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Case Report

Reconstruction using a free vascularised medial femoral condyle corticoperiosteal flap for osteomyelitis of the juxta-articular distal radius: A case report and literature review

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ABSTRACT

Osteomyelitis of the epiphysis after a distal radius fracture is uncommon. If not adequately and promptly treated, the detrimental effects on wrist function can be devastating. However, management of septic bone defects of the epiphysis is significantly challenging. We report the case of a patient with juxta-articular distal radius osteomyelitis successfully treated with a free vascularised corticoperiosteal flap from the medial femoral condyle (MFC corticoperiosteal flap). A 46-year-old right-handed man fell on the grass from a height of 2 m during a demolition. He was diagnosed with a right distal radius and ulnar styloid process fracture. He underwent open reduction and internal fixation. However, he developed a deep infection, resulting in post-operative osteomyelitis. Therefore, thorough debridement was performed and an external fixator was applied. Antibiotics were administered according to the culture results. He underwent reconstruction for bone defect using an MFC corticoperiosteal flap 28 days after re-operation. The patient could resume work without limitations 4 months after the reconstruction. The infection subsided completely, and radiographs confirmed bone union at 5 months after the reconstruction. His wrist range of motion was 40° in dorsal flexion (uninjured side 70°), 50° in palmar flexion (75°), 80° in supination (90°), and 90° in pronation (90°). There was no donor site complication. The patient has reported no pain for 1 year since the injury. The use of the MFC corticoperiosteal flap for reconstruction of the juxta-articular distal radius osteomyelitis decreased the time required for bone union, enabled local antibiotic delivery to control infection, and helped preserve wrist function.

Introduction

Osteomyelitis occurring after a distal radius fracture is uncommon. If this condition is not promptly and completely treated, it can have significant detrimental effects on wrist function. The first line of treatment usually involves debridement and administration of culture-guided antibiotics followed by reconstruction of the bone defects. However, the best procedure to manage septic bone defects,

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especially those at the epiphysis in long bones, remains unclear. Here, we report the case of a patient with juxta-articular distal radius osteomyelitis that was successfully treated with a free vascularised corticoperiosteal flap from the medial femoral condyle (MFC corticoperiosteal flap).

Case reports

The study was conducted with the approval of the institutional review board (No. 1249). Informed consent was obtained in the form of opt-out on the website in accordance with the domestic guideline.

A 46-year-old right-handed man fell on grass from a height of 2 m during a demolition. He was diagnosed with a right distal radius and ulnar styloid process fracture (OA/OTA 2R3A2.2) (Fig. 1). His medical history indicated untreated atopic dermatitis. Four days after the injury, he underwent open reduction and internal fixation using a plate (Stellar 2; HOYA Technosurgical, Tokyo, Japan) (Fig. 1). However, radiographs demonstrated volar displacement of the distal fragment 32 days postoperatively (Fig. 1). Although reoperation to replace the plate was performed 39 days after the initial operation, intraoperative findings indicated severe synovitis and osteolysis in the juxta-articular distal radius, compatible with osteomyelitis. A thorough debridement was performed and an external fixator (Distal Radius Fixator; DePuy Synthes, Raynham, MA, United States) was applied. A specimen of the debrided tissue was sent for microbiological study. The culture revealed methicillin-sensitive *Staphylococcus aureus*; therefore, cefazolin sodium was administered for 6 weeks. The patient underwent reconstruction using a free vascularised MFC corticoperiosteal flap 28 days after the reoperation; the flap was harvested in accordance with a previous report [1]. The graft was 10 × 20 mm of cortical bone with periosteum and cancellous bone. The cortex of the graft was embedded to support the volar cortical gap of the recipient site. The descending genicular artery (DGA) and its accompanying vein were anastomosed to the radial artery and its accompanying vein at the snuff box using the end-to-end procedure; this procedure was supplemented by pinning with two Kirschner wires of diameter 1.4 mm (Fig. 2). The external fixator was removed, and additional pinning was performed 31 days after the third operation. Then, the patient was encouraged to perform gentle exercises to text and improve the range of motion (ROM) of his wrist. The patient could resume work without any limitations 4 months after the reconstruction. The infection subsided completely, and radiographs confirmed bone union at 5 months after the reconstruction (Fig. 3). The ROM at his wrist was 40° in dorsal flexion (uninjured side 70°), 50° in palmar flexion (75°), 80° in supination (90°), and 90° in pronation (90°). There was no donor site complication. The patient has reported no pain for 1 year since the injury.

Discussion

In the present report, the MFC corticoperiosteal flap was useful for the reconstruction of a septic bone defect in the juxta-articular distal radial epiphysis.

For the treatment of osteomyelitis, bone defects must be reconstructed following radical debridement and administration of antibiotics. Initially, less invasive and easy-to-perform procedures, such as a cancellous bone autografts, should be considered. In case of severe bone defects, for which these methods may be insufficient, further intervention, such as the use of the Masquelet technique [2], should be considered. A vascularised bone graft is usually indicated in exceptional cases when other approaches have failed. Cancellous bone autografts are considered the gold standard for bone defects as most segmental bone defects can be reconstructed using cancellous bone autografts; however, non-vascularised cancellous bone grafts could be absorbed or have a weak resistance to infection. Several studies therefore recommend using the Masquelet technique for infected bone defects using a polymethyl methacrylate cement spacer to deliver antibiotics locally, inducing a biological membrane at the defect site, followed by the use of a cancellous bone autograft [2,3]. However, Morelli reported that a persistence of infection or non-union was noted in 18% of the cases

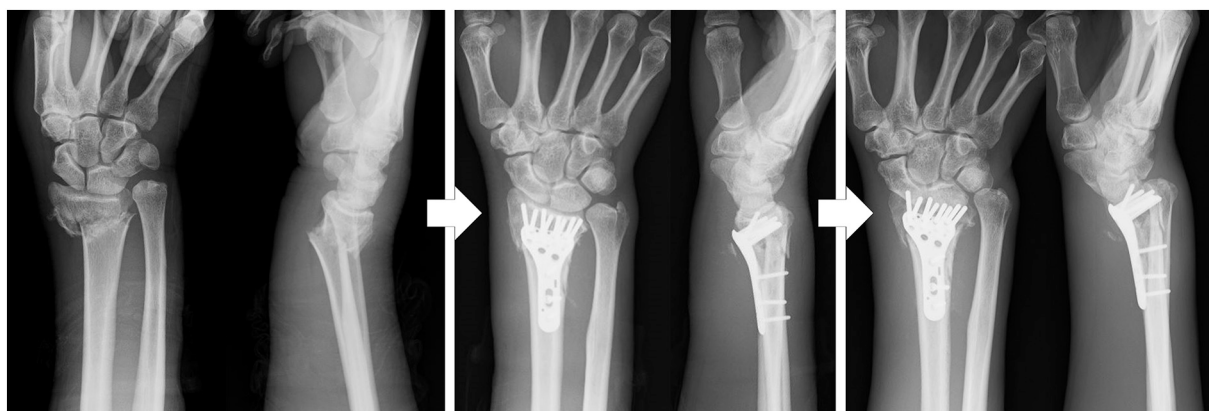


Fig. 1. The patient was diagnosed with a right distal radius and ulnar styloid process fracture (OA/OTA 2R3A2.2). He underwent open reduction and internal fixation using a plate 4 days after the injury. However, radiographs demonstrated volar displacement of the distal fragment 32 days postoperatively.

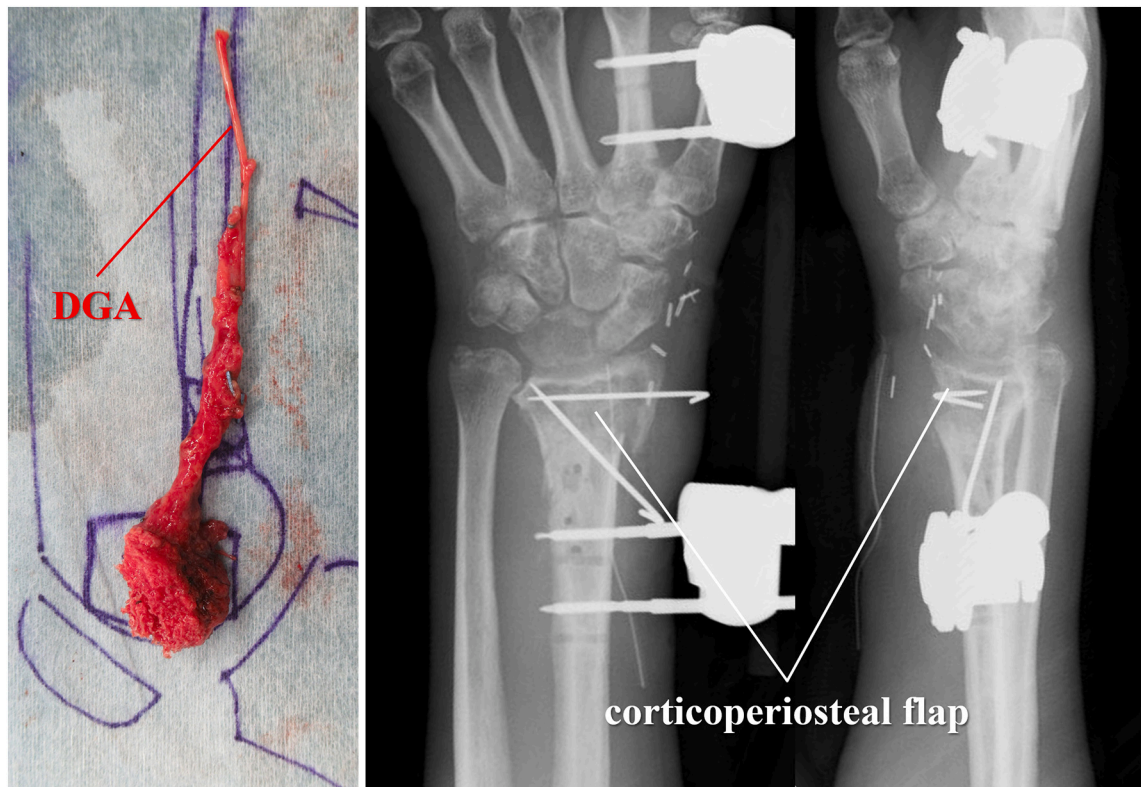


Fig. 2. The patient underwent reconstruction using a free vascularised corticoperiosteal flap of the medial femoral condyle 28 days after reoperation. The graft was 10×20 mm of cortical bone with periosteum and cancellous bone. The cortex of the graft was embedded to support the volar cortical gap of the recipient site. The descending genicular artery and its accompanying vein were anastomosed to the radial artery and its accompanying vein at the snuff box using the end-to-end procedure; this procedure was supplemented by pinning with two Kirschner wires of diameter 1.4 mm.

treated using the Masquelet technique, necessitating reintervention [3]. Moreover, cancellous bone autografts using this technique must typically be postponed for 6–8 weeks until a pseudo-synovial membrane develops. Although vascularised bone grafting is technically demanding, it is associated with a lower risk of postsurgical infection than the use of non-vascularised bone grafts [4]. In addition, a single-stage method could shorten the period until bone union compared to the Masquelet technique. In principle, we believe that both the Masquelet technique and vascularised bone grafting are reliable interventions for osteomyelitis at the diaphysis and metaphysis of long bones because both methods enable the performance of ROM exercises in the early postoperative period in combination with nonbridging external fixation. However, the period until bone union should be decreased in case of epiphysis to start ROM exercises as soon as possible to preserve joint function. We thus concluded that vascularised bone grafts were preferred for juxta-articular osteomyelitis, such as that observed in the present case.

Vascularised bone grafts can be obtained from various donor sites. Selection of the most appropriate donor site is multifactorial; for example, size matching between the donor site and the defect, mechanical demands of the defect, proximity to the donor site, invasiveness for patients, and donor site morbidity should be considered. Based on the articular branch of the DGA, the MFC corticoperiosteal flap was introduced by Sakai et al. to achieve bone union under unfavourable conditions [5]. The MFC corticoperiosteal flap retains the highly osteogenic cambium layer and is preferred for small bone defects such as that observed in the present case [6]. As shown in Table 1, 17 cases have been reported in 9 studies in which the MFC corticoperiosteal flap was used for the radius [6–14]. The causes included fracture non-union in 15 cases, osteomyelitis in one case, and a bone defect after bone tumour resection in one case. Bone union was achieved in all cases. There has been no recurrence of osteomyelitis. The recipient sites included the metaphysis in six cases and the diaphysis in five cases. The information regarding the recipient site was unavailable for the other cases. To the best of our knowledge, the present report is the first to describe the use of an MFC corticoperiosteal flap for a defect in the epiphysis of the juxta-articular distal radius. As mentioned earlier, the reconstruction of bone defects at the epiphysis is difficult to manage using cancellous bone autografts and the Masquelet technique because the long immobilisation period can significantly restrict wrist ROM. Therefore, due to its osteogenesis potential and resistance to infection, the MFC corticoperiosteal flap would be useful for the reconstruction of juxta-articular distal radius osteomyelitis by decreasing the time required for bone union, enabling local delivery of antibiotics to control infection, and preserving wrist function.

As this is the report of a single case, our findings cannot be generalised. Moreover, the retrospective nature of our observation of this case and the possibility that we might have overestimated the effectiveness of the method are the other limitations of our research.



Fig. 3. The infection subsided completely, and radiographs confirmed bone union.

Further large-scale studies are warranted to validate our findings.

CRedit authorship contribution statement

Seigo Sukanuma: Conceptualization, Methodology, Writing – Original Draft, Project Administration.

Kaoru Tada: Methodology, Writing – Review & Editing, Supervision.

Daisuke Yamauchi: Conceptualization.

Shingo Takagawa: Investigation.

Hidetoshi Yasutake: Writing – Review & Editing.

Keito Shimanuki: Investigation.

Hiroyuki Tsuchiya: Supervision.

Table 1
MFC corticoperiosteal flap applied for the radius.

Author	Year	Cases (n)	Recipient site	Cause	Union rate
Del Pinal F [7]	2007	1	U	Non-union	100 (1/1)
Choudry UH [8]	2008	1	U	Non-union	100 (1/1)
De Smet [9]	2009	2	U	Non-union × 1	100 (2/2)
Rodriguez-Vegas JM [6]	2011	3	Metaphysis Diaphysis × 1 Metaphysis × 2	Osteomyelitis × 1 Non-union × 3	100 (3/3)
Vegas [10]	2012	1	U	non-union	100 (1/1)
Hamada Y [11]	2014	4	Diaphysis × 3 Metaphysis × 1	Non-union × 4	100 (4/4)
Fei W [12]	2015	2	Metaphysis × 2	Non-union × 2	100 (2/2)
Guzzini M [13]	2017	2	U × 2	Non-union × 2	100 (2/2)
Quintero [14]	2020	1	Diaphysis	Bone tumour	100 (1/1)
Total		17			100 (17/17)

U: Unknown.

Declaration of competing interest

None.

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