Repair of a lateral malleolus defect with a composite pedicled second metatarsal flap

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Abstract

The patient was a 26-year-old man who fell while riding a motorcycle and friction led to defects in the lateral malleolus and soft tissue of the ankle. Although the wound surface healed with scarring and skin grafting, the patient had symptoms of ankle joint instability 4 months after the injury. Using a second metatarsal composite tissue flap with a dorsalis pedis artery pedicle, we repaired the soft tissue defect of the ankle and reconstructed the lateral malleolus. The head of the metatarsal bone was used to reconstruct the lateral malleolus and the flap was used to cover the wound surface. The distal fibula and metatarsus were completely healed 36 months postoperatively. The ankle had maintained stability at this time, with equal limb length and only a mild limitation of dorsal flexion in the ankle joint. The patient could walk, jog, and walk up and down stairs without limitations. There was no pain or limitation in activity at the donor site. Our findings suggest that the second metatarsal composite tissue flap with a dorsalis pedis artery pedicle is an effective option in reconstruction of the adult distal fibula.

Keywords

Lateral malleolus, second metatarsal flap, reconstruction, ankle joint, dorsalis pedis artery pedicle, distal fibula

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Background

The main causes of lateral malleolus defects are severe trauma and extensive resection of fibular tumors.^{1,2} Lateral malleolus defects may cause ankle joint instability, which seriously affects function of the

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ankle joint. We successfully treated a patient with a traumatic complete lateral malleolus defect. We repaired the soft tissue defect of the ankle and reconstructed the lateral malleolus using a second metatarsal composite tissue flap with a dorsalis pedis artery pedicle. This procedure has seldom been used in adults.

Case presentation

The patient was a 26-year-old man who fell while riding a motorcycle. Friction between the lateral malleolus and the pavement led to defects in the lateral malleolus and soft tissue of the ankle. Wound debridement and dressing changes were conducted at another hospital. The wound surface healed with scarring and skin grafting. However, the patient had symptoms of ankle joint instability 4 months after the injury due to the complete absence of the lateral malleolus (Figure 1A). The study protocol was approved by Changzheng Hospital Ethics Committee. The patient provided written informed consent.

Investigations

Radiography showed slight valgus malformation of the ankle joint (Figure 1B).

Treatment

To simultaneously repair the defects of the lateral malleolus and the soft tissue, we took the dorsalis pedis artery as the vascular pedicle, and used the second metatarsal bone and skin flap. The head of the metatarsal bone was used to reconstruct the lateral malleolus and the flap was used to cover the wound surface. We created a fusiform flap along the vertical axis of the dorsalis pedis artery, identified the dorsalis pedis artery between the extensor hallucis longus and extensor digitorum longus, and retained the deep peroneal nerve. We dissociated the dorsalis pedis artery from proximally to distally to form a second metatarsal composite tissue flap with a dorsalis pedis artery pedicle, including the extensor pollicis brevis and the dorsal skin of the foot. The flap was then transferred to the recipient site through a subcutaneous tunnel towards the proximal end. We made the fibular articular surface of the second metatarsus fit the talus, and fixed the fibula and metatarsus with steel plates to reconstruct the lateral malleolus. The extensor pollicis brevis was used to repair the lower tibiofibular ligament and the flap was used to cover the wound surface of the lateral malleolus (Figure 2). At the donor

Figure 1. (A) Photograph of the patient with an external malleolus defect before the operation. (B) Preoperative X-ray shows a lateral malleolus defect.

Figure 2. Surgical procedure to repair the defects of the lateral malleolus and soft tissue. (A) The second metatarsal bone and skin flap were designed. (B) A second metatarsal composite tissue flap with a dorsalis pedis artery pedicle was formed. (C) The flap was transferred to the recipient site through a subcutaneous tunnel towards the proximal end. (D) Postoperative X-ray shows the ankle joint.

site, the transverse metatarsal ligament was sutured in the dorsum of the foot, and the wound was directly sutured.

Outcome and follow-up

Postoperatively, the foot was fixed in a plaster cast for 4 weeks. Ankle joint exercise was started at 4 weeks postoperatively, partial weightbearing exercise at 8 weeks postoperatively, and full weightbearing exercise at 12 weeks postoperatively. The ankle joint received continuous physical therapy for 12 weeks.

At 12 months postoperatively, radiography showed that the distal fibula and metatarsus were completely healed. A follow-up examination at 36 months postoperatively showed that the ankle had maintained stability, with equal limb length and only

a mild limitation of dorsal flexion in the ankle joint (Figure 3). The patient could walk, jog, and walk up and down stairs without limitations. The American Orthopedic Foot and Ankle Society score was 90.³ There was no obvious pain or limitation in activity at the donor site.

Discussion

Reconstruction of the lateral malleolus defect is generally recommended when the defect is causing valgus instability of the ankle joint.^{1,2,4-7} The current methods used to repair a lateral malleolus defect include a pedicled vascularized fibular head graft,⁴ iliac crest graft,⁵ bone flap from the lateral eminence of the scapula,⁶ and allograft bone transplantation.⁷

Figure 3. Recovery of the patient. (A) Plantar flexion of the ankle joint. (B) Dorsal flexion in the ankle joint. (C) At 12 months postoperatively, radiography shows that the distal fibula and metatarsus are completely healed.

However, there is no gold standard for lateral malleolus defect repair.

The metatarsus can be easily cut and removed, and thus it has been widely used for reconstruction of the finger bones, and metacarpal, ulna, and temporomandibular joints.^{8–11} The metatarsus has two arterial sources of the dorsal metatarsal artery from the dorsalis pedis artery and the plantar metatarsal artery from the posterior tibial artery.¹² These two vessels form a wide arterial network in the head of the metatarsal bone,¹² and provide the main blood supply to the metatarsal base.¹³ The first dorsal metatarsal artery approaches the first metatarsus in the first intermetatarsal space, and its distal end enters the first dorsal metatarsal muscle and the second medial metatarsal head to supply the muscle and bone. The third and fourth metatarsal arteries supply the third, fourth, and fifth metatarsal bones.¹⁴ Blood supply to the second metatarsus is abundant.^{12–14} Therefore, the dorsal end of the dorsalis pedis artery and the first and second metatarsal arteries can be retained when the second metatarsal flap is cut. In the process of repairing the lateral malleolus with the second metatarsus, retention of these metatarsal arteries is conducive to fracture healing.

There are some main points for success when using a composite pedicled second metatarsal flap to repair a lateral malleolus

defect, as follows. (1) According to the degree of soft tissue defect of the lateral malleolus, the designed flap must enable tension-free wound repair after flap transfer. (2) When dissociating the dorsal vessels, care must be taken to avoid damaging the first and second dorsal metatarsal arteries, which enter the second metatarsus from the dorsalis pedis artery. When the head and flap of the metatarsal bone are cut, the soft tissue connection between the head and the flap must be protected, and they cannot be separated. This is because microvascular branches of the dorsalis pedis artery enter the flap. (3) The dorsalis pedis artery and vein must be dissociated as far as possible towards their proximal ends to ensure that the vascular pedicle of the flap has sufficient length. This is performed to avoid tension on the vessels after the tissue flap is rotated. (4) The lower tibiofibular ligament must be inspected, repaired, and reconstructed as much as possible. (5) The wound at the donor site can be sutured directly. If the defect area is large and cannot be sutured directly, a rotational flap can be used to repair the wound at the donor site.

In 2008, Hu et al.¹⁵ reconstructed the lateral malleolus with a pedicled second metatarsal flap for a 4-year-old boy. After 7 years of follow-up, their patient had adequate ankle function and stability.

We repaired a soft tissue defect of the ankle and reconstructed the lateral malleolus using a second metatarsal composite tissue flap for a 26-year-old man. Our results are similar to those of Hu et al.¹⁵ These findings suggest that the second metatarsal composite tissue flap with a dorsalis pedis artery pedicle is a useful option for reconstructing the distal fibula. Using a composite pedicled second metatarsal flap to repair a lateral malleolus defect has advantages and disadvantages. The advantages of this method are as follows. (1) The anatomical positions of the vessels and bone tissues of the donor site are constant and are close to the recipient site. (2) Local transfer of the vascular system can be used to simultaneously repair defects of the lateral malleolus and the soft tissue. The technically easy method, abundant blood supply, and good healing properties minimize the occurrence of complications, such as an anastomotic stoma. (3) The skin over the area of the repaired lateral malleolus retains feeling, and the shape is close to normal. The skin is conducive to wearing shoes and has good resistance to abrasion. The disadvantages of using a composite pedicled second metatarsal flap to repair a lateral malleolus defect are as follows: (1) one main vessel of the ankle is damaged; and (2) the integrity of the transverse arch is damaged to varying degrees. The plantar fascia should be tightened and sutured to reduce morphological changes of the arch.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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