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## Research Paper

## Dorsalis Pedis Artery-based Flap to Cover Nonhealing Wounds Over the Tendo Achillis—A Case Series

## 用足背動脈蒂皮瓣來覆蓋非癒合的跟腱手術傷口—系列病例報告

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## ABSTRACT

**Background/Purpose:** Soft tissue necrosis after the repair of a ruptured tendo Achillis is a difficult problem commonly encountered by orthopaedic surgeons. Such wounds are difficult to manage because of the tenuous blood supply and the characteristic anatomical features of the area. Flaps such as the reverse sural flap, medial plantar flap, gastrocnemius flap and free flaps cover such wounds with a good success rate. The aim of our study was to investigate the use of a dorsalis pedis artery (DPA)-based flap to cover a wound over the tendo Achillis insertion area.

**Methods:** We report a series of 11 patients in whom wounds over the tendo Achillis insertion area were covered with a DPA-based flap. Between 1995 and 2012, 11 patients (nine men and two women), who were referred to us with a nonhealing wound over the tendo Achillis because of soft tissue necrosis after the open repair of a ruptured tendon, were selected for soft tissue coverage of the wound by using a DPA-based flap.

**Results:** The average follow-up period was 2.4 years (range, 1–6 years). The mean operative time was 1.7 hours (range, 1.5–2.0 hours). At the latest follow-up examination, the flaps had survived in all patients.

**Conclusion:** A DPA-based flap is a good and relatively less complex procedure to use to cover defects over the tendo Achillis with minimum donor site morbidity.

## 中文摘要

**背景:** 跟腱修補手術的傷口出現軟組織壞死,是骨科醫生常見到但很難處理的併發症。由於該區域的脆弱的血液供應和解剖特徵,使傷口難以處理。文獻中已經描述了許多不同的皮瓣,例如反向腓腸皮瓣,內踝側皮瓣,腓腸肌皮瓣以及一些游離皮瓣來覆蓋這些傷口,都有良好的成功率。我們本研究的目的是,調查用足背動脈蒂皮瓣(Dorsalis Pedis artery based flap, DPA flap)來覆蓋這些跟腱手術傷口的成效。

**方法:** 從1995年到2012年,一系列共11病例(9男2女)接受了DPA flap來覆蓋跟腱修補手術後不能癒合的傷口。

**結果:** 隨訪時間平均為2.4年(範圍由1–6年)。手術時間平均為1.7小時(範圍由1.5至2小時)。在最後的隨訪,所有的病例的皮瓣都存活。

**結論:** 用DPA flap來覆蓋跟腱傷口有很好的果效,步驟簡單而且對供皮區的傷害很少。

## Introduction

An open repair of a ruptured tendo Achillis is associated with the common complication of wound dehiscence. Soft tissue reconstruction of the tendo Achillis insertion region because of its anatomical peculiarities is challenging for the treating

reconstructive surgeon.<sup>1,2</sup> Such wounds have been covered by various types of local and free flaps. A commonly used flap is the neurosensory distally based island sural flap.<sup>3,4</sup> Other flaps are the medial plantar flap and the muscle or musculocutaneous flap using the gastrocnemius, peroneus brevis or abductor hallucis.<sup>5–9</sup> The dorsalis pedis artery (DPA)-based flap has been used to cover ankle and foot defects.<sup>1,10</sup> To cover a heel wound, a DPA-based flap may have to be lengthened by a graft or the whole flap may have to pass through the interosseous membrane between the tibia and fibula to

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short-circuit the pedicle or to enable the flap to reach the site without tension.<sup>11,12</sup> In this series, we have used the DPA-based flap to cover wounds over the tendo Achillis without any lengthening of the artery by using a venous graft because this technique has less need for an excursion length to the tendo Achillis insertion site. This flap has a wide arc of rotation, reliable vascularity, and can also be used as a sensory flap.<sup>1</sup>

## Patients and methods

Between 1995 and 2014, 11 patients were referred to us with defects over the tendo Achillis, after its open repair (Figure 1). The size of the defects ranged from 1.5 cm × 2 cm to 2 cm × 3 cm. The flap size was mapped by the wound size. The wounds were caused by tissue breakdown and skin necrosis after an open surgical repair of a ruptured tendo Achillis that had been performed elsewhere. The open wounds were contaminated, although we could not isolate any positive bacterial culture in any patient. One reason for this finding could be the prolonged use of antibiotics that the patients were already receiving before coming to us. The patients were selected for a DPA-based flap to cover the wound over the tendo Achillis. The selection criteria included (1) the clinical presence of dorsalis pedis and posterior tibial arterial pulses, (2) healthy skin over the dorsum of the foot, and (3) no history of longstanding diabetes mellitus or peripheral vascular disease. The 11 patients comprised nine men and two women. The mean age of the patients was 41 years (range, 30–52 years). The wound was healthy in all patients, except one patient in whom the infection subsided after 1 week of regular dressings and antibiotic therapy. After wound healing, the patients were followed up at 6 weeks, 6 months, 1 year, and 3 years. In two patients, we obtained a magnetic resonance (MR) angiogram at the 3-month follow up examination to demonstrate the presence of a vascular pedicle extending to the flap site (Figure 2).

## Surgical technique

With the patient supine, the operation was performed under tourniquet control. First, the surface was marked. The size of the flap was determined by mapping the wound with sterile paper and using it as the template. The boundary of the skin available for the flap extended proximally from the ankle joint to the metatarsophalangeal joint distally. The mediolateral borders of the flap extended from the tendon of the extensor hallucis longus medially to the tendon of the extensor digitorum longus. A distal incision was first created at the first web space, and the first dorsal metatarsal artery was then identified, ligated, and divided. The branches of the superficial peroneal nerve were similarly identified and divided laterally. The flap was dissected distoproximally deep to the



Figure 1. The wound over the tendo Achillis before surgery.

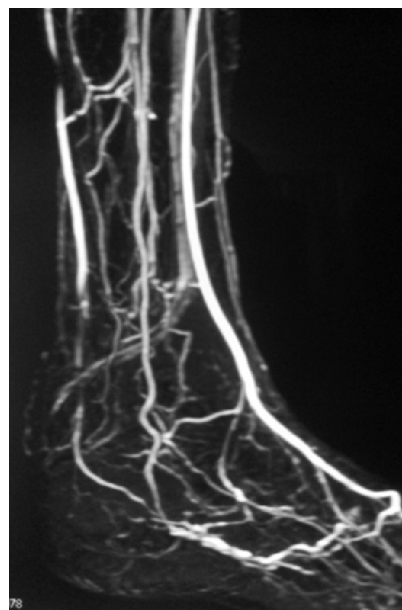


Figure 2. The magnetic resonance angiogram of a patient at the 3-month follow up shows that the diverted route of the dorsalis pedis artery extends to the base of the flap.

first dorsal metatarsal artery. The paratenon of the extensor tendons were preserved. The dissection of the flap was continued proximally. As the dissection proceeded from the medial to the lateral side, the DPA was further dissected from the underlying tarsal bones and the maximum amount of tissue was preserved between the extensor hallucis longus and extensor digitorum longus tendons. With the proximal incision completed, the extensor retinaculum was opened and the DPA and its venae comitantes and nerves were identified. The extensor digitorum longus was retracted laterally, thereby exposing the extensor digitorum brevis. The first head of the muscle remained connected to the superficial tissues but separated from the rest of the muscle. The lateral tarsal artery was ligated deep to the muscle. The flap was finally isolated on the vascular pedicle. We dissected the pedicle proximally and continued assessing the length of the pedicle required to reach the recipient site. The average length of the pedicle was 18.1 cm (range, 16–20 cm). However, we believe that discussing any mean length or its measurement does not impact the performance of the procedure.

The dissection continued until the desired length was achieved (Figure 3). The tourniquet was deflated to assess circulation in the flap. The first head of the extensor digitorum brevis must be included to preserve the blood supply of the overlying skin. The extensor digitorum brevis dissected out will naturally maintain the



Figure 3. The intraoperative image shows the flap with the vascular pedicle of dorsalis pedis artery.



**Figure 4.** The wound early in the healing process just after stitch removal on post-operative day 13.



**Figure 5.** The recipient site at 2 years after surgery.

blood supply to the muscle tissue, which should provide a healthy environment, similar to what occurs when muscle pedicle flaps such as the gastrocnemius flap and soleus flap are used. Because of the rich blood supply in the muscle tissue, these flaps also aid in eradicating local infections.

The presence of the extensor digitorum brevis muscle in the flap, akin to the myocutaneous flap, provides the advantage of vascular muscle tissue over a necrotic relatively ischaemic tendinous insertion. To route the flap, a subcutaneous tunnel was created between the edge of the wound to the site of the dissected pedicle and flap with the attached muscle tissue gently eased out towards the recipient site. The donor site on dorsum of the foot was covered with a split skin graft harvested from the opposite thigh.



**Figure 6.** The donor site at the 2-year follow up.

## Results

At the first dressing 24 hours after the operation, all flaps appeared normal, except for one flap that had venous congestion, which subsided by the 4<sup>th</sup> postoperative day. In all patients, the operative wound healed uneventfully in an average time of 15.4 days (range, 13–22 days; [Figure 4](#)). Patients resumed work 4–6 weeks after the operation. They were followed up for a mean period of 2.4 years (range, 1–6 years). All flaps survived well ([Figure 5](#)).

The function of an ankle can be affected by a previous tendo Achillis repair and hence determining the loss of function due to a flap procedure is difficult. All patients maintained walking ability with full weight bearing on the tip of the toes, which indicated sound healing of the tendo Achillis. All patients had an average loss of 10 degrees of dorsiflexion on the operated side, compared to the normal side.

At the latest follow up, the donor site was healthy in all patients ([Figure 6](#)). In two patients, an MR angiogram was performed at 6 months to document that the vascular pedicle extended to base of the flap ([Figure 2](#)). In all patients, the DPA could be felt subcutaneously the over lower third of the fibula because all flaps were rerouted subcutaneously over the lateral aspect of lower leg to extend to the desired recipient area.

## Discussion

Soft tissue defect of the tendo Achillis insertion area is a difficult problem commonly encountered by orthopaedic reconstructive surgeons.<sup>1,2</sup> Various types of local and free flaps have been used to cover such wounds. Commonly used flaps are the distally based island sural flap, medial plantar flap, and muscle flaps using muscles such as the gastrocnemius, peroneus brevis, and abductor hallucis. These flaps cover such wounds with a good success rate.<sup>2–7</sup> A few studies have described the use of the DPA-based flap to cover wounds over the distal lower leg, ankle, and heel.<sup>1</sup> In this series, we successfully used this flap to cover wounds over the tendo Achillis insertion area in 11 patients. Gajiwala et al<sup>12</sup> found that the DPA-based flap could adequately cover a wound over the weight-bearing part of the heel. However, they noted that the anterior subcutaneous route resulted in an inadequately long vascular pedicle, and they decided to short circuit the course of the pedicle by passing the flap through the interosseous membrane. In our study, the wound site was well above the weight-bearing part of the heel and the pedicle was of sufficient length to reach the target site. This flap is not commonly used because of donor site morbidity and the need to sacrifice an important vessel of the foot.<sup>1</sup> However, we did not have any donor site complications and all flaps survived uneventfully.

A reverse sural flap is a good alternative to cover distal leg wounds.<sup>1</sup> Dharmangaonkar and Patankar<sup>13</sup> performed a reverse sural fasciocutaneous flap in 109 patients who had moderate to large soft tissue defects in the distal third of the leg and ankle. Contrary to the aforementioned study, our series included comparatively smaller wounds. Muscle flaps can cover these wounds but at the expense of function.<sup>14</sup>

Two patients underwent an MR angiogram at 6 months to demonstrate the vascular pedicle but we could not determine the exact change in the flap thickness at the recipient site. In due time, the muscle Extensor digitorum brevis (EDB) in the flap is expected to change into intermediate connective tissue and no longer functional muscle.

Akhtar S. et al<sup>1</sup> reported that this flap can be used as a sensory flap. We did not strive to use this flap as sensory flap and tried to preserve the branches of superficial peroneal nerve for that purpose. Sensations were definitely dull to touch and to pain at the recipient site.



Free flaps can also be formed, but there are certain disadvantages to this procedure such as the need for a remote donor site, long operative time, use of a major vessel, and the procedure is technically demanding.<sup>1</sup> Our procedure also has few disadvantages such as the need for a meticulous dissection, sacrifice of an important vessel, and donor site morbidity such as the lack of sensation and graft breakdown. The limitations of this flap are a larger wound size and the need for a venous graft if the flap requires extension. The absence of a posterior tibial pulse, diabetic microangiopathy, and peripheral vascular disease are obvious contraindications for the flap. However, if properly created, it is easy to perform, is less time-consuming, and has a reasonably good survival rate.

### Conclusion

The DPA-based flap is not a commonly performed procedure; however, it is useful for covering nonhealing wounds after an open repair of the tendo Achilles—provided posterior tibial artery pulsation exists. The main advantages of this procedure are microvascular surgical facilities are not required, it is a less time-consuming procedure, donor site morbidity is insignificant, and the muscle in the flap aids in the healing of the repaired tendon.

### Conflicts of interest

The authors have no conflicts of interest to declare.

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