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TUBE FLAP GRAFTING

BY

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In injuries associated with extensive defects and lesions of the skin, our first task should be to take care of the life of the patient; the reconstruction of tissue defects is of second-rate importance. There is nothing to object to this rule except, perhaps, that more attention should be paid also to the second task if it does not interfere with the first. That is, if it is not dangerous for the life of the patient, we should begin earlier with measures helping the reconstruction of lost tissues. Because, if we examine more closely how the reconstruction of tissue defects is going on, even if we succeed in preventing infection, we must confess that the natural healing process is not at all a perfect one. If we do not hasten the healing of skin defects by grafting, they will fill themselves with granulation tissue and, in the best event, also epithelize during a more or less prolonged time. But such an epithelium covers a hard, stiff, poorly vascularised scar tissue, is thin and immovable on its base, and breaks easily from the least bruise. Besides, owing to the transformation of the granulations into the cicatrix tissue, and the contraction of the same if located on extremities and in the neighbourhood of joints, contractures, and even subluxations, with all their sequelae will follow. Appearances of this kind are not infrequent with patients treated even in well-furnished hospitals, where every care has been taken for their primary lesion but no attempt made to cover the defect with skin grafts.

Large defects of the skin may follow scalds and burns, trauma or infection. In burns the depth of the wound varies. If the epithelium is destroyed in all its thickness there will be, after the sloughing of the coagulum, a granulating surface of the wound. In more superficial burns the epithelium of profound tissues, such as hair follicles, sweat ducts, and sebaceous glands, may be spared to form islets from which the new epithelium will spread and cover the surface of the granulation tissue. In deeper burns the subcutaneous tissue is also destroyed. From these wounds,

if no infection follows, the coagulum will separate in the third or fourth week and the wound will be covered with healthy granulations. In case of avulsion of the skin, the deeper layers, such as muscles, fasciae, vessels, nerves and bones, may be uncovered. Such a wound is often primarily infected and a great deal of the tissue so much injured that it will slough. The granulation tissue follows rapidly on muscles, but the bone, cartilage and ligaments usually necrotize if exposed, and if infection is present their healing is slow.

Severe injuries of the extremities are sometimes also followed by large areas of gangrenized skin. The infection of these parts can be prevented by treating them in hot air boxes. In this case the gangrene will dry and resembles the eschar of burns, and will finally separate, although it takes much more time. But much more prolonged is the healing of the sloughing of the skin following infection. In this case, after the separating of the necrotized skin, the aponeurosis, tendons, cartilages and fasciae will be exposed and may slough in their turn, and the healing by granulation, especially in chronic infections, may take years.

Two chief moments may be considered in the process of the healing of an open wound: first from the fibrous cells of the denuded wound-surface the granulations spring and fill the defect and, secondly, from the edges of the wound the epithelium which covers the surface of the granulations develops.

After they have filled the defect of the wound, the granulations will again transform in the connective tissue from which they derived by losing their capillaries and succulent appearance. This process also causes the contraction of the whole area of the wound up to one-third of its size. The larger the wound, the greater will be the contraction of the scar. The amount of the newly-formed scar or connective tissue depends on the amount of the granulations. If, for some reason, the healing is delayed, as in the centre of a large wound, the covering granulations will thicken, causing in their turn the increase of scar tissue. But the formation of granulations is limited. As seen in old ulcerations the granulations lose their former red colour, and become pale, transparent and atrophic. This appearance is caused by the deeper layers becoming contracted and the vascularisation poorer. Such a tissue is also a bad base for healthy epithelization. So we see that the delay in the development of one of the chief moments

in the healing of the wound, the retarded formation of granulations, causes the delay of the epithelization, and *vice versa*, if the epithelization is delayed, the contraction of the wound will take the upper hand and avascular granulation tissue will follow, which is a bad base for the good growth of the epithelium. The vicious circle can be broken only by the artificial hastening of the process of epithelization before the contraction of the wound is accomplished and the vascularisation of the wound-surface diminished. In creating, in the early stages of the process of the healing of the wound, an even and tight network of islets of epithelium on its surface, or covering it totally with grafts of the full thickness of the skin, we hasten the process of epithelization and at the same time considerably prevent the unnecessary formation of surplus scar tissue and the annoying contraction of the wound. In other words, by treating the large wounds this way, the contraction of the wound, which is estimated by Carrel & Hartman* as the most important moment in the cicatrization, lessens, and the epithelization, which, in natural healing of the wound, takes place only at the final stage of the contraction, becomes a more active factor. Splinting, traction and other mechanical means to prevent contractures without skin grafting are quite useless, because they do not prevent the formation of the excessive granulation tissue from which the scar develops. The immediate plastic covering of the wound is of course the ideal treatment from every standpoint. In lacerated wounds of the hand Beekman & O'Connell** recommend, as an ideal procedure, the immediate application of a pedicle flap, as the subcutaneous tissue of the flap prevents the scar from adhering to the bones and tendons, and prevents the formation of the scar itself. Unfortunately, this is not always possible, because most wounds which are the result of trauma or burns are infected primarily, and we must wait till the separation of the sloughs or eschars, or the subsidence of the acute infection, before a plastic operation can be made. Only then can we be sure that the grafts will take.

* Carrel, Alexis & Hartman, Alice: Cicatrization of Wounds. The Relation between the Size of the Wound and the Rate of its Cicatrization, Journ. Exper. Med. Vol. XXIV, p. 429, 1916.

** Beekman, F. & O'Connell, R. J.: The Healing of Surface Wounds for the Prevention of Deformities. Ann. Surg. Vol. 98, 1933.

In burns treated by tannic acid the eschar will separate at the end of the fourth week, leaving a healthy, vital, even surface of granulation tissue, an ideal ground for the growth of grafts. In avulsions where the subcutaneous tissue is lost and infection present, the muscles will soon be covered with granulations ready for grafting, but the sloughing of other neighbouring tissues will spoil the taking. Here we must wait several months before all the surface is covered by healthy granulations. For hastening the separation of sloughs as well as the production of good granulation tissue and the control of the infection, Löh r's codliver-oil ointment method proved of great value to us. The grafting must be made immediately after all sloughs have been separated. The grafts will not take if there are still fistulae or deep nests of infection. But the secretion from healthy granulation does not interfere with the taking.

For covering large surfaces it is preferable to use little grafts of full thickness, not larger than 0,5 cm in diameter. Such islets put tightly all over the surface will give a strong epidermis which does not hornify easily, and, as its base is sufficiently vascularized, will form a normally smooth and pliable skin. The grafts will acclimatize before the formation of contracting scar tissue.

For the reconstruction of deeper and smaller defects the use of the tube flap method is indispensable. As so many important inventions have become the common property of everybody, without anybody's remembering the author, it is unknown who used this method first. During the world war the London surgeon Gillies elaborated the tube flap method. By this method it is possible to transplant from a distance about 40 cm away grafts sized 8×40 cm and even more to a pedicle. The principle of the method is that a strap of the skin, with the subcutaneous tissue, about 8 cm in width and up to 40 cm in length, is built with both its ends remaining in connection with the body. Both the edges of the strap must be sewed together immediately, forming a tube with the skin surface on the outside. Both the edges of the remaining wound beneath the tube are also undermined and stitched together. Owing to the fact that the tube remains for some time with both its ends in organic connection with the organism, its vascularisation is good and no contraction will develop in its inside. One end of the tube with connection flap can be lifted after some time and used for transplantation pur-

poses. We can develop the vascularisation of the tube voluntarily through one of its bases by clamping the other one temporarily. To be sure of the taking of the flap to be transplanted we must dissect it completely away from the underlying fascia after three weeks approximately and, after careful hemostasis, replace it and approximate with interrupted dermal sutures. The purpose of this procedure is to permit the formation of new bloodvessels through the other pedicle before the complete severance of the distal end. If after that there occurs a necrosis of the edge of the distal flap, we can be sure that the remaining part will be surely vascularised through the proximal pedicle and will take totally also in its new bed. This next stage can be performed about 2—3 weeks later.

The following case is instructive, not only from the standpoint of the use of this method, but also of the other rules and requirements of plastic surgery.

Patient Karl K., newspaper reporter, 24 years old, 12 years ago had had lupus of the face, which destroyed the top of his nose with *alae nasi* and the *filtrum* of the upper lip. With gold therapy and x-rays the spread of the disease was stopped. An attempt was made in another hospital one year ago to sew the defect, but the refreshed edges of the defect necrotised and, as the patient states when admitted to the I Surgical Clinic, the defect became larger than before the first operation. As seen in Fig. 1 it extended over two-thirds of the lip. The defect reached the gums in the middle of the lip, and the patient could not close the mouth totally and had to wear a bandage. Because the neighbourhood of the defect was cicatrized, no sliding flap came into consideration.

We had the intention to use one and the same graft also for the building of a new top to the nose and nostrils as well as the lip. The patient agreed and the tube flap method was chosen. Accordingly, on the 5. V. 34. an S-shaped strap from the skin of the breast was built with its proximal pedicle above the left, and distal below, the right mammary gland. Stitching the edges of the strap, we got a good mobile tube and succeeded easily in stitching the S-shape defect. The tension of the last stitches was eased by making a lot of 2 mm long punctures with the point of the scalpel on both sides of and parallel to the suture. The last method proved useful to us in several cases of sliding flap ap-

plications. The length of the tube bridge was 25 cm, the width or circumference 8 cm. The healing of both sutures was *per primam*, except two little triangles on both ends of the S-shape suture, where no parallel punctures had been made and where the silk

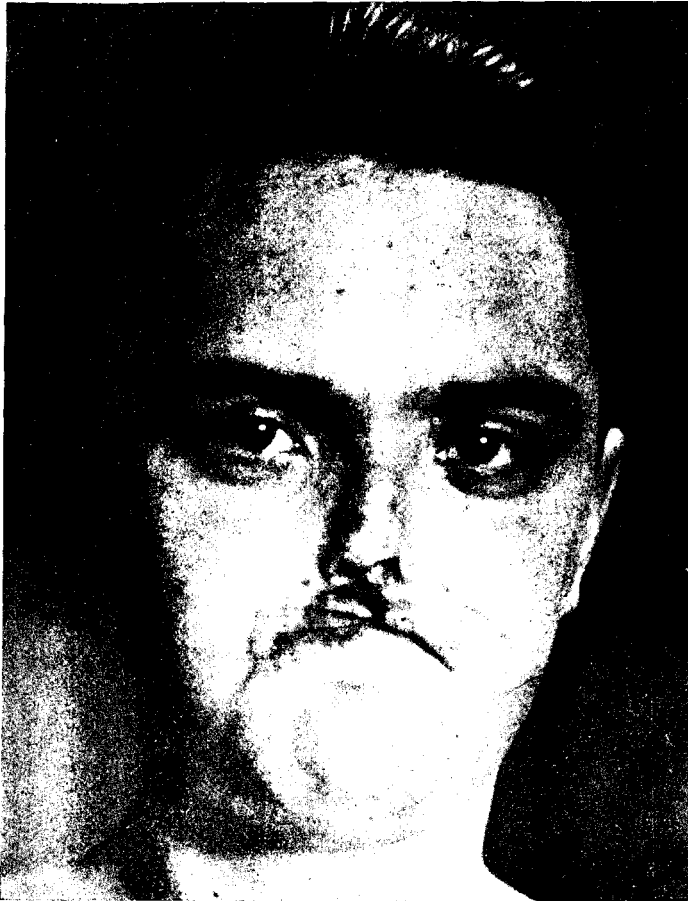


Fig. 1.

stitches had cut through the skin. All the stitches were removed on the 15-th May. The patient temporarily left the clinic and was told to come back when the both granulating triangles had been epithelialized. He was also recommended to pull at the bridge and twist it at home. He came again on the 25. VI. Although the patient had been warned to pull on the tube the same proved

shortened and measured now only 20 cm and the circumference scarcely 7 cm. By clamping the distal pedicle the viation proved sufficient through the proximal one. As a doubt arose that the

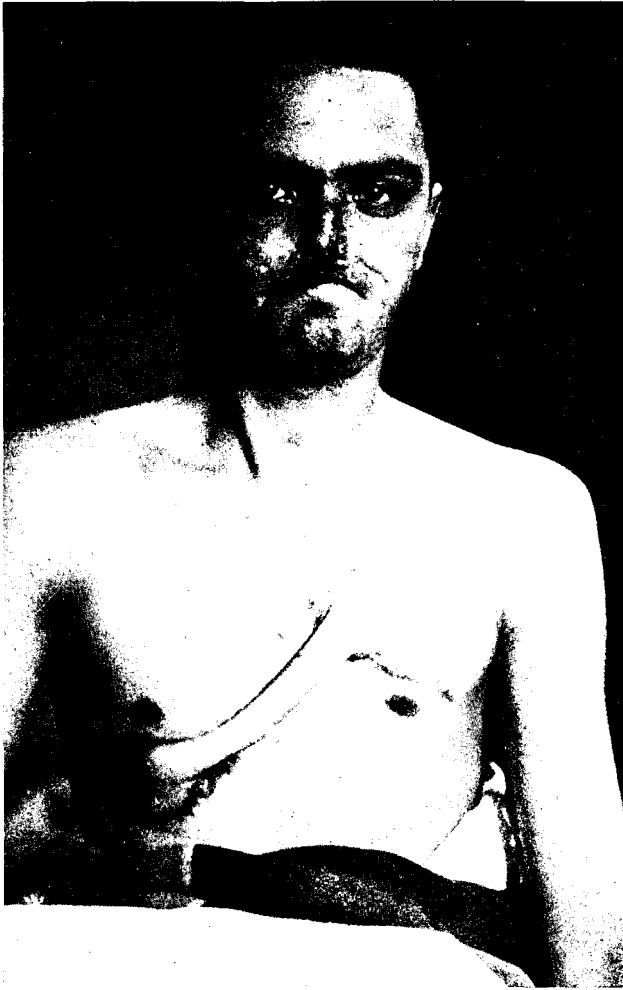


Fig. 2.

shortened tube would reach the nose freely, a round flap about 8 cm in diam. with the distal pedicle was completely dissected away from the underlying fascia, its proximal part turned into a tube — to lengthen the same — and, after careful hemostasis, replaced, and the skin edges approximated with interrupted

dermal sutures. In the lateral upper part of the flap little necrosis followed. After removing the stitches on the 8-th day the patient was sent home and told to twist and pull the proximal pedicle.

On 6. X. 34. the defect of the necrotized part of the flap was cured so far that one could now transplant the original raised



Fig. 3.

flap to its final bed in place of the upper lip (Fig. 2). The patient's back and the back of his head were covered with plaster-of-paris, so as to hold his head firm and keep it bowed down in order to prevent any tension on the tube graft. As the patient had no lip at all in the midline, it was necessary at first to build a base for the transported flap here. For that purpose two wing-shaped flaps about 2 cm in width and 3 cm in length were cut from both sides of the defect with their tops directed to the cheeks. The wings were turned with their raw surface

outside and sutured in the midline with interrupted stitches knotted towards the gum. The upper edges were sutured to the refreshed gum just below the septum (Fig. 3). Now the flap of the distal pedicle was punctured with the point of a scalpel and a couple of leeches applied to the bleeding points, the flap ex-



Fig. 4.

cised and transported carefully with the leeches hanging to the newly formed raw bed and sutured here with separate skin sutures (Fig. 4).

No bandage was applied to the transported flap in order to avoid any pressure which might disturb the circulation. The sutures were powdered with calomel. The plaster-of-paris bed proved very inconvenient for the patient in a half-sitting position and it was replaced by pillows. After two weeks the stitches were removed and the wound healed *per primam*. Only in the

middle of the upper edge just beyond the *septum nasi* was there a little suppuration, resulting in a fistula (Fig. 5).

On the 27. X. 34. the IV stage could be performed. It was meant only as a temporary lifting of the proximal pedicle of the graft from its place in order to gain material for building the new top of the nose. But the patient now refused categorically owing to economical considerations. So we had to become re-



Fig. 5.

conciled with sadness to the forming of the lip only. The tube was clamped at the left corner of the mouth and, as no change in the colour of the transplant of the lip followed, it was cut through. It needed no anaesthetics, only a faint pain was felt in the tube. The resulting wound was sutured with fine interrupted silk stitches. Although the lip was originally very thick, no attempt was made to make it thinner expecting that the subcutaneous tissue would atrophy in time.

On 3. XI. 34. the edges of the fistula below the septum were refreshed and sutured. The healing followed by granulation. As seen in Fig. 6, the lip is still thick with shining and extended skin.

On the 15. II. 35. the patient presented himself again with complaints that the mouth had become smaller and he could not eat except with a tea-spoon and that the dentist had refused to cure his carious teeth until his mouth had been sufficiently widened. The lip proved thinner and shorter. The external sutures



Fig. 6.

were well cicatrized, the temperature of the skin did not differ from that of the cheeks. Only in the midline the lip was about 1,5 cm thick and a lump of hard tissue protruded into the defect of both incisors. The sensibility to pain in the flap was normal and for the correcture operation local anaesthetics were necessary. An incision was made along the lower border of the lip and the disturbing scar tissue excised. As the inside of the lip was shortened so the opening of the mouth was lengthened towards the left side and a vertical incision was made in the mucosa here and sutured horizontally. A ribbon from the skin of the lip was cut away and the midline between the two front-

ally dissected parts of the lip burnt with Paquelin in order to get an excavation imitating the filtrum of the lip. The edges of the wound were sutured with interrupted silk stitches. At



Fig. 7.

the same time according to the wish of the patient, the stump of the soft proximal tube pedicle was removed.

In autumn 1936 the patient presented himself at the clinic again. He is now very pleased with the result. The lip is now flat and not at all protruding, sufficiently elastic, and not only allows the opening of the mouth freely but also change of expression. Only under the influence of the summer sun the pig

mentation of the lip is more intensive than in other parts of the face (Fig. 7).

This case proves that even in such bad conditions as a base cicatrized by lupus and x-ray treatment good results may be obtained by tube-flap grafting.

Summary.

The natural healing process of great skin defects is not at all a perfect one. Because of the contraction of the deeper parts of the granulations, the epithelization is always delayed and contractions of the scar with bad skin covering result. To avoid this, early covering of the granulations by grafting is emphasized.

Löhr's cod-liver oil procedure hastens the sloughing and makes good healthy granulations for full-thickness skin-grafting. Tube-flap grafting for covering large skin and subcutaneous tissue defects is emphasized. In a case with a large defect of the upper lip after x-ray treatment of lupus, tube-flap-grafting was made.

To ensure the taking of the pedicle the author recommends making with the point of the scalpel a trellis-work of punctures to the depth of $\frac{1}{4}$ cm along the edges of the flap and the application of leeches to maintain the bleeding.
