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Case Report

내측족저 피판 및 무지내전근 근절제술을 이용한 손바닥 화상 구축의 치료

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Sensate Medial Plantar Free Flap Transfer and Adductor Pollicis Myotomy for Treatment of Palmar Burn Scar Contracture

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A postburn contracture involving the palmar skin and subcutaneous tissues results in a severe loss of functionality of the affected hand. The corrective surgical procedures aim for an improvement of the range of motion of the metacarpophalangeal (MCP) joints and target the reconstruction of a durable and sensitive palmar-specific anatomical structure. We successfully treated a 53-year-old male patient with a long-standing postburn contracture of all the right MCP joints and underlying palmar tissue. We performed contracture release and adductor pollicis myotomy and reconstructed the resultant palmar defect with a sensate medial plantar free flap to restore acute skin sensitivity and resurface the glabrous skin of the palm. The Kirschner-wire fixation utilized for stabilizing the extended MCP joints was maintained for 3 weeks after contracture release. The restored palmar skin and soft tissue improved the MCP joint movements, enabling grasping and pinching motions and thus restoring functionality of the operated hand.

Key Words: Surgical flaps, Hand, Burns, Contracture

INTRODUCTION

A burn injury of the hand can lead to devastating functional sequelae such as contracture deformities and cosmetic disfigurement. A palmar burn contracture results in joint stiffness and contracture of the metacarpophalangeal (MCP) joints, disabling hand movements. Therefore, contracture release and subsequent reconstruction procedures are performed with the primary goal of restoring the normal range of motion of the hand. However, for a successful surgical outcome, palmar burn-scar contracture release and a reconstruction procedure should be able to overcome the technical difficulty of restoring intricate palmar anatomy and functional characteristics along with preventing possible recurrence of the deformity.

The unique functional characteristics of palmar skin include its glabrous nature along with a higher number of sensory mechanoreceptors[1]. Also, reconstructed palmar

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skin must be durable (to withstand mechanical stress) and sensitive (to perceive delicate stimuli) and should meet the patient's expectations cosmetically. Here, we report our experience in managing a case with a long-standing postburn contracture that we treated surgically with a release procedure integrated with adductor pollicis myotomy, K-wire insertion, and reconstruction with a sensate medial plantar free flap transfer, thereby restoring the sensitivity and durability of the palmar skin along with the pinching and grasping functions of the hand. The written informed consent for the patient's photography was obtained.

CASE REPORT

A 53-year-old male patient presented to the clinic with a history of burn contracture on the right palm with amputations performed at the level of the proximal interphalangeal joints of all fingers. Severe scalding burn injury of bilateral hands led the amputation of the necrotic area of distal fingers when the patient was a 9-year-old. The burn contracture of the right palm had caused the MCP joints of the 3rd, 4th, and 5th fingers to be immobilized at 90° flexion, and the 1st and 2nd MCP joints were contracted and fixed at 45° flexion position (Fig. 1A). Also, the 1st metacarpal bone was completely adducted and contracted, resembling a "thumb-in-palm" deformity, usually seen in patients with cerebral palsy. The range of motion of all the right MCP joints and fingers was severely restricted. The patient was unable to perform pinching movement and grasp an object with the right hand. A preoperative hand X-ray confirmed that all the right fingers had been amputated at the level of the proximal phalangeal joint (Fig. 1B).

The damaged palmar skin was required to be replaced by a suitable alternative graft tissue that possessed good stability and had acute dermal sensitivity. For the reconstructive procedure, we chose a free medial plantar flap, which has the advantages of being a thin, sensate, and glabrous neurofasciocutaneous flap with high mechanical stability[2].

Under general anesthesia, the palmar contracture was released. The severely scarred areas were identified, and the fibrotic tissue adhesions were removed. The palmar aponeurosis, neurovascular tissues, and flexor tendons were preserved, while adductor pollicis myotomy was performed proximal to the muscle origin to relieve the thumb contraction. However, only the transverse head of the muscle was dissected in order to preserve its function to a certain extent (Fig. 2A). The flexed and contracted MCP joints were fixed with Kirschner wires (K-wires) in a position of full extension. The radial artery, the radial vein, and a branch of the superficial radial nerve were dissected for microvascular anastomoses. The size of the defect in the right palm was found to be 8.5×8 cm.

A medial plantar flap was elevated from the right side. We used a pencil Doppler to locate the medial plantar artery, which branches from the posterior tibial artery. We designed and performed an incision that would expose the medial plantar vessels and allow us to elevate the flap to a level that would be sufficient to cover the palmar defect. The flap was elevated from the non-weight bearing surface of the foot, from over the medial edge of the plantar aponeurosis at the point where the perforators

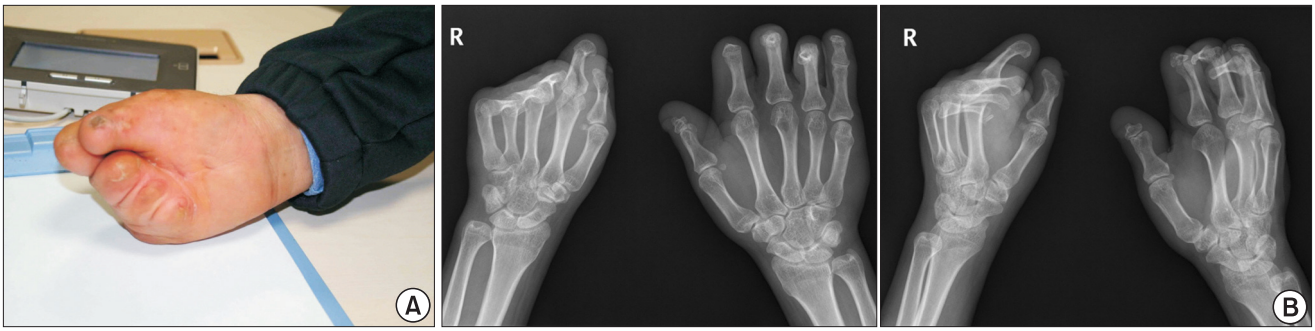

Fig. 1. Preoperative (A) clinical photograph and (B) radiograph of the postburn palmar contracture.

emerge from the medial plantar artery[3]. After exposing the abductor hallucis muscle and performing a transmuscular dissection, a flap containing neurovascular and fasciocutaneous components including the secured medial plantar artery, venae comitantes, and the medial plantar nerve was elevated, while the lateral plantar artery and nerve were left undisturbed (Fig. 2B, Fig. 3B). The flap size was measured to be 9×8.5 cm.

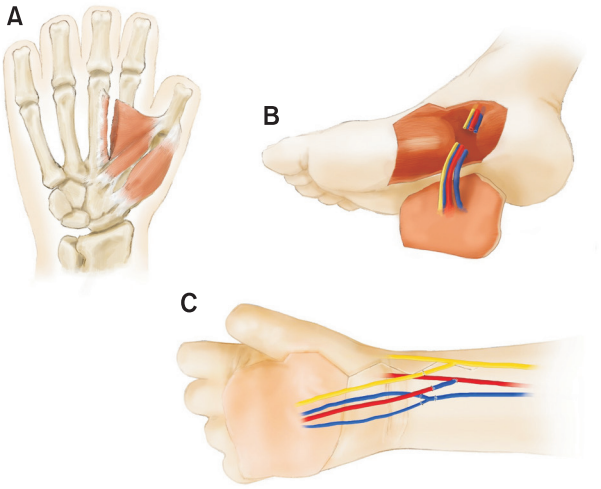

Fig. 2. Illustrations of the operative procedures. (A) Adductor pollicis myotomy of the transverse head for release of the 1st webspace contracture. (B) Elevation of sensate medial plantar free flap with the medial plantar pedicle and nerve. (C) Micro-anastomosis of the medial plantar vascular pedicle with the right radial artery and cephalic vein (using an interpositional vein graft) and of the medial plantar nerve with a split portion of the superficial branch of the radial nerve.

Under a microscope, the medial plantar artery was anastomosed with the radial artery using an interpositional vein graft in an end-to-side fashion. The venae comitantes of the medial plantar artery were successfully anastomosed with the cephalic vein in an end-to-end fashion using a Y-shaped interpositional vein graft, as a venous spasm had been observed while attempting to anastomose the former with the venae comitantes of the radial artery. The dissected medial plantar nerve was anastomosed with a split portion of the superficial branch of the radial nerve (Fig. 2C, Fig. 3C). Following a confirmation of the patency of its pedicle on Doppler, the flap was set in position after trimming the margin (Fig. 3D). The defect at the flap donor site was covered with split-thickness skin graft from the right thigh. An aseptic light dressing along with a static splint was applied on the right hand and forearm, and a usual tied-over dressing was performed for the right foot.

During the hospitalization, the flap was kept soft and

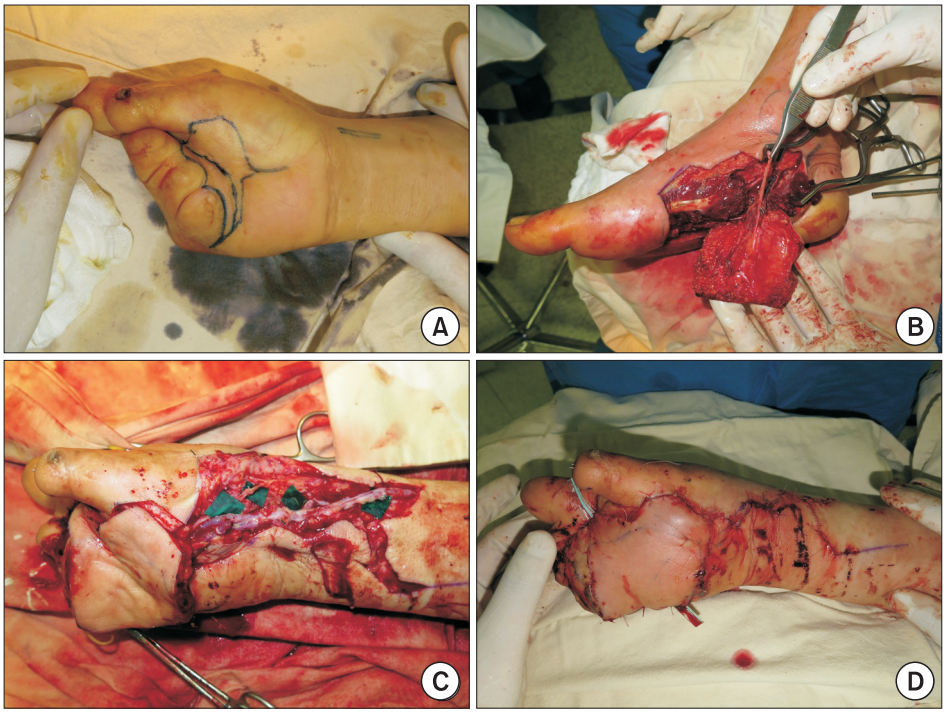

Fig. 3. Intraoperative clinical photos are shown. (A) The preoperative palmar burn contracture of the right hand with the indicated incision line, designed for contracture release. (B) The elevated sensate medial plantar free flap with the pedicle and the medial plantar nerve. (C) Micro-anastomosis of medial plantar pedicle and nerve. (D) Flap inset and wound closure.

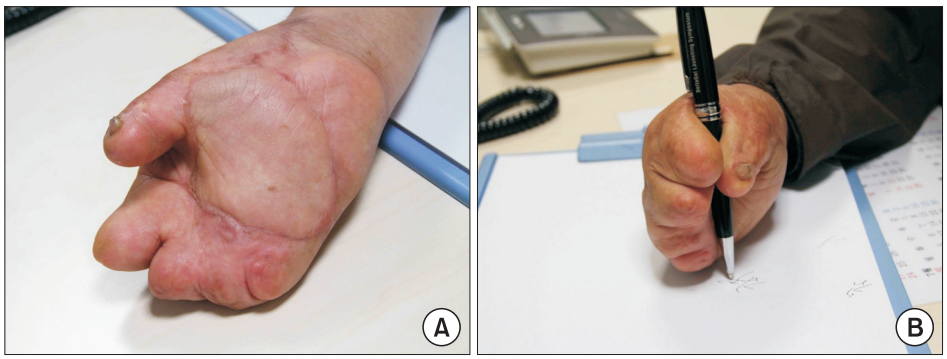

Fig. 4. Clinical photos taken at 6 months postoperatively. (A) Release of postburn palmar contracture and successful coverage with free medial plantar sensate flap. (B) Finer hand function restored as demonstrated by the patient grasping a pen and writing.

warm until discharge. The postoperative course was uneventful and the surgical wound and the donor site healed well. After completion of 3 postoperative weeks, the K-wires were removed. The patient underwent daily physiotherapy for rehabilitation of the MCP joints along with the maintenance of the operated fingers in a long-standing night-splint for three months. In the 6th postoperative month, patient could use all five right metacarpal joints with a markedly increased range of motion (Fig. 4A). No recurrence of the contracture was observed. He could grasp a pen and write his name, showing a restoration of finer hand movements (Fig. 4B). He could appreciate two distinct stimuli separated by 7-8 mm on the static two-point discrimination test performed on the reconstructed palm during the 12-month follow-up, which indicates an achievement of normal skin sensitivity.

DISCUSSION

The surgical release and reconstruction of a postburn palmar contracture is particularly challenging. The procedure aims at not only resolving the MCP joint contractures and preventing their possible recurrence, but also at restoring the functional neurovascular tissues and at preserving the adductor pollicis tendon along with the functional tendons of other digital muscles, to regain hand dexterity. The resurfaced palm should be able to achieve prompt tactile gnosis in response to external skin stimuli. Lastly, the restored integument should be characteristically thin but resistant to pressure and shearing forces, a requirement for using any tools effectively with the remodeled palm.

The palmar skin has many unique features such as a hairless integument, which protects underlying structures, and the presence of a durable fibrous septum connecting the skin and subcutaneous fat, thus enabling the performance of repetitive grasping and gripping motions[1]. These unique characteristics emphasize the necessity of reconstructing palmar skin with structurally similar tissue following the scar tissue excision[3]. Restoring the functionality of the hand depends not only on the donor-tissue enabling a smooth gliding motion of tendons during muscle movements but also on it being able to match the surface-level sensitivity of the original palmar skin. The recovery of sensation is especially essential for an earlier rehabilitation of overall hand function.

The medial plantar flap bears a structural similarity to palmar tissue and offers many advantages when utilized for its reconstruction. The medial plantar skin is also glabrous, thin, and has high mechanical stability. Moreover, the medial plantar flap depends on the medial plantar neurovascular pedicle and can therefore be utilized as a free and sensate flap during the transfer. This enables the reconstructed palm to retain acuity of sensation as compared to its preoperative state, and a speedy recovery of the tactile sense shortens the rehabilitative duration required to resume activities of daily living[4]. Previous reports on the static two-point discrimination test performed over a sensate medial plantar flap following palmar reconstruction found that the patients achieved perfect scores (7-8 mm), showing an attainment of precise dermal sensitivity, as seen in this case (at the 12-month follow-up), in which the medial plantar nerve was anastomosed to the superficial branch of radial nerve[3]. Moreover, a medial plantar flap elevation does not significantly impede the vascular and neural supply

over the foot, as the technique excludes the lateral plantar nerve and artery. These continue supply to the weight bearing portions of the foot, thereby incurring low morbidity at the donor site. The size of the medial plantar free flap is limited to 9×10 cm as it is harvested from the non-weight-bearing plantar arch. If required, it is possible to extend the size by combining it with a medialis pedis flap for covering a larger palmar soft tissue defect[5,6].

Our patient had flexion contractures of all MCP joints of the affected right palm along with an adduction of the first MCP joint across the palm due to the severely diminished 1st webspace. The resultant malformation mimicked the "thumb-in-palm" deformity seen in cerebral palsy patients[7]. Therefore, a myotomy was performed solely on the transverse head of the adductor pollicis muscle to preserve a pinching movement which would have been be weaker with a complete myotomy[8].

We inserted K-wires through the MCP joints to preserve them in the released state. Following a contracture release, there can be a gradual shortening of the aponeurosis, the flexor tendons, and the neurovascular structures leading to a recurrence of the deformity. To avoid this relapse, immobilization of the released joints during the postoperative period (using K-wires) is mandatory[9]. The stabilization of the extended joints with K-wires helps maintain the corrected position of the structures and ensures a satisfactory take of the transferred medial plantar free flap. The K-wires were removed 3 weeks after the operation, and a night splint was applied for a further 3-month duration to sustain the corrected positioning.

In this case, a 44-year-old palmar postburn contracture with a resultant deformity of the inner-hand structures that had worsened due to the natural growth since sustaining the injury, was successfully managed with a release and reconstruction surgery. The postsurgical immobilization of the operated MCP joints in full extension may have acted as an internal splint and maintained the released tissues and joints in a stretched position[10]. Surprisingly, we were able to restore the patient's skillful hand movements and the palmar acute sensory function with delicate contracture release combined with an adductor pollicis myotomy, K-wire insertion procedures, and an analogous, sensate medial plantar free flap transfer. However, further studies and applications of this unique combination of techniques is needed to establish the validity of our surgical approach. Our successful experience suggests that this approach may have further applications in the treatment of old postburn palmar contractures.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

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내측족저 피판 및 무지내전근 근절제술을 이용한 손바닥 화상 구축의 치료

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손바닥 피부 및 연부조직에 발생한 화상 후 구축은 수부운동기능의 심각한 손상을 야기한다. 수술적 교정 시에는 중수지 관절의 관절운동가동범위 개선을 시키고 조직 결손 부위를 손바닥의 특이적인 해부학적 구조와 유사한 조직으로 대체할 수 있어야 한다. 저자는 우측 수부의 중수지 관절 및 손바닥 연부조직에 발생한 화상 후 구축을 주소로 내원한 53세 남성에 대해 구축이완술, 무지내전근 근절제술, 유리 감각 내측족저 피판술을 시행하였다. 이후 환측 손바닥은 높은 내구성과 평활 피부의 특성을 갖는 피판으로 재건되었고 예민한 감각기능을 회복하였으며 중수지 관절의 관절운동가동범위를 개선시킬 수 있었다. 동시에 무지내전근 근절제술로 내전 구축되어 있던 무지의 변형을 해소하였으며 '집기'와 '잡기'가 가능하게 되어 정교한 수부 기능을 회복하였음을 보고하는 바이다.

색인단어: 피판술, 수부, 화상, 구축

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