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Case report

Skin defects covered using medialis pedis flaps after correction of severe flexion contracture of the big toes due to plantar fibromatosis

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Introduction

Flexion contracture of the fingers caused by fibromatosis of the palmar aponeurosis is a common pathologic condition known as Dupytren's contracture. Plantar fibromatosis has been frequently reported and is known as Ledderhose's disease; but unlike Dupytren's contracture of the hand, flexion contracture of the toes is rare.[1,2]

During treatment of severe Dupytren's contracture, skin defects are often created in the palm of the hand or the palmar aspect of the fingers after correcting the contracture. Some authors recommend leaving the skin defects open and waiting for granulation formation in the wound, leading to skin formation.[3] Others have covered the skin defects using multiple triangular flaps (Z-plasty), free skin grafts, cross-finger flaps, or local flaps.[3–6] In this report, we document a patient with severe plantar fibromatosis bilaterally involving the feet who was treated by removing the plantar aponeurotic cords, with skin coverage created after correcting the flexion contracture of the toes using a medialis pedis flap obtained from the ipsilateral foot.[7] We also discuss the usefulness of the medialis pedis flap to cover a skin defect created after correcting flexion contracture of the toes.

Anatomy of the medialis pedis flap

According to an anatomical study by Masquetet and Romana,[7] the medial plantar artery bifurcates just medial to the abductor hallucis muscle to give a superficial branch and a deep branch in the medial aspect of the foot. The deep branch passes over the tibialis posterior tendon just proximal to the navicular bone tubercle and bifurcates to medial and lateral branches. The medial branch of the deep branch of the medial plantar artery nourishes the skin of the medial aspect of the foot along the midlateral line of the first metacarpus. A flap can be extended to the middle of the first metacarpus distally and the medial malleolus proximally. The maximum size of a flap based on this branch is reported to be 5–10 cm (Fig. 1).[7]

Case presentation

A 53-year-old man complained of gait disturbance over the past 2 years due to bilateral flexion contracture of the big toes. He had been walking with both big toes wrapped in thick sponge gauze to protect the tips of the toes from directly touching the floor or shoes (Fig. 2). The patient had undergone surgery for bilateral release of contracture of the fingers several times over the previous 15 years; however, the contraction of the fingers recurred and severe bilateral flexion contracture in the fingers was evident (Figs. 3, 4). Except for the bilateral involvement of the hands and feet, no other body parts were involved in this disease process. The patient reported that his father had had a similar disease, but no other relatives or children were affected. He did not drink alcohol or smoke, and he had no other predisposing factors related to the occurrence of this disease. Blood tests showed no abnormal findings. Physical examination showed severe bilateral rigid flexion contracture of the big toes, with 30° of flexion in the metatarsophalangeal (MP) joint and 50° of flexion in the interphalangeal (IP) joint. The flexion contracture was extremely rigid, and passive extension of the big toes was impossible. The second and third toes were also bilaterally involved, with slight flexion contracture. A rigid cord-like material, which was demonstrated to have low density on both T1- and T2-weighted magnetic

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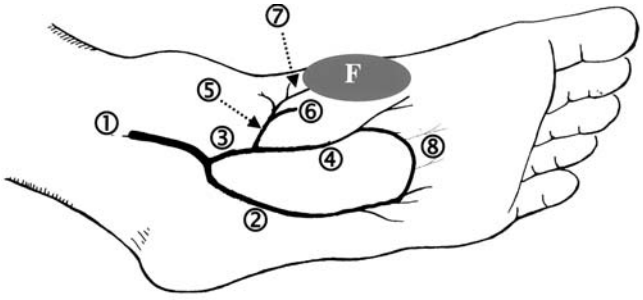

Fig. 1. Anatomy and surgery of a pedicled medialis pedis flap. *1*, posterior tibial artery; *2*, lateral plantar artery; *3*, medial plantar artery; *4*, superficial branch of the medial plantar artery; *5*, deep branch of the medial plantar artery; *6*, lateral branch of the deep branch of the medial plantar artery; *7*, medial branch of the deep branch of the medial plantar artery; *8*, plantar arch

Fig. 2. Photographs of the left foot before surgery. The flexion contracture of the big toe was marked. The patient had been walking with both big toes wrapped in thick sponge gauze to prevent the tips of the toes from directly touching the floor or shoes. A callosity was present on the heel

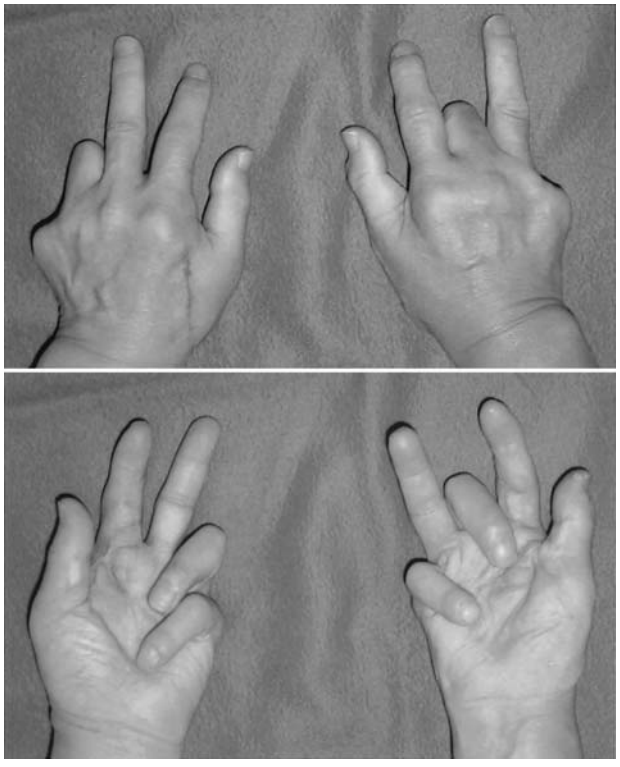

Fig. 3. Photographs of the two hands. The patient had undergone several operations on both hands beginning 15 years before, but there was recurrence

resonance images (MRIs), was palpable just under the skin in the sole of each foot (Fig. 5). The cord-like material did not form nodules in the feet. The patient was diagnosed as having bilateral Dupytren's contracture in the feet and underwent surgery.

The left foot was operated on first. The skin was separated from the underlying aponeurosis through a zigzag incision in the plantar aspect of the foot (Fig. 6). In several parts of the sole, separating the skin from the aponeurosis was so difficult the skin became extremely thin. The aponeurosis was firmly attached to the flexor tendon sheath and the ligaments encasing the neurovascular bundles of the foot. The aponeurosis was carefully separated from the flexor tendon sheath and neurovascular bundles with the assistance of an operating microscope. The attachment of the aponeurosis to the sesamoid bones was sharply detached. The flexor hallucis brevis, adductor hallucis, and abductor hallucis tendons were separated from the proximal phalanx of the big toe. The excursion of the flexor hallucis longus tendons was poor because of the long-term flexion contracture of the big toe. Therefore, it was also separated just proximal to the MP joint. Removal of the rigid, thickened, cord-like aponeurosis, transection of the long and short flexor, adductor, and abductor tendons, and extensive release of the joint capsules and ligaments of the MP and IP joints of the big toe allowed both joints to extend up to 0°. After the flexion contracture of the big toe had been corrected, an elliptical skin defect (5.5×3.0 cm) was left on the plantar side of the MP joint of the toe (Fig. 7). The vascularity of the big toe was good when the MP and IP joints were held at 0° extension. A medial pedis flap (6.0×3.5 cm) based on the medial branch of the deep branch of the medial plantar artery and its concomitant veins was harvested from the medial aspect of the ipsilateral foot. After the medial

Fig. 4. Plain radiographs of both feet before surgery (*left*, anterolateral view; *right*, oblique view). Severe flexion contracture of both big toes is evident

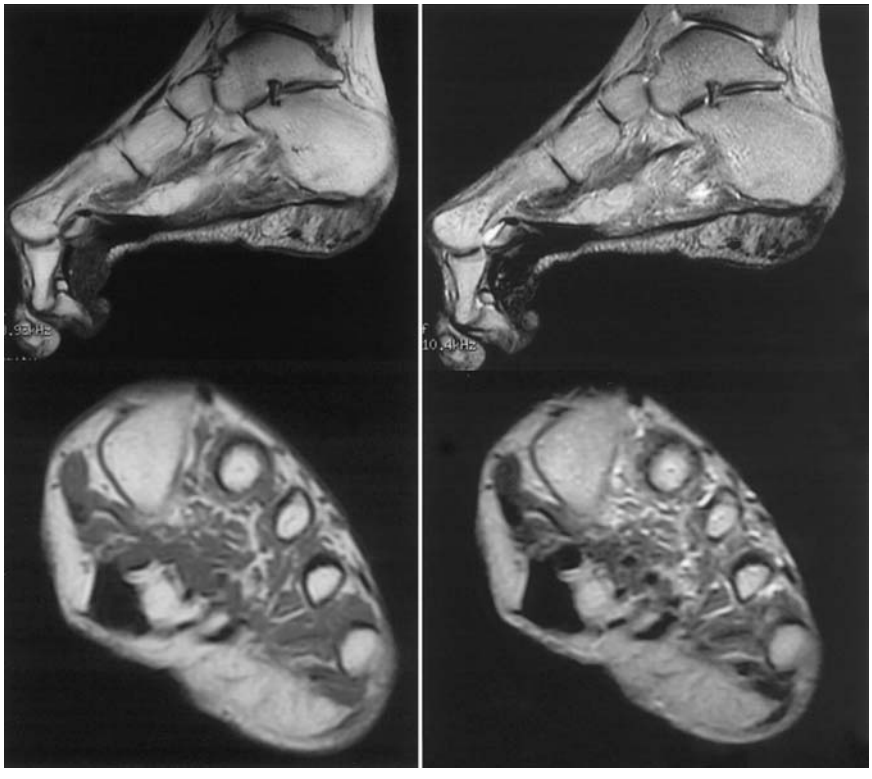

Fig. 5. T1-weighted and T2-weighted magnetic resonance imaging (MRI) scans of the left foot before surgery. A thick, cord-like aponeurosis is evident on the sole of the left foot

plantar artery had been ligated just proximal to the bifurcation of the superficial and deep branches, the flap, based on the superficial medial plantar artery and its concomitant veins, was raised distally. Finally, the medialis pedis flap was supplied with orthotic blood flow by the deep branch of the medial plantar artery and with retrograde blood flow from the superficial branch of the medial plantar artery. The elliptical skin defect on the plantar side of the MP joint was covered by the flap taken from the medial aspect of the foot. The skin defect created after obtaining the medialis pedis flap was covered by a full-thickness skin graft taken from the ipsilateral inguinal area (Fig. 8). Because the MP and IP joints had been forced to remain in the hyperflexion position for a long time, both the articular cartilage and the osseous structure of the joints were destroyed or deformed. The articular surfaces of the MP and IP joints of the big toe were too incongruous to be held in the neutral position. Therefore, both joints were immobilized temporarily at 0° extension using a 2.4 mm K-wire

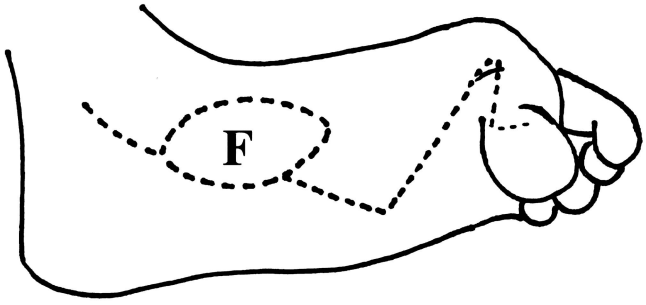

Fig. 6. Skin incision. A zigzag incision was made in the plantar aspect of the big toe and the sole. *F*, medialis pedis flap

inserted from the tip of the big toe and passing through the IP and MP joints. Histology of the excised cord-like tissue was consistent with the clinical diagnosis of plantar fibromatosis (Fig. 9).

Four weeks after the operation, the flap had successfully survived, and the K-wire was removed from the toe. The patient was then allowed to walk with full weight-bearing. The patient underwent the same operation on the right foot 8 months after the operation on the left foot. Three years after the operation on his left foot, the MP and IP joints of either big toe were almost ankylotic in the neutral position (Figs. 10, 11). There

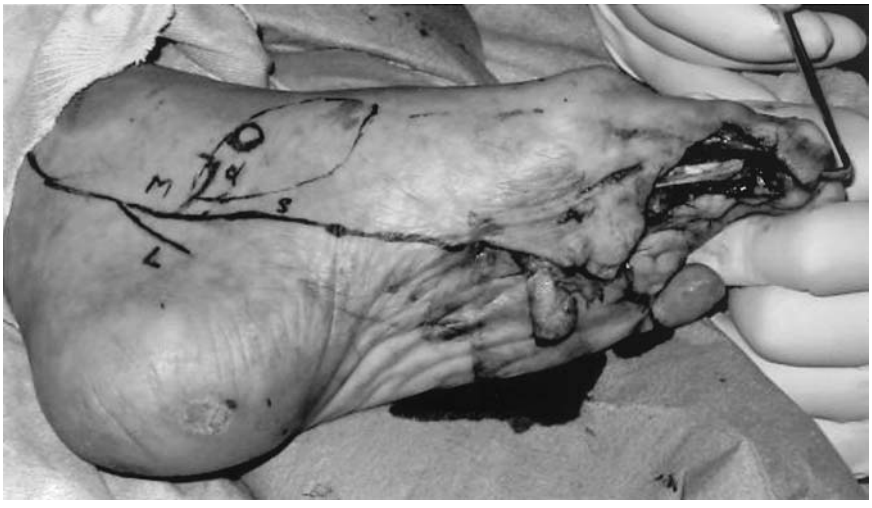

Fig. 7. Intraoperative photograph of the left foot. The flexion contracture of the big toe was released, and a skin defect was created in the plantar aspect of the metatarsophalangeal (MP) joint of the toe

Fig. 8. Photograph obtained just after the operation. The donor site was covered by a full-thickness skin graft taken from the left inguinal area

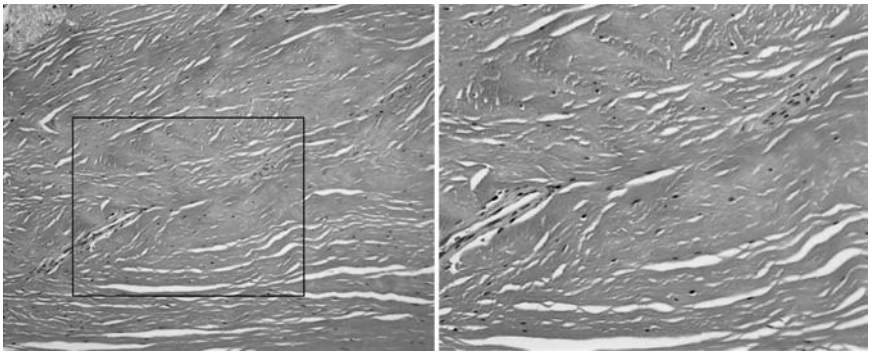

Fig. 9. Photomicrographs of the longitudinal section of the excised pathological plantar aponeurosis *Left*, ×40. *Right* (rectangular area in the left section) ×100. Although hyalinization of the tissue is marked, it is compatible with a clinical diagnosis of plantar fibromatosis. H&E

was no sensory disturbance. There was no sign of any recurrence of the flexion contracture in either big toe. The patient was able to walk smoothly wearing shoes with a rocker bar, which facilitated stepping with rigid big toes (Fig. 8).

The patient and his family were informed that his data would be submitted for publication and gave their consent.

Discussion

We successfully treated a patient with plantar fibrosis demonstrating severe bilateral flexion contracture of the big toes by covering a skin defect created after correcting the flexion deformity using a medialis pedis island flap. Three years after the operations there was no sign of any recurrence of flexion contracture in either big toe, and the patient could walk without toe pain.

Fig. 10. Left foot 3 years after surgery. The callosity observed on the heel before surgery has disappeared, indicating an improvement in the patient's gait

Fibromatosis, a pathologic diagnosis is characterized by local proliferation of fibroblasts and manifests clinically as soft tissue thickening. The most common form is Dupytren's disease of the hands. It sometimes involves the sole (Ledderhose's syndrome), the penis (Peyronie's disease), and the dorsum of the proximal interphalangeal joint (Garrod's nodes).[2] Less frequently, it involves the popliteal fossa, neck and antecubital fossa, hip, and auricular conchae.[8] A positive family history is known to be related to the development of Dupytren's disease and its early onset.[9,10] Plantar fibromatosis is an uncommon form of Dupytren's disease. Most lesions are found as nodules in the non-weight-bearing midsole region of the fascia, and they remain asymptomatic until they become large enough to cause pain from pressure while standing.[11] Unlike Dupytren's disease of the hands, it seldom causes flexion contracture of the toes and feet.[1,2] The coexistence of Dupytren's contracture of the hands and plantar fibromatosis has been reported in 9%–65% of cases.[2]

During treatment of flexor contracture of the toe caused by plantar fibromatosis, coverage of the skin defect created after correcting the flexion deformity is important because the skin defect is usually in the weight-bearing part of the sole of the foot. Because this part of the sole is exposed to tremendous compressive and sliding forces during walking, the skin defect should be covered by a skin flap that is strong enough to bear such forces. There have been numerous articles on covering palmar skin defects created by the treatment of Dupytren's contracture of the hand by multiple triangular flaps (Z-plasty), free skin grafts,[5] cross-finger flaps, or pedicled vascularized flaps.[4] Roush and Stern[6] studied the postsurgical recurrence of Dupytren's contrac-

Fig. 11. Plain radiographs of both feet before surgery (*left*, anterolateral view; *right*, oblique view). Severe flexion contracture of both big toes was corrected

ture of the hands and reported that the recurrence rate in cases treated by aponeurectomy combined with coverage of skin defects with skin grafts was much lower than that for aponeurectomy without skin grafts. Several authors have recommended treating Dupytren's contracture by leaving the skin defects open and waiting for granulation of the wound followed by skin formation, rather than closing the defects with or without skin grafts.[3]

Although the open wound method is simple and can avoid complications related to postsurgical hematoma,[3] it was not suitable for treating the defects in the feet in our patient because the defects were created in the weight-bearing portion after correcting the plantar flexion deformity of the toes. The scarred skin formed from the open wound might cause pain or uncomfortable sensations in the sole. Moreover, the open wound method requires patients not to bear weight on the affected foot for a long time, until skin forms that is strong enough to bear weight. The wound should be kept clean until skin coverage is complete. Split-skin or full-thickness skin grafts were also not suitable for covering the skin defects in the feet in our patient. Because split-skin or full-thickness skin grafts contain little subcutaneous tissue and directly transmit forces applied to the sole to the plantar bones, the patient would feel pain and discomfort of the sole during their gait, and an ulcer or decubitis would easily form in the area to which the grafts were applied. Although the Z-plasty method is handy and useful for obliterating a skin defect, there is a limit to the expansion of the skin and it is impossible to close large skin defects such as that created after correcting the severe flexion deformity of the toes of our patient.

The best candidate for covering a skin defect in the sole of the foot should be the same type of skin as the original skin in the sole of the foot. The medialis pedis flap has skin that is close in nature to that of the sole of the foot and is strong enough to bear the loads to which the foot is subjected. It also contains sufficient subcutaneous fatty tissue, which can act as a cushion and reduce the stress forces transmitted to the plantar bones.[7] Moreover, the donor site of the medialis pedis flap is not in a weight-bearing area and therefore can be closed using a split-skin or full-thickness skin graft. The instep island flap, which is based on the lateral branch of the medial plantar artery, can also provide skin for the sole of the foot because it contains subcutaneous adipose tissue and is strong enough to bear the weight loads.[12] The instep flap should be taken from the non-weight-bearing portion of the foot; however, it is still the sole of the foot and can be a weight-bearing portion when shoes are worn. In addition, the plantar digital nerves are sometimes sacrificed during harvesting the instep flap.

With Dupytren's contracture of the hands, the contracture can be corrected only by removing the thickened aponeurosis. The tendons, joint ligaments, or volar plates of the fingers seldom cause the contracture. It is rare that the cartilaginous or osseous structures of the joints are deformed in the hands by long-term flexion contracture that results in joint incongruity after reduction of a deformity. In this patient, the big toes required immobilization in the neutral position by K-wires for 4 weeks after surgery because of the extreme instability of the big toes, which had been caused by the severe incongruity of the MP and IP joints. The big toes were stabilized by the scar tissue formed around the MP and IP joints during the 4-week fixation of the joints with K-wires. The patient used shoes with a rocker bar that allowed him to walk smoothly because both of his big toes were stiff. Improvement in his gait was confirmed by the disappearance of the callosity in the heel that had been evident before surgery.

Conclusions

Severe bilateral flexion contracture of the big toes caused by plantar fibromatosis was treated successfully using a medialis pedis flap taken from the ipsilateral foot after removing of the thickened plantar aponeurosis, joint capsule, and ligaments and transection of the tendons of the big toes. The medialis pedis flap is suitable for covering the skin defect created in the sole of a foot after correcting flexion contracture of the toes because the nature of the skin of the flap is close to that of the sole of the foot and the donor site is in the non-weight-bearing portion of a foot.

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