Vascularized genicular osseous-periosteal flap for pseudarthrosis of the proximal phalanx of the little finger: a case report

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Abstract This study describes pseudoarthrosis of the proximal phalanx of the little finger and its successful treatment using a free vascularized genicular osseous-periosteal flap. Since this thin and pliable flap can be harvested as a small vascularized unit, it is ideal for the treatment of phalangeal pseudoarthrosis.

Keywords Genicular osseous-periosteal flap · Vascularized periosteum graft · Pseudarthrosis · Nonunion · Bone graft

Introduction

The optimal goal of treatment for fractures is bony union with maintained pre-injury range of motion. Given this, it is necessary to operatively fixate the fracture so that early motion exercises are possible; however, premature motion exercises with insecure fixation occasionally result in pseudarthrosis. Treatment of pseudarthrosis in the phalanx is more difficult and challenging than in other parts of the body because sclerosis may occur along bony contact surfaces and because there is limited space for bone grafts. However, small, vascularized bone grafts at the site of pseudarthrosis are an option for reinforcing bony healing.

As has been previously reported, the vascularized periosteal from the medial condyle of the femur is ideal bone graft material [2, 8, 9, 11]. This flap is particularly

well suited for small-scale applications, such as in the phalangeal joints, due to its thinness and flexibility [1].

In this work we describe successful treatment of phalangeal pseudarthrosis using a small version of this flap.

Case Report

A 26-year-old man sustained an oblique fracture of the proximal phalanx of the little finger in his right hand while playing football (Fig. 1a). He initially underwent open reduction and fixation with Kirschner and soft wires at a clinic (Fig. 1b). Five months after the initial injury, incomplete bone union with loosening and protrusion of wires was recognized, so the wires were removed and a conventional bone chip graft was applied to the remaining defect (Fig. 1c). Two weeks after removal of the wires, he sustained a painless re-fracture along the transverse hole of the removed wire during light everyday work. He underwent cross pinning with another bone chip graft. Since bony union had not been achieved 4 months after the re-fracture, he was referred to our hospital. Radiographs showed blunt edges on the fracture site with surrounding osteosclerosis (Fig. 1d). Refreshment of the fracture line with debridement, curettage of sclerosed bone, and internal fixation with a vascularized bone graft was planned. A vascularized bone graft suitable for a small pseudarthrosis site should be appropriately sized, thin, and pliable. A free vascularized genicular osseous-periosteal flap was therefore chosen for this case.

The technique for harvesting the free vascularized periosteum graft from the medial condyle of the femur follows that reported by Sakai et al. [9] (Fig. 2). Under tourniquet control, a 12-cm longitudinal incision was made

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Fig. 1 A radiographic course of pseudarthrosis. **a** Initial fracture, **b** initial open reduction and fixation, **c** re-fracture after removal of wires, **d** consequent pseudarthrosis with the blunt edge and surrounding osteosclerosis

on the medial side of the distal femur along the anterior border of the sartorius muscle (Fig. 3a). The descending genicular vessels were identified underneath the vastoadductor membrane between the vastus medialis and the sartorius muscle. The vastoadductor membrane was incised

Fig. 2 Periosteal blood supply of the medial condyle. *F* femoral artery, *S* sural artery, *DG* descending genicular artery, *A* articular branch, *SMG* superior medial genicular artery. The genicular osseous-periosteal flap can be harvested in outlined rectangular area

to identify the origin of the descending genicular vessels. The descending genicular vessels were dissected distally to the bifurcation of the articular and the saphenous branches. In the original technique, the saphenous branch must be ligated to achieve a long vascular pedicle at the origin of the descending genicular vessels. In this case, the saphenous branch was preserved because the articular branch was long enough for the vascular pedicle. The articular branch was further dissected distally with ligation of arborizing branches to the vastus medialis. At this point, we were able to identify the periosteal vasculature of the medial condyle derived from the descending genicular vessels (Fig. 3b). Osteotomes were used to harvest a 1×2 cm osseous-periosteal flap attached to the vascular pedicle of the articular branch (Fig. 3c, d).

At the recipient site, debridement and curettage of sclerosed bone was done through the previous dorsal incision, and preparations for the bone graft and micro-anastomoses were completed simultaneously. Prior to flap transfer, cancellous bone chips harvested from the same donor site in the distal femur were inserted into the bony gap, and circumferential wiring for osteosynthesis was administered. The refreshed pseudarthrosis site was wrapped with the osseous-periosteal flap (Fig. 3e). The arterial stump of the vascular pedicle was a T portion, so the arterial pedicle was interposed to the radial digital artery. The concomitant vein was anastomosed to the dorsal subcutaneous vein in an end-to-end fashion. To avoid excessive compression on the vasculature by primary closure, part of the wound was covered with a full-thickness skin graft (Fig. 3f).

Fig. 3 **a** Under tourniquet control, a 12-cm longitudinal incision was made on the medial side of the distal femur along the anterior border of the sartorius muscle. **b** Identification of the periosteal vasculature of the medial condyle derived from the descending genicular vessels. **c**, **d** A 1×2-cm sized genicular osseous-periosteal flap was harvested. **e**, **f** The arterial pedicle was interposed to the radial digital artery using ‘T portion’. The concomitant vein was anastomosed to the dorsal subcutaneous vein in an end-to-end fashion. To avoid compression on the pedicle, part of the wound was covered with a full-thickness skin graft

Complete bone union was achieved in 5 weeks (Fig. 4a, b). Range of motion (ROM) of the proximal interphalangeal joint (PIPJ) was severely restricted due to the long treatment period (about a year after the initial injury). Although another operative intervention for mobilization of the PIPJ was recommended to the patient, he went back to his home country to begin a new job.

Discussion

Since most refractory pseudarthrosis in the hand region is accompanied by atrophic change, bone defects, or local infection [5], vascularized bone grafts are often a useful option for treatment. The utility of the genicular osseous-periosteal flap as a small vascularized bone graft has been

Fig. 4 a, b Bone union could be achieved 5 weeks after the application of the vascularized osseous-periosteal graft

proven in metacarpal reconstruction [10], arthrodesis of the distal interphalangeal joint [4], and treatment of pseudarthrosis of the scaphoid [3]. The technique for using the osseous-periosteal flap differs from other vascularized bone grafts for the hand region, such as the free vascularized radius [13], free vascularized basal phalanges of the foot [6], and pedicled vascularized metacarpal bone [7]. The osseous-periosteal flap, which consists of a thin cortex and periosteum, retains abundant osteoblasts in the cambium layer between the cortex and the overlying periosteum. As a result, thin flap does not simply fill a bony defect but instead wraps and/or seals a defect that has been filled with a conventional bone chip graft, such as an onlay bone graft.

Pseudarthrosis of the phalanx is difficult to treat because there is only a small bony contact surface available. Furthermore, there is a risk of iatrogenic avascular necrosis of the phalangeal head due to aggressive operation around the metaphysis [12]. Wrapping the bony contact area and the phalangeal metaphysis with a vascularized osseous-periosteal flap in the form of a thin onlay graft can help advance bony healing and prevent unexpected avascular necrosis of the phalangeal head. Due to its unique physical properties and bone-forming capabilities, the osseous-

periosteal flap is an excellent choice for treating small-scale phalangeal defects. Since ROM of PIPJ of the little finger is important for power grip and hook grip. Although the patient still had severely restricted ROM of the little finger when we saw him last, improvement of ROM with further operative mobilization was able to be expected because contour of PIPJ were preserved.

A saphenous flap nourished through the saphenous artery can be attached as a monitoring flap, but its harvest is time-consuming and technically difficult, especially in cases where a small monitoring skin is needed. Although it is impossible to evaluate and rescue vascular trouble in early postoperative stage, whether vascularity of the flap is maintained afterward can be assessed with survival of a skin graft directly over an osseous-periosteal flap.

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Conflicts of interest The authors declare that they have no conflict of interest.

References

1. del Piñal F, Innocenti M. Evolving concepts in the management of the bone gap in the upper limb. Long and small defects. *J Plast Reconstr Aesthet Surg.* 2007;60:776–92.
2. Doi K, Sakai K. Vascularized periosteal bone graft from the supracondylar region of the femur. *Microsurgery.* 1994;15:305–15.
3. Doi K, Oda T, Soo-Heong T, et al. Free vascularized bone graft for nonunion of the scaphoid. *J Hand Surg Am.* 2000;25:507–19.
4. Grant I, Berger AC, Ireland DC. A vascularized bone graft from the medial femoral condyle for recurrent failed arthrodesis of the distal interphalangeal joint. *Br J Plast Surg.* 2005;58:1011–3.
5. Jupiter JB, Koniuch MP, Smith RJ. The management of delayed union and nonunion of the metacarpals and phalanges. *J Hand Surg Am.* 1985;10:457–66.
6. Kakinoki R, Ikeguti R, Matsumoto T, et al. Reconstruction of a phalangeal bone using a vascularized metacarpal bone graft nourished by a dorsal metacarpal artery. *Injury.* 2008;39:25–8.
7. Nissenbaum M. Avascular necrosis of the distal phalangeal epiphysis following physeal fracture: a case report. *J Hand Surg Am.* 1999;24:633–7.
8. Sakai K, Doi K, Tamaru K, et al. Free vascularized bone and periosteal graft for pseudarthrosis in the upper limb. *J Jpn Soc Surg Hand.* 1988;5:698–704. In Japanese with English abstract.
9. Sakai K, Doi K, Kawai S. Free vascularized thin corticoperiosteal graft. *Plast Reconstr Surg.* 1991;87:290–8.
10. Sammer DM, Bishop AT, Shin AY. Vascularized medial femoral condyle graft for thumb metacarpal reconstruction: case report. *J Hand Surg Am.* 2009;34:715–8.
11. Serafin D. The genicular osseous-periosteal flap. *Atlas of microsurgical composite tissue transplantation.* Philadelphia: W. B. Saunders; 1996. p. 679–91.
12. Snelling CF, Hendel PM. Avascular necrosis of bone following revascularization of the thumb. *Ann Plast Surg.* 1979;3:77–87.
13. Yajima H, Tamai S, Ono H, et al. Vascularized bone graft to the upper extremities. *Plast Reconstr Surg.* 1998;101:727–35.