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Surgical reconstruction of the fascia lata and posterior tibial artery perforator flap to treat children with simultaneous injury to the Achilles tendon and heel skin

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Abstract

Children with simultaneous injury to the Achilles tendon and heel skin remain a challenge for clinicians. The purpose of this study is to evaluate a combined surgical procedure involving use of the fascia lata to reconstruct the Achilles tendon, and the posterior tibial artery perforator flap to cover the accompanying heel skin injury.

Between February 2010 and February 2013, 8 children (3 females and 5 males) between 3 and 12 years of age, with a median age of 7.5 years, were hospitalized in the First Affiliated Hospital of Shantou University Medical College. All injuries involved damage to an Achilles tendon and heel skin. In all patients, the fascia lata was transplanted to reconstruct the Achilles tendon and the posterior tibial artery perforator flap transplanted to cover the skin injury.

Hospitalization was 11 to 15 days (mean 13.5 days). Local necrosis (15% of the area) occurred in 1 flap, but healed after changing dressing. All other flaps survived well. At follow-up after 1 to 2 years, all children had recovered good plantar-flexion and supported their weight while walking. Use of the Arner-Lindholm standard to rate clinical efficacy revealed that of the 8 cases, 6 cases showed excellent recovery and 2 were good, with 0 cases ranking moderate or poor. The excellent and good rate was 100%.

Child patients with Achilles tendon injury accompanied by heel skin injury are still a challenge for clinicians. Use of the fascia lata, combined with a posterior tibial artery perforator flap, to reconstruct the Achilles tendon and heel skin for children is a feasible, safe, effective method, faster than other methods for recovery, and should be widely applied in the clinic.

Abbreviation: PTAPF = posterior tibial artery perforator flap.

Keywords: Achilles tendon, children, fascia lata, heel, posterior tibial artery perforator flap

1. Introduction

Clinically, an Achilles tendon defect, accompanied by a heel skin defect, is one of the most challenging areas in surgery. Treatment requires not only partial or full reconstruction of the Achilles tendon but also repair of the skin defect. Children easily get hurt due to little formal education and lack of safety consciousness. Both traumas physically and psychologically are very large and can even cause a huge negative impact on child growth and development.

Although many methods such as free flap, cross-leg flap have been used to repair this injury, some limitations such as high rate of necrosis and disadvantages still exist.[1] In this study, we present a series of child cases with Achilles tendon injury accompanied by injury to the heel skin. We also describe a rare and potentially serious damage of the soft tissue in children and report the successful use of the fascia lata transplants to reconstruct Achilles tendon, and posterior tibial artery perforator flap transplants to cover the skin injury.

2. Materials and methods

2.1. Patients

Between February 2010 and February 2013, 8 children (3 females and 5 males) between 3 and 12 years of age (median age 7.5 years) were hospitalized in the First Affiliated Hospital of Shantou University Medical College. Modes of injury were as follows: traffic accident (2 cases), motorcycle twist injury (4 cases), falling object injury (1 case), and agricultural machinery accident (1 case). Injury to both the skin and Achilles tendon only was found in 6 patients, and injury to the Achilles tendon and skin, accompanied by a fracture of the calcaneus, was found in 2 patients. All injuries involved an Achilles tendon injury accompanied by a heel skin injury, the length of Achilles tendon injuries ranged from 3.0 to 5.5 cm, and the area of heel skin injuries ranged from 4.0 cm × 5.0 cm to 7.0 cm × 12.0 cm. In all

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Table 1

Patient details.

Case	Age/sex	Nature of injury	Flap dimension, cm	Wound healing	Achilles tendon loss, cm	Arner–Lindholm rating
1	12/male	Falling object injury	9.0 × 11.0	Good	4.0	Excellent
2	6/male	Motorcycle twist injury	5.0 × 9.0	Good	3.0	Excellent
3	4/female	Traffic accident	10.5 × 7.0	Good	5.0	Excellent
4	10/male	Motorcycle twist injury	7.0 × 12.0	Good	4.0	Good
5	7/female	Traffic accident	10.7 × 7.0	Good	4.0	Excellent
6	7/male	Motorcycle twist injury	6.5 × 12.0	15% necrotic area; healed after changing dressing	4.5	Good
7	5/male	Motorcycle twist injury	8.4 × 9.5	Good	4.0	Excellent
8	9/female	Agricultural machinery accident	4.0 × 5.0	Good	5.5	Excellent

patients, fascia latae were transplanted to reconstruct the Achilles tendon, and the posterior tibial artery perforator flap was transplanted to cover the skin injury. Hospitalization was 11 to 15 days (mean 13.5 days), and all patients were followed up for 1 to 2 years (average 17.5 months). The patient details are summarized in Table 1.

Ethical approval was obtained from the Ethics Committee Board of The First Affiliated Hospital of Shantou University Medical College for this study.

2.2. Operative technique

We first determine the posterior tibial artery exists by using Doppler examination before surgery, then look for the perforating branch artery along the axis of the flap, and mark the location of the superior medial malleolus.

After wound debridement, under a 20° plantar flexion and the knee in a 30° flexion, the length of Achilles tendon injury and the injured area of skin were measured to understand their shape. The surgery was divided into 2 stages. The first stage included transplantation of the fascia lata to reconstruct the Achilles tendon.[2] At this stage, first, the fascia lata of a size about 4 to 5 cm in width and 3 cm longer than the length of the Achilles tendon injury was harvested from the ipsilateral thigh of the child. The smooth side was placed facing outward and the fascia lata was shaped into a cylinder by using an atraumatic suture. Second, the fascia lata was inserted into the upper and lower ends of the fractured tendon. While bending the knee and during plantar flexion, the cylindrical cushion was knotted under the foot by a Bunnell suture with extractable steel wire. Subsequently, the procedure was finished with an "8" pattern suture for reinforcing the broken ends by using the atraumatic suture.

For the second stage of the operation, a flap was transplanted to cover the skin lesion.[3] First, different sizes of the posterior tibial artery perforator flaps were designed according to the lesion of the recipient. Taking the connecting line as the axis between the tibial medial condyle to the midpoint of the medial malleolus and Achilles tendon, the rotation point of the flap was the position that perforates the branch of the posterior tibial artery that protrudes out. The posterior skin of the vessel pedicle was dissected until the deep fascia was reached, enabling the identification and preservation of the perforators, and then the incision was continued distally. After the flap was dissociated, we observed and made sure the blood circulation was good, rotating the skin flap to cover the wound followed by wound closure with a silk suture. The donor site was covered by a split-thickness skin graft obtained from the thigh.

Postoperative management involved a bending knee plantar flexion plaster stone for 6 weeks, plaster removal after the inner fixation of the wire, and gradual commencement of exercise. Patients could return to normal activities after 6 months to 1 year.

2.3. Case report

A 12-year-old boy fell and was injured by masonry and glass, resulting from the fall, crushing his right leg so badly that the injury was complicated with hemorrhage and dysfunction 2 hours before hospital admission (No. 1 in). Examination showed a right Achilles tendon segmental loss of approximately 4.0 cm, and a local skin lesion approximately 9.0 × 7.0 cm, which was accompanied by a partial calcaneus fracture and wound contamination. Plantar-flexion of the right ankle was limited, but the blood to the toes was still good. After admission, the patient was immediately prepared for emergency surgery. After wound debridement, we used the fascia lata to reconstruct the Achilles tendon, and harvested the posterior tibial artery perforator flap to cover the heel skin injury. After surgery, the flap survived and the rehabilitation exercise course began. At the 1-year follow-up, the patient walked normally (Fig. 1).

3. Results

In all patients, the fascia lata was transplanted to reconstruct the Achilles tendon, and posterior tibial artery perforator flap was transplanted to cover the heel skin lesion. Their hospitalization was 11 to 15 days (mean 13.5 days), and all patients were followed up for 1 to 2 years (average 17.5 months). Local necrosis (15% area) occurred with 1 flap, but healed after changing dressing. All other flaps survived well. All of them had gained a good plantar-flexion and walked supporting their weight. Clinical efficacy was evaluated by the Arner–Lindholm standard.[4] Among the 8 cases, 6 cases were rated excellent and 2 were rated good. None of the cases were rated moderate or poor. The excellent and good rate was 100%. Table 1 summarizes the detailed results of all patients.

4. Discussion

There are many clinical reports concerning reconstruction of the Achilles tendon. The materials that have been used Achilles tendon reconstruction can be broadly divided as follows: autologous tendon, allograft tendon, and artificial tendon. Each material has its own advantages and disadvantages in different situations.[5–8] For the reconstruction of Achilles tendon following an open Achilles tendon injury, transplantation of an autologous tendon[8] is more suitable for children aged 3 to 15 years.

As a repair material comprised of autologous tissue, the fascia lata has theoretical advantages based on features including

Figure 1. Case, a 12-year-old boy injured by falling objects. (A) Achilles tendon injury with accompanying injury to the heel skin. (1) The fractured Achilles tendon. (B) During the operation. (2) Complete repair of the Achilles tendon with the fascia lata. (3) Perforating branch of the posterior tibial artery. (C) Complete flap retention with good wound healing following removal of the stitches. (D) Normal walking by the patient at the 1-year follow-up.

morphology, histological characteristics, and physiological function. On the basis of morphology, the fascia lata can be cut to a wide range of sizes, and it has a broad range of uses as a valuable graft material.[9] On the basis of histology, the fascia lata is comprised of a dense connective tissue with fibroblasts interwoven into a network visible by microscopy. Scanning electron microscopy shows collagen fibers mostly presenting as interlacing fiber bundles and a fiber network structure in fiber bundles.[10] This special structure possesses a robustness similar to that of the Achilles tendon, and also has good stability. On the basis of physiological function, removal of a portion of the fascia lata has little influence on the lower limb function, and the operation is simple because of its superficial position. In summary, as a result of its abundance, the nature of durability, elasticity, economic efficiency and relative ease of harvesting, and no rejection, the fascia lata provides an ideal graft material for repair of the Achilles tendon and greatly enhances the stretching force that is conducive to early exercise and recovery of ankle function. The clinical results of our child patients proved to be successful.

Skin defects of the foot and ankle are often associated with exposure of the bone, joint, tendon, vessels, and nerves. Preservation of Achilles tendon function and reduction of deformity requires that the skin defect be covered by a flap to improve local wear resistance. Various types of skin flaps have been described, such as the free flap,[11] cross-leg flap,[12] lateral leg flap,[13] and medial leg flap,[14] each of which has its own merits and demerits. The medial leg flap is simple and practical, provides robust axial perfusion for flaps, and is easier to transpose when compared with free flaps.[14] Moreover, it does not contrast cross-leg flaps, which are associated with long-term and uncomfortable immobilization of the legs, and the donor area is hidden. The defects of the lateral malleolar region are also common in clinical, which needs to be addressed; Ceran et al[15] found that distally based peroneus brevis flap is an easy-to-do local flap and better cooperates than grafts to this defect; however, our patients have skin defects on the surface of the Achilles tendon. The soft tissue is thin at this site, and it requires wear-resisting, and considering the concealment of the supply area, we believe that the medial led flap is better for pediatric patients.

The medial leg flap contains the posterior tibial artery flap and the posterior tibial artery perforator flap. In 1982, the flaps were first designed on the posterior tibial vessels as described by Vaienti et al.[3] Subsequently, Carriquiry et al[16] found the perforating branch of posterior tibial artery, which was mostly located at a constant anatomic position, and many investigators confirmed the reliability for the design of the flaps based on the perforator from the posterior tibial artery. Heymans et al[17] found that the posterior tibial artery perforators are connected in an axial network, and Tang et al[18] found that the vascular caliber is more rough. On the basis of the above properties, the posterior tibial artery perforator flaps allows the surgeon to design large flaps that can cover wounds of different sizes and shapes. Tibial artery perforator flaps also enable early coverage with vascularized skin flaps that help in prevention of deep tissue infections and long-term morbidity. At follow-up, our patients showed good contour with excellent color, texture, and thickness matching with the wounds. Patients had a shorter hospital stay and exercised early postoperatively, facilitating normal growth and development of child patients.

Some situations arise where the posterior tibial artery is absent.[19] Studies have shown that the posterior tibial artery is absent in 8% of limbs.[20] Subsequent to locating these vessels using the Doppler probe, inspecting the skin vessels arising from the posterior tibial vessels. In such an instance, we can also determinate the perforators through intraoperative meticulous dissection according to the axis of flap.

Open wounds of this type are heavily contaminated and easily infected, so the correct treatment and complete debridement is one

of the key means to aid recovery.[1] These case studies were treated with surgery within 8 hours of their injury. The wound was done debridement during operation and early get rid of skin soft tissue contusion. Subsequently, it was rinsed with hydrogen peroxide solution and saline and iodophor alternatively, and make sure the wound is free from dirt. In our experience, if wound debridement could done within 8 hours of injury, so that we can primary repair for this defect, when this time has elapsed, it needs second surgery because that increase infection rate of open wound.

The diagnosis of children with complicated injuries is often missed because of their uncooperative attitudes toward treatment due to pain and fear. All patients were inquired in detail about their injury and were examined carefully. After excluding other serious accompanying injuries or infection, we advocated primary repair of such defects because early repair of defects of the foot and ankle can benefit and even heal speedily for a child.

The operation should be gentle and the nerves of the flap protected, as far as possible, with excess pulling being a significant cause of poor blood supply to the tissue. After surgery, the patient should rest and the affected limb should be placed high above the heart. Mostly, postoperative training is one of the keys to achieve successful results.

5. Conclusion

Children with heel skin lesions accompanying Achilles tendon injuries remain a challenge for clinicians. We describe a feasible, safe, effective procedure, using the fascia lata combined with a posterior tibial artery perforator flap to reconstruct the Achilles tendon and cover skin wounds, respectively, of child patients. This procedure is widely applicable for Achilles tendon reconstruction and can be readily used in the clinic.

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