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Hemi-corticotomy in the management of chronic osteomyelitis of the tibia

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Abstract We reviewed 20 cases of chronic osteomyelitis of the tibial diaphysis without shortening or deformity resulting from different causes. Debridement included removal of the anterior half of the tibial cortex with any sequestrum, leaving the posterior cortex intact with its vascular muscle attachments. This was then followed by hemi-corticotomy (hemi-circumferential corticotomy and partial bone fragment transfer) in order to reconstruct the resulting defect. This technique proved effective in 19 out of the 20 patients. Follow-up was by plain radiography and sedimentation rate estimations, with an average follow-up of 34 months after operation. In nine patients, early removal of the fixation frame immediately after segment transfer followed by cast application produced the same outcome as achieved with patients in whom the frame remained in position until the end of the procedure.

Résumé Nous avons revu 20 cas d'ostéomyélite chronique de la diaphyse tibiale résultant de causes différentes, sans raccourcissement ni déformation. Le débridement a inclus l'ablation de l'hémi corticale antérieure avec tous les séquestres, en conservant la corticale postérieure intacte avec ses insertions musculaires vascularisées. Cela a été suivi par une hémi-corticotomie (corticotomie hémi-circumférentielle et transfert osseux partiel) pour reconstruire le déficit osseux. Cette technique s'est avérée efficace chez 19 des 20 malades. Le suivi a été fait par radiographies ordinaires et estimations de la vitesse de sédimentation, avec un délai moyen de 34 mois après l'opération. Chez 9 malades l'ablation précoce du fixateur immédiatement après le transfert du segment osseux, suivi par immobilisation plâtrée a conduit au même résultat que chez les malades où le cadre est resté en position jusqu'à la fin du traitement.

Introduction

Chronic osteomyelitis of the tibia is not a rare problem [7]. It can be secondary to an open tibial fracture, arise as a complication of an open reduction with internal fixation [2], or it may follow haematogenous osteomyelitis in young and in immune-compromised patients [3]. The aim of treatment is to cure the infection and obtain the best possible limb function. Management involves debridement, with removal of dead bone and any other dead material [11]. A good blood supply is helpful, and this can be produced by the use of either a rotational or a free vascular muscle flap. Surgical treatment is combined with the administration of appropriate antibiotics, and – when indicated and available – the use of hyperbaric oxygen [9].

Debridement is needed mainly for dead sclerotic bone (sequestrum), while bones with good vascularity usually have greater resistance to infection [6]. In the tibia, the anteromedial cortex has the least muscle cover and therefore probably less blood supply [10], while the posterior cortex has a more vascular muscle bed and, as a result, a better blood supply.

It can be difficult to determine the extent of infection, even with modern methods of investigation. That is why some authors recommend radical excision of the whole suspected segment, although this may require a more complicated and lengthy reconstruction [12]. Others prefer a less aggressive approach with minimal debridement of the symptomatic area, or advise the use of antibiotics; however, these methods probably produce a lower rate of success [14].

Limb reconstruction using the Ilizarov technique has proven successful, but it is lengthy and the active co-operation of the patient is essential [4, 13]. Many authors agree that a good blood supply and vascular bed are the keys to curing infection of bone [5]. In addition, the general condition of the patient is an important consideration when choosing the method of treatment [2].

This study is a review of 20 patients with chronic osteomyelitis of the tibia either following an open frac-

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ture, due to secondary infection after an open reduction, or as the late sequelae of a primary haematogenous infection. In our patients these chronic infections were managed by debridement and removal of dead bone (sequestrectomy), which usually consisted of the anterior tibial cortex. We did not remove the posterior cortex, thus keeping the periosteal attachment intact and ensuring a good vascular supply. Corticotomy of the anterior half of the tibial cortex at the adjacent healthy segment was then performed, leaving the posterior cortex intact. Gradual segment transfer 3 weeks after surgery using the Ilizarov technique was then used to fill the defect. This can be considered either as a hemi-circumferential corticotomy with partial bone fragment internal transport [1] or as a hemi-corticotomy with partial bone transfer.

Material and methods

Twenty patients with chronic osteomyelitis of the tibia were included in this study. Their average age was 24 years (range: 18–39), and there were 18 men and two women. Infection followed open reduction and internal fixation in 10 patients, it complicated an open fracture in nine, and one had previously suffered a haematogenous osteomyelitis. Patients with infection secondary to open reduction and internal fixation had had their implants previously removed, while those with osteomyelitis following an open fracture had been treated by external fixation until the fracture had united. At the time of presentation, all fractures had united with minimal or no deformity and all infections were in the diaphysis. Five patients had osteomyelitis of the proximal diaphysis, in nine the middle third was involved, and six infections were in the distal third of the tibial diaphysis.

All patients had a chronic bone infection and presented with a persistent discharging sinus, pain and swelling. The average duration of their symptoms was 30 months (range: 18–72).

Plain radiographs were taken routinely, and computerised tomography (CT) was used in all cases to demonstrate sequestered bone and as an aid in surgical planning. Magnetic resonance imaging (MRI) was used in five patients, but it gave no more information than CT in surgical planning. A complete blood picture, sedimentation rate and C-reactive protein estimations, as well as regular radiographs, were used pre-operatively and at follow-up. Culture and sensitivity testing was performed on the intra-operative specimen (the bone removed during surgery). Using the 'staging' of Cierny and Mader [2] our series included eight patients with type 3A and 12 patients with type 4A.

Primary management comprised debridement, excision of the sinus in the incision and removal of the anterior half of the tibial cortex and any sequestrum, leaving the posterior cortex intact in its vascular muscle bed (Fig. 1). The wound was then closed. The average length of the segment removed was 10 cm (range: 8–12) and this depended on the pre-operative investigation and surgical planning. After about 3 weeks, and when the condition of the surgical wound allowed, a partial corticotomy was performed of the anterior aspect of the tibia adjacent to the area from which bone had been removed. The 'hemi-corticotomy' starts with a skin incision allowing a postero-medial approach to the tibia. The incision is deepened to expose the antero-medial surface of the tibia. The tibial periosteum is incised 1 cm anterior to the posterior tibial cortex and periosteal stripping is avoided – especially of the lateral and posterior tibial cortex as both these areas have good muscle cover giving good vascularization. Multiple drill holes in an L-shaped configuration are then made, and these are 'connected' using an osteotome to separate the anterior half of the tibia from the posterior half (Fig. 2). The segment used in hemi-corticotomy has an average length of 10 cm (range: 8–12). In 18 patients, an

Fig. 1 Removal of the anterior half of the infected tibial segment leaving the posterior cortex intact in its vascular bed, and hemi-corticotomy at the adjacent bone segment

Ilizarov external fixation frame was then applied, and an Orthofix limb reconstruction external fixation system was used in two patients. The Ilizarov frame that we use has two proximal and two distal rings. The hemi-corticotomy was secured by using half pins, and wires, or both, at multiple levels attached to one ring. With the Orthofix limb reconstruction system frame we used one clamp to hold the proximal and one for the distal ends of the tibia, and another to hold the segment to be transferred. The gradual segment transfer usually required about 3 weeks to fill the defect (Fig. 2). Antibiotics were given for 2 weeks only post-operatively according to the culture and sensitivity report on the material removed during surgery. No patients received either hyperbaric oxygen or any treatment other than surgery.

The average duration of follow-up was 34 months (range: 30–48) and included clinical and plain radiography during the segment transfer (average duration of segment transfer was 14 weeks, with a range between 12 and 30). Bone maturation usually needed twice the time required for segment transfer.

The external fixation frame remained in place in 11 patients until full maturation of the new bone (average duration was 38 weeks). Nine patients asked for removal of the frame immediately after the segment transfer had been completed (Fig. 3), and in these patients the frame was removed about 1 week after finishing the transfer. A below-knee cast was applied and a gradual increase in weight bearing was allowed. The average period the cast remained in place was 18 weeks (range: 16–36).

Fig. 2 Gradual segment transfer of the hemi-corticotomy segment with new bone generation

Results

Out of the 20 patients, 19 lost all their limb pain and had complete healing of the infection and of the discharging sinus. Radiography confirmed consolidation of the new bone and laboratory follow-up showed a progressive decrease in the sedimentation rate. Complete wound healing occurred within 3 weeks in 12 patients and after 5 weeks in seven. There were neither skin problems nor docking site problems in any patient, but pin tract complications occurred in three. These appeared at pin sites in the transferred segment and caused delayed skin healing around the pins during the segment transfer. This problem did not change the management protocol and responded to daily dressing with saline and antibiotic ointment. The average time of return to full activity was 44 weeks from surgery. There was no statistically significant difference in callus maturation, nor in the time needed to return to full activity, between patients in whom the external fixation frame was removed very soon after segment transfer and those who kept the frame until bone consolidation.

This technique did not work in one patient, however, whose sinus continued to discharge for 8 weeks after surgery. This was thought to be due to persistent infec-

Fig. 3 A patient who had removal of the external fixation following segment transfer. X-ray taken 6 weeks after removal of the external fixation frame

tion related to insufficient removal of infected dead bone, and this required modifying the method of treatment. Segment transfer was discontinued and the transferred segment was returned to its original site. This was followed by another operation with complete excision of the segment of suspected infection, and corticotomy of the posterior tibial cortex adjacent to the anterior tibial segment that had been originally hoped to transfer. We then transferred both halves as one segment followed by routine management, and this resulted in adequate callus formation.

Discussion

The management of chronic osteomyelitis using the Ilizarov technique always needs time and effort from both the treating surgeon and the patient [13], which makes patient selection important [1]. Selection not only depends on the state of the osteomyelitis but also on the psychological condition of the patient. The long duration

of external fixation usually puts stress on both patient and doctor [8].

The advantage of our technique is that it can make life easier for the patient who has difficulty in accepting external fixation for a long period. This kind of patient is not rare, and our technique gives the patient an option of removal of the external fixation frame just after segment transfer with no need to wait until maturation of the callus. In this situation, and with proper selection of the indications, the external fixation frame only need remain in place for about one-third of the time needed with total segment removal followed by segment transfer.

Another advantage is avoidance of both docking site problems and the delayed healing that usually occurs between the transferred segment and normal bone. This is a common complication that usually significantly delays healing and may necessitate further operation to freshen the bone edges. It perhaps may also require a bone graft [4]. Thus, the wide area of bone contact with our technique helps bone healing and does not interfere with the segment transfer. In addition, there is only minimal soft tissue interposition between the bone ends.

Our technique may be more technically demanding both in pre-operative planning and in surgical technique than the classic surgical total segment excision operation. However, it can help with patient compliance, which often plays an important part when using the Ilizarov technique.

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