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Plastic Replacement of Palmar Defects

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Abstract

Purpose — to present the results of palmar defect plastic replacement with a prelaminated tissues complex from the forearm. ***Materials and Methods.*** The authors have developed a two-step method of plastic substitution of the palmar defect, which had consisted in the preliminary preparation of the tissue complex on the own fascia of the forearm and then transposition it to the hand as island flap on the radial vascular bundle after the excision of the scar and eliminate flexion contractures of the fingers. According to the proposed method, 7 patients with vicious scars of the palmar surface of the hand and flexion contracture of the fingers were operated. Males prevailed, the mean age of patients was 39±12.4 years. In 5 cases, the cause of scar contracture of the hand was an open trauma with a tissue defect, in other cases, contact burn. ***Results.*** Patients were examined in 3, 6 and 12 months. The complication was noted in one case, which was a partial necrosis of the skin part of the flap, which required additional plasty with a split skin graft, which did not affect the final result. The flaps were stable and resistant to mechanical stress, no correction was required in any case. By 6 months protective sensibility in the hand recovered in all cases. ***Conclusion.*** The described method of substitution of extensive deep palmar defects can be applied after correction of scar deformation and elimination of flexion contracture of fingers. Prelamination provides reliable engraftment of a full-layer or thick split skin graft taken from any area of the human body. Strong fixation of the skin graft to the fascia provides a small displacement of the skin and and the lack of excess tissue. The flap is resistant to mechanical stress and provides restoration of protective sensitivity. The damage to the donor area is insignificant, as the scar on the forearm remains hardly noticeable. The disadvantages of the proposed method include the need to perform two surgical interventions.

Keywords: hand palmar defects, blood-supplied tissue complexes, prelamination.

Competing interests: the authors declare that they have no competing interests.

Publishing ethics: the patient provided voluntary consent for publication of case data.

Introduction

The skin of the palmar surface of the hand differs from it's dorsal surface: it is thicker, devoid of hair, immobile due to the cellular structure of subcutaneous tissue, tightly fixed to the skin and underlying tissues by fascial septums [1]. Defects of soft tissues of the palmar surface of the hand can be primary (due to injury) or secondary — after correction of scar contracture of various origins — post-traumatic, postoperative, post-burn. The tightening scars on the palm lead to the limitation of the extension of the fingers, that is, to the flexion contracture of varying degrees of severity. The most common cause of such contracture is post-burn scars. Hand injuries are observed in more than 45% of patients with burns. At the same time, deep burns of the hand make up 14% of the total number of injured persons. Joint contractures develop

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in 32.5 % of all post-burn deformities, in children this number is higher and is about 66 % [2]. Elimination of contracture after scar excision leads to formation of soft tissue defect with exposure of deep structures of the hand — tendons of flexors and neurovascular bundles. Such defects require plastic replacement with blood-supplied tissue complexes [3].

Replacement of extensive deep defects of tissues of the Palmar surface of the hand presents certain difficulties in connection with the special requirements of the palm as a recipient area, which are as follows: there should be no excessive volume of transplanted tissues, the skin should be little displaced, resistant to mechanical stress and devoid of hair, in addition, it is desirable to restore sensitivity [4]. The concept of «extensive tissue defect» implies that its size does not allow to perform plastic surgery by using the surrounding skin [5].

The possibility of replacing deep defects of the palmar surface of the hand using local tissues is limited. Therefore, in the presence of an extensive defect, tissue complexes taking from forearm — radial or ulnar flap, or free tissue complexes are most often used [4, 6, 7]. One of the significant disadvantages of the use of fascio-cutaneouse flaps as a plastic material to replace the palmar defects is excess tissue, which is often the reason for additional surgery.

Fascial and muscle flaps are devoid of this disadvantage, but their use requires covering the surface of the flap with a split skin graft, which can make it difficult to control the state of blood supply to the transplanted flap and cause complications. The above requirements of the palm as a recipient area ideally corresponds to the medial plantar flap or instep flap, but its size is limited, it can be used only as a free graft on the hand, and when it is isolated on the medial plantar artery, the length of the vascular pedicle is short [8].

Most surgeons choose the forearm as a donor area to replace extensive defects of the palm, where you can select a complex of tissues on the vascular pedicle with reversible blood on the base of radial, ulnar or posterior interosseous artery. The island fasciocutaneouse radial flap is considered to be the gold standard for replacing hand defects. Significant disadvantages of its use for plastic palmar surface of the hand are: excessive mobility and volume with a pronounced layer of adipose tissue, as well as noticeable cosmetic damage to the donor area. To avoid these negative aspects of the use of radial flap we propose a method of substitution of the palmar defects of the hand using preliminated tissue complex based on radial fascial flap (Patent RU No. 2275171).

Purpose — to present the results of plastic replacement of palmar defects using a prelaminated complex of tissues from the forearm.

Materials and Methods

Surgery technique

This is two-stage method. The first stage involves the implantation of a full-layer skin graft under the skin of the anterior surface of the forearm on its own fascia in the projection of the future radial flap (Fig. 1).

After 10 days, the second stage is performed, which consists in excision of the scar on the palm, elimination of finger contracture and replacement of the defect with a prelaminated tissue complex, which is a fascial flap with a full-layer skin graft on its surface (Fig. 2). The skin of the created tissue complex is tightly fixed to the fascial layer, does not shift, and functionally and cosmetically is largely similar to the normal skin of the palm.

Patients

According to the proposed method, 7 patients with restrictive scars of the palmar surface of the hand and flexion contracture of the fingers were operated.

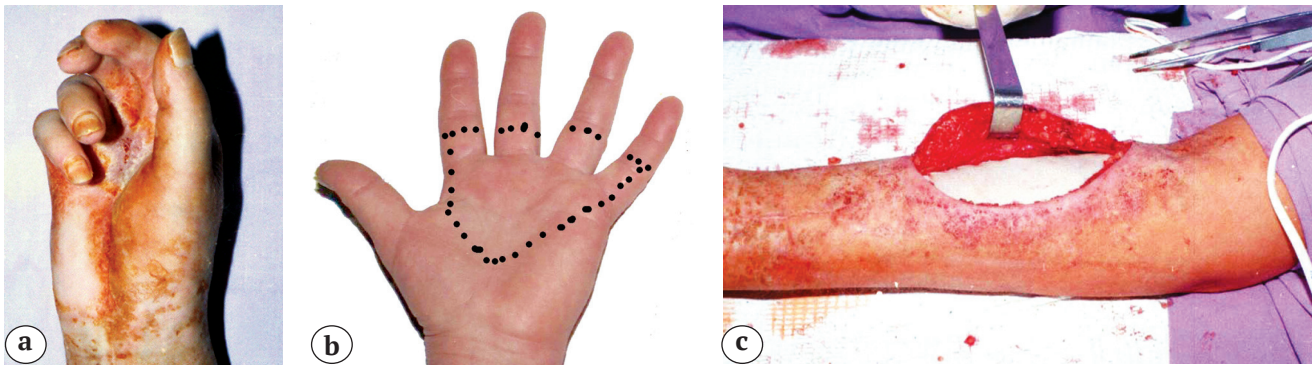
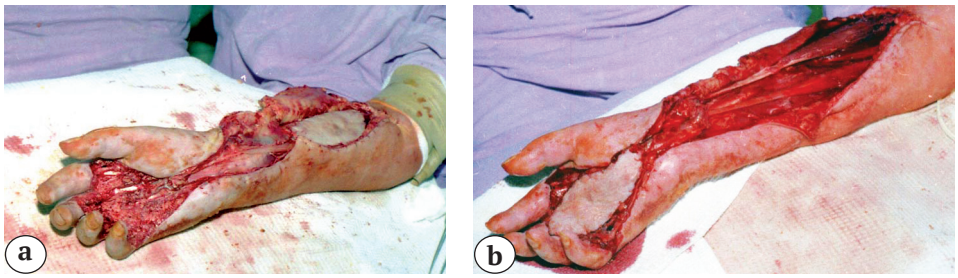


Fig. 1. The first stage of replacement of palmar defect with a prelaminated fascio-cutaneous radial flap:
a — fingers scar flexor contracture of the right hand before the operation;
b — estimation of the size of the expected defect on the palm by reference to the intact hand;
c — implantation of a full-layer skin graft on the forearm own fascia;
d — donor area of the forearm 10 days after the surgery



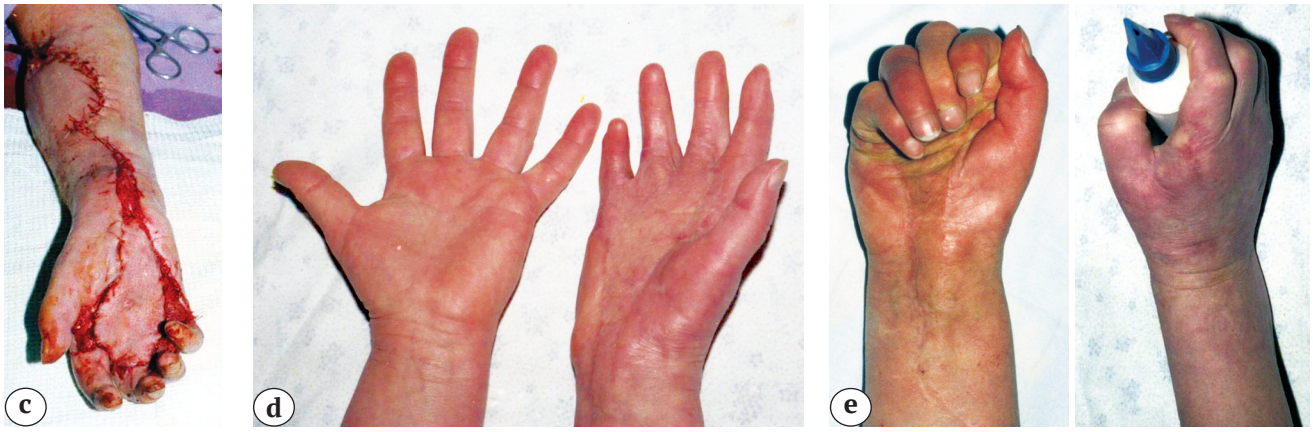


Fig. 2. The second stage of surgery:
a — eliminated contracture of the fingers, tenolysis of the flexor tendons; incision was made on the forearm along the scar for access the vascular pedicle and raising of the prelaminated fascio-cutaneous radial flap on the distal vascular pedicle;
b — flap transposition into the palm defect;
c — hand appearance at the end of the surgery;
d — palm in 6 months after surgery;
e — cylindrical grip and fist grip in 6 months after the surgery

Males prevailed, the mean age of patients was 39±12.4 years. In 5 cases, the cause of scar contracture of the hand was an open trauma with a tissue defect, in other cases, contact burn. Complications were observed in one case, which was a partial necrosis of the skin graft, what required additional skin graft, this did not affect the final result. In other cases, the engraftment was complete.

Results

All patients were examined through 3, 6 and 12 months after surgery. The condition of the restored skin and sensitivity were assessed. It should be noted that in all cases the skin of the palmar surface was resistant to mechanical stress, little displaced, tightly fixed to the underlying tissues, what allowed to perform all types of grips. To six months the protective sensibility was recovered in all cases.

Discussion

The choice of the method of plastic replacement of the extensive deep palmar defect is determined by its size and localization. Tubiana divided the palmar surface of the hand into functional areas that differ in the requirements for the restoration of the skin. The boundaries between the zones pass along the palmar folds separating the area of the ulnar edge of the palm (U), the Central zone (C), the area of the thenar (R) and the distal zone (D). For the U and R zones, thin sensitive skin is necessary, but stability and mechanical strength are not as important as for the C zone, where sensitivity restoration can be neglected [4, 9].

Taking into account these requirements, a suitable transplantat can be selected for each zone. So the restoration of sensitive skin can provide a thin radial fascio-cutaneouse flap, lateral flap of the arm and the dorsal foot flap. Mechanical strength and stability of the skin can be achieved by fascial or muscular flap covered with a split skin graft, especially taken from the unloaded plantar zone of the foot, and both these qualities are peculiar only to the medial plantar flap. A variety of fascial flaps: temporal, serratus anterior, radial are used for plastic purpose [4].

In 1985, Y.T. Jin et al presented their experience of using fascial radial flap. Fascia size 10–12 cm wide and 20–30 cm long can be raised through a curved incision on the forearm and reversed on vascular pedicle to cover the defects of the hand. A split skin graft is required to cover the fascial flap, but this method allows to close the donor defect on the forearm into a line [10].

In 1982, T.Y. Shen described the possibility of creating transplants with required properties and introduced the concept of «pre-fabrication». Preliminary preparation of tissue complexes or pre — fabrication is a method of formation of flap with axial type of blood supply and the desired composition of the tissues, suitable for subsequent transplantation into the recipient area [11].

The basis of the method of preliminary formation of flaps is the process of tissue revascularization, which can be achieved by two different ways: by implanting an axial vascular bundle with or without surrounding tissues in the selected donor area or by transplanting a complex of tissues with a random type of blood supply in the zone with an axial vascular pattern. In both cases, revascularization is carried out through anastomoses between the implanted vessels and the flap's own vessels, which are gradually formed from the implanted vascular bundle and form a complete network of blood vessels, which subsequently is the main source of blood supply to the flap [12].

J.J. Probass proposed the term «pre-lamination» to separate two very different ways of pre-preparation of tissue complexes. He expressed the opinion that the term «prefabrication» is best used in cases where the first stage is performed transplant vascular carrier to the zone of the flap formation, while the term «prelaminate» involves transplantation the unaxial tissue complex to the zone for-

mation of the flap or other effect on the flap to create the required tissue complex [13].

The word «lamination» means the binding of thin plates. In reconstructive surgery, the term «flap pre-lamination» was proposed to describe a two-stage operation. The first step is to combine the different layers into an area with axial blood supply, which takes some time to mature before transposition. At the second stage, the laminated layers are transplantated to the defect as a tissue complex based on the original axial blood supply. Like other complex of tissues, these added layers must be quite thin and small. The rational idea consists in the assumption that it provides the best chance for fusion, stabilization of the pre-laminated layers and creation of the expected structure if the structure is made on an acceptable vascular bed in a safer place with respect to possible complications [14].

N.O. Milanov et al developed a general systematization of microsurgical transplants, where they identified a group of «pre-fabricated» flaps as transplans, which include artificially created combinations of different anatomical tissues on the basis of one natural source of their revascularization [15]. The technique of preliminary preparation of tissue complexes is widely used in head and neck surgery [14], but, unfortunately, has not become popular in limb surgery, which in our opinion is unjustified, since the use of this technique can expand the possibilities of reconstructive surgery.

Conclusion

The described method of covering of extensive deep palmar defects can be applied after correction of scar deformation and elimination of flexion contracture of fingers. A prelaminated transplant has a number of advantages. The size and shape of it can be different, and is restricted to the anterior surface of the forearm. Prelamination provides reliable engraftment of a full-layer or thick split skin graft taken from any area of the human body. Strong fixation of the skin graft to the fascia provides a small displacement of the skin and the lack of excess tissue. The flap is resistant to mechanical stress and provides restoration of protective sensitivity. The damage to the donor area is insignificant, as the scar on the forearm remains hardly noticeable. The disadvantages of the proposed method include the need to perform two surgical interventions.

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