CASE REPORT

Vascularized proximal fibular epiphyseal transfer: Two cases

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Summary Vascularized proximal fibular epiphyseal transfer in children enables reconstruction of long-bone epiphyseal defect, while conserving axial growth potential. This technique was applied in two children for diaphyseal-epiphyseal reconstruction of the proximal humerus and distal radius respectively, using a graft vascularized only by the anterior tibial artery. There were no major complications during harvesting. Both cases showed transplant growth, of a mean 0.5 cm/year. Joint function in the proximal humerus reconstruction was satisfactory, with functional range of motion. In the distal radius reconstruction, range of motion was almost zero; insufficient transplant growth induced radial club hand, requiring partial correction by progressive lengthening using an external fixator. In case of severe bone loss, fibular epiphyseal-diaphyseal graft vascularized only by the anterior tibial artery is a feasible attitude.

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Introduction

Vascularized fibula epiphyseal transfer allows reconstruction of long-bone epiphyseal defect while conserving axial growth potential in children by the provision of active growth plate. Two fibular epiphyseal-diaphyseal transfers vascularized only by the anterior tibial artery in children are reported.

Case reports

The first case concerns a 5-year-old girl presenting with Ewing’s sarcoma of the proximal extremity of the left humerus (Fig. 1).

Treatment comprised preoperative chemotherapy and 10 cm resection of the proximal humerus, capsule and rotator-cuff tendons. Reconstruction was performed in the same surgical step by 11 cm vascularized fibula epiphyseal transfer, including part of the femoral bicipital tendon to reconstruct the rotator-cuff tendons. Venous bypass was used to extend pedicle length; flap vascularization involved only the anterior tibial artery with termi-lateral anastomosis onto the common humeral artery (Fig. 2).

Non-union found at the implant-humerus junction, managed by cortico-cancellous iliac graft, showed favorable
evolution at 9 months. There were no other complications except foot hypotrophy at the harvesting site. Tibiofibular arthrodesis prevented possible ankle valgization. There was no knee laxity.

At 10 years’ follow-up, active ranges of motion were very satisfactory: $90^\circ$ antepulsion, $80^\circ$ internal rotation, $45^\circ$ external rotation, and $80^\circ$ scapulothoracic and glenohumeral abduction. The reconstructed proximal humerus had lengthened by $5.3\text{ cm}$ in 10 years; at end of growth, however, there remained a $7\text{ cm}$ length discrepancy. Plain X-ray showed excellent joint remodeling, with a progressively spherical fibular epiphysis (Fig. 3).

The second case concerns a 3-year-old boy who had had an accident with a lawn mower, presenting with subtotal left forearm amputation, 2nd and 3rd digit amputation, and multiple open metacarpal and 4th digit fractures. The radial artery was sectioned and stripped over a length of $8\text{ cm}$ (Fig. 4). X-ray assessment found avulsion of $5\text{ cm}$ of the distal third of the radius extending to the growth plate, and fracture of the distal extremity of the ulna, with a $3\text{ cm}$ intermediate fragment (Fig. 5).

Emergency management comprised repositioning and osteosynthesis of the distal radius as free bone flap, radial artery bypass repair and reimplantation of the 2nd digit (regularized at day 3) (Fig. 6).
At 6 months, there was complete lysis of the distal extremity of the radius, requiring 2-step reconstruction: insertion of a cement spacer under antibiotics and with an external fixator, followed, at 11 months post-trauma, by a 10 cm vascularized fibula epiphyseal flap. Vascularization involved only the anterior tibial artery prolonged by a venous bypass with termino-lateral anastomosis onto the ulnar artery. The femoral bicapital tendon, harvested with the flap, allowed a dorsal capsular plane to be reconstructed at the wrist (Fig. 7).

Postoperative course showed slight limping and common peroneal nerve neurapraxia, both showing spontaneous resolution by 4 months.

At 6 years’ follow-up, despite 3 cm distal tibial shaft growth, radial club hand had developed (Fig. 8), partially corrected by progressive lengthening under external fixation (3 cm in 3 months).
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Discussion and literature review

Restrepo et al. [1] and Taylor’s [2] studies of vascularization of the proximal extremity of the fibula in the 1980s led to a mixed epiphyseal-diaphyseal graft technique including the growth plate and vascularized by anterior tibial artery branches and the fibular artery, the anterior tibial artery donor site being reconstructed by bypass.

In 2000, Menezes-Leite et al., in a cadaver study, demonstrated that an epiphyseal graft vascularized by the anterior tibial artery alone could on average be extended to almost 12 cm of the shaft [3]. Dual anterior tibial and fibular vascularization was thus not mandatory, to the benefit of the donor limb.

Mozaffarian et al., however, found anatomic variations in the circumflex fibular neck artery that may contra-indicate harvesting due to deficient pedicle length and caliber [4], making preoperative angiography a prerequisite.

The present results for patient 1 were satisfactory and in line with literature reports.

Patient 2 showed graft consolidation and growth, which represents a success for the microsurgery; results, however, were disappointing, due to insufficient initial graft length to restore a positive radio-ulnar index and to early transplant epiphysiodesis caused by a peripheral bone bridge between the transplanted bone and the distal radial metaphysis.

Few relevant data were to be found in the literature.

In a patient requiring proximal humerus extremity reconstruction for osteomyelitis, Pho and Patterson [5] found ROM to be more or less equal in abduction and antepulsion (respectively, 80° and 70°) but lower in rotation, at just 30° after rotator-cuff fixation onto a fibular muscle stump. Femoral bicipital semi-tendon graft seems to improve rotator-cuff reconstruction with better rotational ROM.

In a 5-case series of radial distal extremity reconstruction secondary to tumor resection, Innocenti et al. [6,7], reported a mean 0.8 cm/year transplant growth and very satisfactory wrist motion at a mean 66° flexion, 54° extension, 80° supination and 72° pronation. Complications comprised three cases of peroneal nerve paresthesia, one of paralysis, with resolution at 1 year postoperatively, and one of enduring paralysis. Dissection, on an anterolateral approach, should be performed with caution around the common peroneal nerve and also around the motor nerve branches innervating the anterior leg compartment muscles, to avoid causing paralysis or muscular deficiency. The author reported no hypotrophy of the foot on the harvesting side, but systematically reconstructed the anterior tibial artery by saphenous bypass. Sacrifice of the anterior tibial axis may induce hypotrophy of the foot by arterial insufficiency.

In his most recent (2007) series [8], Innocenti et al. reported 27 vascularized fibula epiphyseal transfers, including 17 onto the proximal humerus and seven onto the distal radius. At the wrist, he found growth to be equivalent to the contralateral side and adequate for ulnar growth. Results in terms of ROM were equivalent to those in the previous series, although shoulder ROM was less satisfactory (no quantified data shown). There were five cases of early humeral epiphysiodesis and six of fracture (five humeral, one radial).

Tsai [9], in an 8-case experimental series, reported four early epiphysiodeses and four cases of continued growth.

In the proximal extremity of the femur, Debarge et al. [10] reported poor evolution in all three cases, with complete graft resorption, and therefore advised against vascularized fibula epiphyseal graft at this site.

Conclusion

Vascularized fibula epiphyseal transfer is the sole option for reconstructing epiphyseal bone loss while conserving bone growth with the hope that remodeling will restore good joint function. In case of severe bone loss, an epiphyseal-diaphyseal graft vascularized only by the anterior tibial artery is feasible when preoperative angiography has ruled out anatomic abnormality.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References


