery than the two stages described for the Belfast technique. This is in contrast to the multiple operations often necessary after saucerization and curettage. In fact, this is a reflection of the inadequacy of the original saucerization and curettage [18], which unfortunately is still often practised in developing countries for the management of chronic osteomyelitis.

Our low recurrence rate is very encouraging and may be due to the release of a substantial quantity of ceftriaxone (a very potent anti-microbial agent) from the beads that we use. The retention of antibiotic beads in some patients (reminiscent of a cemented implant) did not appear to increase the risks of further infection. The only death after the second-stage surgery was in the HbSS patient who had a sequestration crisis. The high prevalence of primary chronic osteomyelitis in patients with sickle cell anaemia (50%) may have selected out the patients with more severe disease. The main difficulty with our study is the short follow-up. The incidence of longer-term recurrence requires further study.

In developing countries where patients and their relatives fund medical treatment, the Belfast technique offers a shorter hospital stay and allows for primary wound closure, thereby obviating the need for prolonged wound dressing. These advantages, coupled with patient satisfaction, makes the Belfast operation a cost-effective technique in the management of chronic osteomyelitis in a tropical setting.

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