Clinical Case Report

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Single-cortex is better than double-cortex in fibula grafts for large tibia bone defect in a 2-year-old child

A case report of a successful surgery and discussion of bone graft choices

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Abstract

Background: Large bone defect in infant or small patients has been little reported and the management of such a patient is difficult. Considering the little knowledge of this area, we present this special case of a successful single-cortex fibula graft for the treatment of a large tibia bone defect in a 2-year-old patient to share our experience.

Case summary: A 2-year-old male patient presented to our hospital with history of leg pain for 4 months. According to his medical records, he was involved in a traffic accident and diagnosed with open tibia fracture. A previous surgery of emergent debridement and external fixation was performed in our institution, leaving a 6-cm tibia bone defect. After that this patient received several times of vacuum sealing drainage (VSD), skin grafting, and changed external fixation to cast because of pin tract infection.

The physical examination of the patient showed a healed skin wound and a good dorsal arterial pulse. X-ray indicated a large bone defect at the tibia fracture site with osteosclerosis at the fracture sections. This patient received ipsilateral single-cortex vascularized single-cortex fibula graft, other than double-cortex fibula graft. X-ray and CT scan 4 months after the operation confined bone healing. The patient returned to normal activities with an inconspicuous limb.

Conclusion: Ipsilateral single-cortex fibula graft is effective for the treatment of large tibia bone defect in infant or small aged patients. It exhibited better potential benefits than double-cortex graft in such cases.

Abbreviations: CT = computerized tomography, VSD = vacuum sealing drainage.

Keywords: bone defect, case report, fibular graft, infant

1. Introduction

Large bone defect is a great challenge in clinical practice, especially in infants or small patients at early ages. The conventional double-cortex fibula graft for adult usually causes severe complications in small patients.[1] And the studies about effective methods for large bone defect in patients younger than 3 years are rare in literature. In this article, we report a case of 2-year-old boy with a large tibia bone defect treated by ipsilateral single-cortex fibula graft, and it achieves a satisfactory result.

2. Case

The patient provided informed consent for the publication of his clinical and radiological data. This case report was approved by Medical Ethical Committee of our hospital.

A 2-year-old male patient presented to our hospital with history of leg pain for 4 months. The timeline of this case is shown in Fig. 1. According to his medical records, he was involved in a traffic accident and diagnosed with open tibia fracture (Fig. 2). A previous surgery of emergent debridement and external fixation was performed in our institution, leaving a 6-cm tibia bone defect (Fig. 3). Later this patient received several times of vacuum sealing drainage (VSD), skin graft, and changed external fixation to cast because of pin tract infection.

Physical examination showed the skin wound was healed and the dorsal arterial pulse was good. The CRP and erythrocyte sedimentation rate were normal. X-ray indicated a large bone defect of 6-cm at the tibia fracture site with osteosclerosis at the fracture sections, indicating no further bone growth in the defect part (Fig. 4). This patient was diagnosed as large tibia bone defect and received a 5-cm ipsilateral single-cortex bone graft from the right fibula, and the outer blood supply around this fibula cortex bone was especially protected. Locking plate was applied and calcium sulfate artificial bone was also used at the mean time

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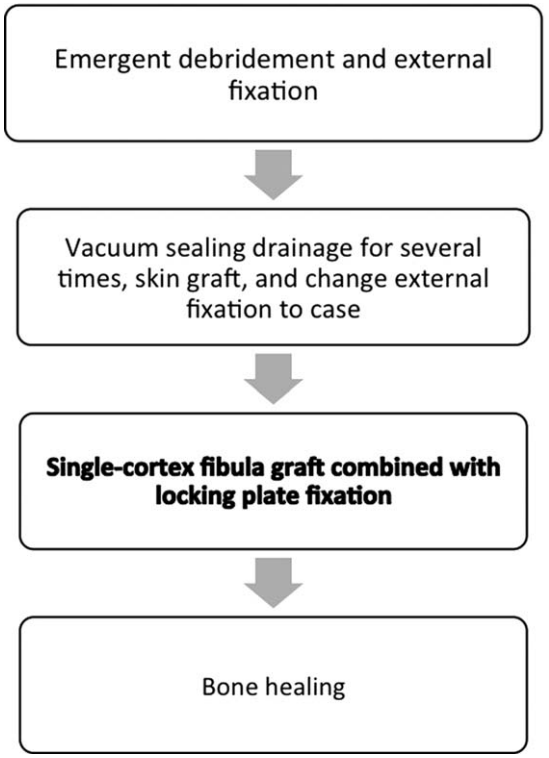

Figure 1. Timeline of this case.

Figure 2. White arrow refers to the displaced tibia fracture with soft tissue swelling. Black arrow refers to the coexist fibula fracture.

Figure 3. External fixator was applied on right tibia, leaving a 6 cm bone defect (arrow).

(Figs. 5 and 6). Cefotiam was used for 3 days after the surgery to prevent infection.

X-ray 3 months after the operation showed calcium sulfate artificial bone was replaced by autologous bone (Fig. 6). One year after the operation, both the X-ray and CT showed the tibia was recovered to a nearly normal shape (Fig. 7). The patient returned to normal activities with an inconspicuous limb. He was able to walk independently without the help of a crutch. Till the last follow-up 14 months after bone graft operation, no obvious morbidity was found in this patient. He and his family are satisfied with this outcome. The plate in this patient is removed 1 year after the operation.

3. Discussion

While many techniques can be used to treat bone defects in adult, it is still a great challenge for infants or small patients at early ages.[2] Our patient is only 2 years old. To our understanding, such a large bone defect in a small boy patient is rarely reported in literature and hard to treat in clinical practice. In this patient, we use ipsilateral vascularized single-cortex fibula graft, other than conventional double-cortex. To our knowledge, this is the first case of such bone graft in small patients.

The double-cortex fibular graft from the healthy side is a commonly used method for large bone defect in adults.[3] This

Figure 4. Four months after the accident, X-ray indicated a large bone defect at the tibia fracture site with osteosclerosis at the fracture ends (arrow).

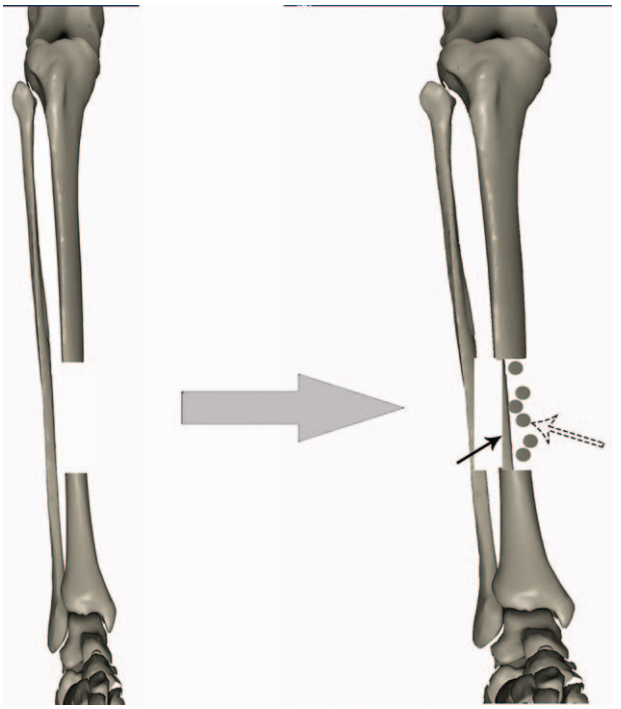

Figure 5. Schematic diagram of bone graft, black arrow refer to the grafted single-cortex tibia, white arrow refer to calcium sulfate artificial bone.

technique has been proved effective in many previous studies.[4,5] However, the side effect of this method in small patients is still questioned for many years. Abdul et al report 8 cases of fibular graft section in Malaysia. They include children aged from 3 to 12 years, and follow between 3 and 12 years. Two patients at 3 and 5 years of age developed abnormal growth of the distal tibia, leading to ankle valgus, and another patient aged 6 years develops hindfoot valgus because of weakness of the tibialis posterior muscle. However, for other patients older than 8 years,

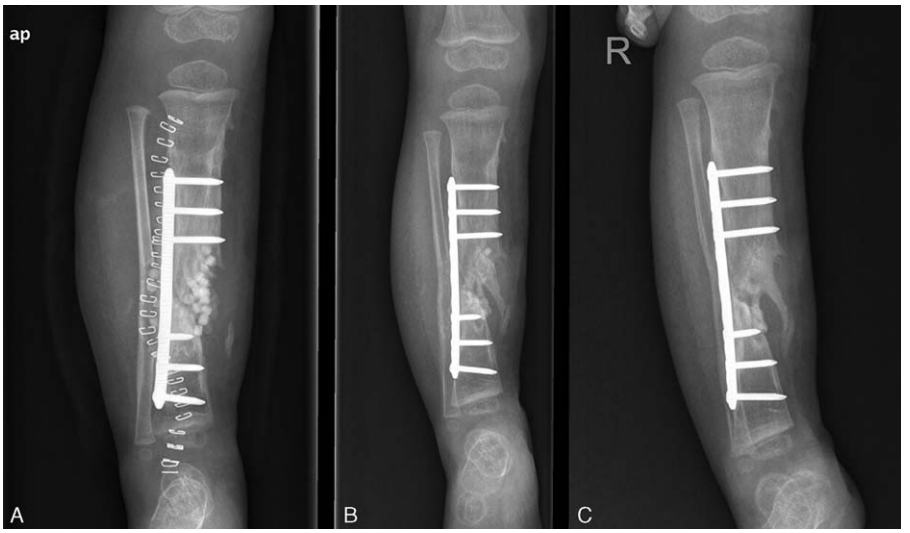

Figure 6. X-ray showed calcium sulfate artificial bone was replaced by autologous bone. (Part A) Postoperative film of the right tibia; (Part B) 1 month after the operation; (Part C) 3 months after the operation.

no one has ankle or hindfoot deformity.[1] This strongly indicates that double-cortex fibular graft resection will cause obvious growth deformity in small patients and should not be used in patients younger than 6 years.

We use a 5-cm single-cortex bone graft, leaving the lateral wall of right fibula intact and maintain the whole length of the fibula (Fig. 5). The fibula has various kinds of blood supplies: Firstly, the middle third is supplied by a large nutrient vessel from the fibular artery; Secondly, the proximal head and the epiphysis are supplied by a branch from the anterior tibia artery; Thirdly, the shaft periosteum receives many small branches from the fibular artery. In this case, the graft bone comes from the middle third part, and the blood supply mainly comes from the branches of fibula artery. These branches around the single-cortex bone are carefully protected, and grafted to the defect side in the tibia. Such single-cortex fibula graft relatively reduces the injury on surrounding muscles, decreasing the possibility of postoperative weakness of these muscles. The calcium sulfate artificial bone is also used to fill bone defects. We consider that the blood supply around the bone graft plays an important role in the process of bone healing. These branches, together with the small vessels around the fracture sections, provide enough nutrients for the osteoblast growth and differentiation at the fracture site, and gradually fill the gaps left by the absorption of calcium sulfate artificial bone. We do not use double-cortex fibula bone graft, because the intact lateral cortex maintains the length of the fibula, and assists the stability of locking plate fixation. In our opinion, it is of great importance for the bone development.

Ilizarov technique is also a useful method to treat large bone defect.[6] However, most of the patients reported for this technique in literature are older than 5 years, and the effectiveness of this method in children is still questioned.[7] This technique has obvious limitations: the joint lossening or stiffness, change of limb alignment, nerve or artery injury, nail site infection, bone nonunion, refracture and persisted pain during application.[8] All the above possible complications make us more cautious in

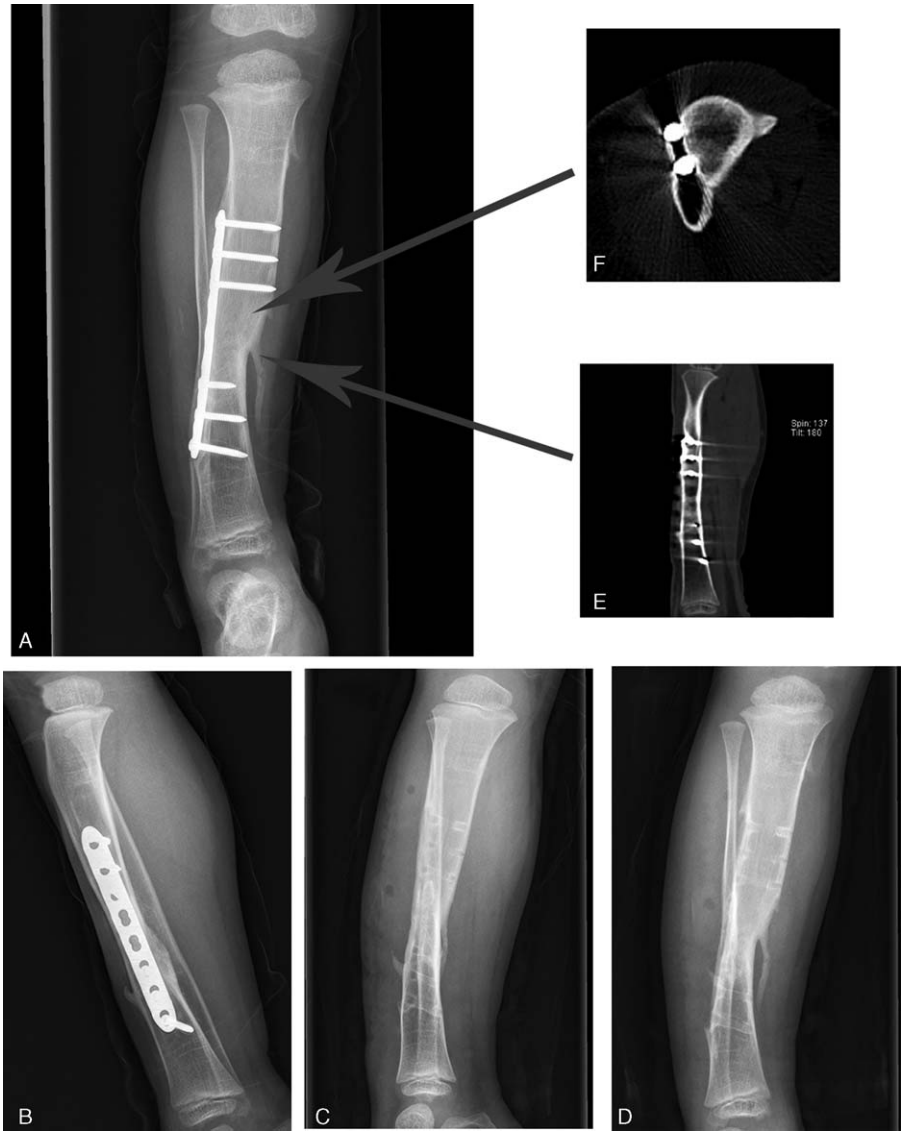

Figure 7. One year after the operation. (Parts A and B) X-ray showed the shape of the tibia was recovered to nearly normal. (Parts C and D) The X-ray after removing the plate. (Parts E and F) Cross and sagittal section CT conformed the bone healing at the fracture site.

applying such technique in this small patient. Additionally, the previously painful experience of the pin tract infection also makes the parents strongly against the external fixator.

Iliac crest and rib graft are other potential choices for tibia defect. The possible morbidity of these 2 methods prevents us choosing these techniques. It is reported an intact cartilaginous epiphysis of the iliac crest is essential during the first decade of life, and harvesting these cartilaginous epiphysis at an early age will lead to local ossification disturbances around the crest.[9] Additionally, though rib graft is commonly used for mandibular condylar replacements, the rib graft has a limited bone stock, and a unpredictable growth fashion. Peltomaki et al[10] make a histological analysis on grafted ribs, and find signs of metaplasia in some cases. Based on above reasons, we consider single-cortex fibula graft is better in this case.

Additionally, there is a new technique reported for large bone defect in children. Gouron et al[11] report 14 large bone defect cases, and treat them by Masquelet's induced membrane reconstructive technique. The mean follow-up is 30 months (range: 1–63), and bone union is achieved in 9.5 months (range: 2–25). There are 35% nonunion cases. However, the patients in that group are relatively older (range: 12–17 years), and the duration of the process is much longer. All the patients should receive the second operation for bone graft. Though theoretically Masquelet's technique is suitable for patients at younger ages,[12] this method is easy to get postoperative junctional pseudarthrosis,[11] stabilization failure,[13] and resorptions.[14] The reported studies about this technique are limited, and more studies are still needed to confirm its effectiveness in small patients. On one hand, repeated operations will cause more pain and damage to this little boy; on the other hand, we consider our technique (vascularized sing-cortex fibula graft) as much more simple with less potential morbidities, comparing with Masquelet's technique.

The locking plate fixation is a key point to achieve tibia stability. The locking screws and plate offer stable mechanical support to the bone, and reduce potential damage to surrounding blood supply.[15,16] The rational length of the plate avoids damage to epiphyseal cartilage, which is especially beneficial in our case.

This technique still has some limitations. These local nutrition branches of fibular artery prevent the graft distance of the fibula, leading to fusion between the section side in the fibula and fracture site in the tibia. Whether such fusion will affect the long-term alignment abnormality or joint dysfunction still needs further observation.

4. Conclusion

Ipsilateral single-cortex fibula graft is effective for the treatment of large tibia bone defect in infant or small aged patients. It exhibited better potential benefits than double-cortex graft in such cases.

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