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The principle of reversal of flow in blood vessels

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Summary—In this paper the enormous possibilities of using the principle of blood flow reversal in new surgical techniques are contrasted with the very limited number of scientific papers referring to this principle. Four illustrative cases are described.

The principle of reversing the direction of blood flow through arteries and veins has been used in many types of surgery for centuries. I described it in detail in 1971 (Orticochea, 1971), but references to it are rare in the plastic surgery literature.

Why do plastic surgeons ignore this principle of circulatory haemodynamics? There may be several reasons:

(i) The surgeon may use it without understanding the technique and he may construct flaps based on this principle without even realising it.
(ii) Though aware of the principle, the surgeon may not fully realise its benefits.

My interest in dealing with this subject now is to draw the attention of plastic surgeons to this principle and to open up a new chapter in plastic surgery, superior in importance to that developed from the introduction of musculocutaneous flaps (Orticochea, 1972).

History of the author's research

When I began to work on the reconstruction of the nose by using retroarticular skin, conchal cartilage and the skin of the anterior surface of the concha (Orticochea 1971, 1980) I ran into a serious problem; there are two distinct vascular zones in the temporoconchal flap, the upper zone made up from superficial temporal vessels and the inferior, irrigated by the posterior auricular vessels, and there is an intermediate zone separating both vascular areas.

In 1971 I described how I overcame the circulatory barrier by transplanting the superficial temporal vessels to the retroarticular region so that at a second stage the whole flap could be moved safely to the nose (Fig. 1).

In the third stage, when I divided the pedicle of the flap, I realised, on cutting the superficial temporal vessels, that the artery bled abundantly in re-

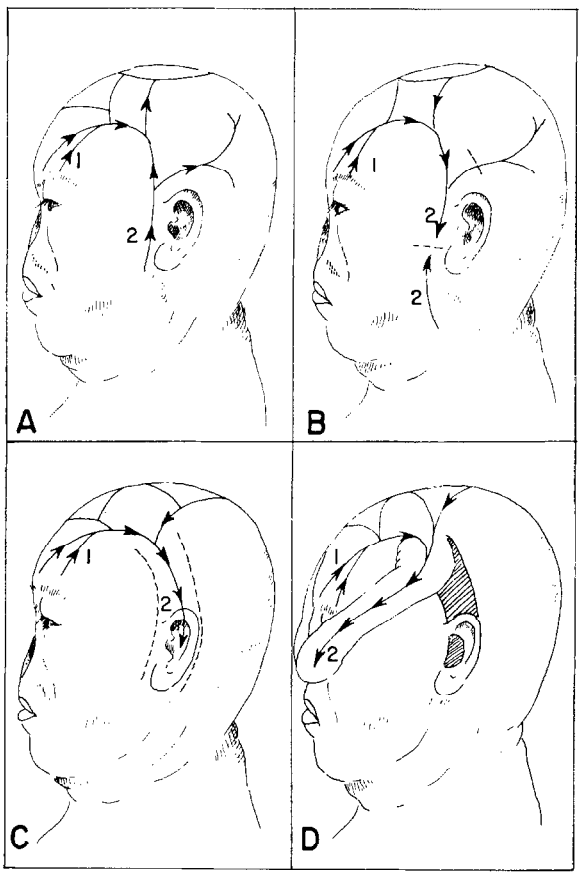

Fig. 1

Figure 1—Conchal flap for reconstructing the nose. (A) Circulation through the supraorbital artery (1) and the superficial temporal artery (2) showing anastomoses between both arterial territories. (B) Division of the superficial temporal artery (2) and (2), in the preauricular region, showing reversal of the arterial flow. (C) The divided superficial temporal artery (2) transplanted from the preauricular to the postauricular region. (D) The fronto-conchal flaps transplanted from the ear to the nose. The circulation in the superficial temporal artery descends from the forehead to the nose. The blood flow of the arteries goes from the supraorbital vessels through the anastomoses with the superficial temporal artery, following a reversed path to its normal direction.

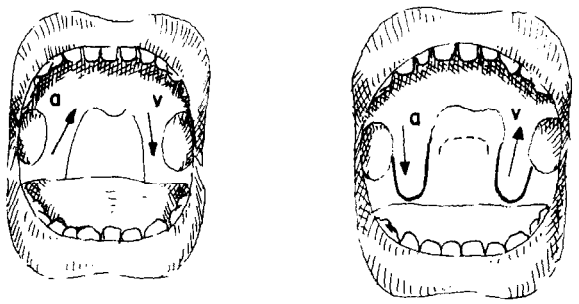

Fig. 3

Figure 3—Dynamic sphincter pharnygoplasty
Left. The direction of arterial and venous circulation in the posterior faucial pillars. The arterial flow goes from below upwards through small arteries (a). The venous flow (v) goes from above downwards in the direction of the pharyngeal venous plexus.
Right. The flaps of the posterior pillars have been raised *and the arterial and venous circulation have changed direction.*

Fig. 2

Figure 2—Division of the pedicle of the temporo-conchal flap. The arterial blood is seen coming out with a strong stream, showing excellent reverse flow in the superficial temporal artery.

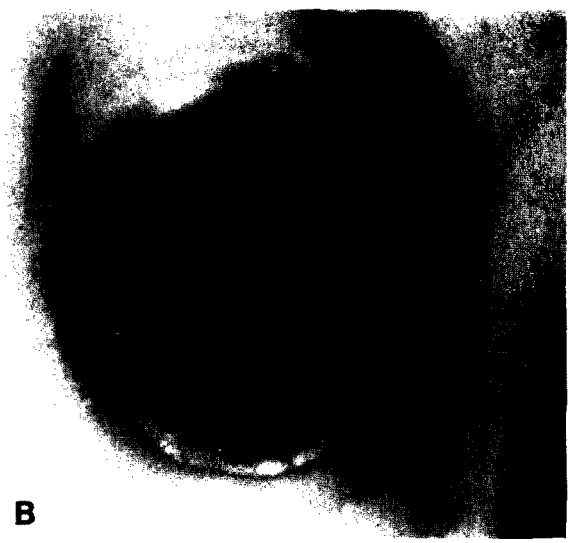

Fig. 4

Figure 4—(A) The dynamic muscle sphincter of the pharynx at rest. (B) The sphincter closed during phonation.

verse and even created a long spurt (Fig. 2). *At this moment I understood the principle of reversal of the flow of blood in arteries and veins and that it could be applied to all parts of the body.*

The principle

When many arteries (and their accompanying veins) are divided the blood flow changes direction in the vessels distal to the site of section. The tissues irrigated by the divided distal vessels may be transplanted from one part of the body to another, thanks to the circulation they receive through these vessels.

Application of the principle

For many years, when sectioning the bowel to perform an intestinal anastomosis or colostomy, the surgeon has used the principle of reversing the direction of the blood flow in mesenteric arteries and veins. The same principle may be applied to many areas of the body; where there are anastomoses between two arteries and their related veins the surgeon may take advantage of this anatomical fact when transplanting tissues from one site to another. The appreciation of this creates the possibility of developing a tremendous field of activity, with very wide applications.

An example of its application in recent years is the use of the radial forearm flap as an island flap to reconstruct the thumb (Biemer and Stock, 1983) or to cover skin defects and reconstruct tendons in the hand (Reid and Moss, 1983; Soutar and Tanner, 1984). To do this the radial vessels are divided in the proximal part of the forearm and the flap is based distally.

The flaps of the dynamic sphincter pharyngoplasty (Orticochea 1968, 1970a) rely on the reversal of flow for their survival (Figs 3 and 4).

The naso-labio-genial flap for reconstructing the opposite side of the face (Orticochea, 1970b) also relies on this principle. A further case is illustrated in Figs 5 to 7 (Case 1). Other examples from my own practice are illustrated in the following case reports.

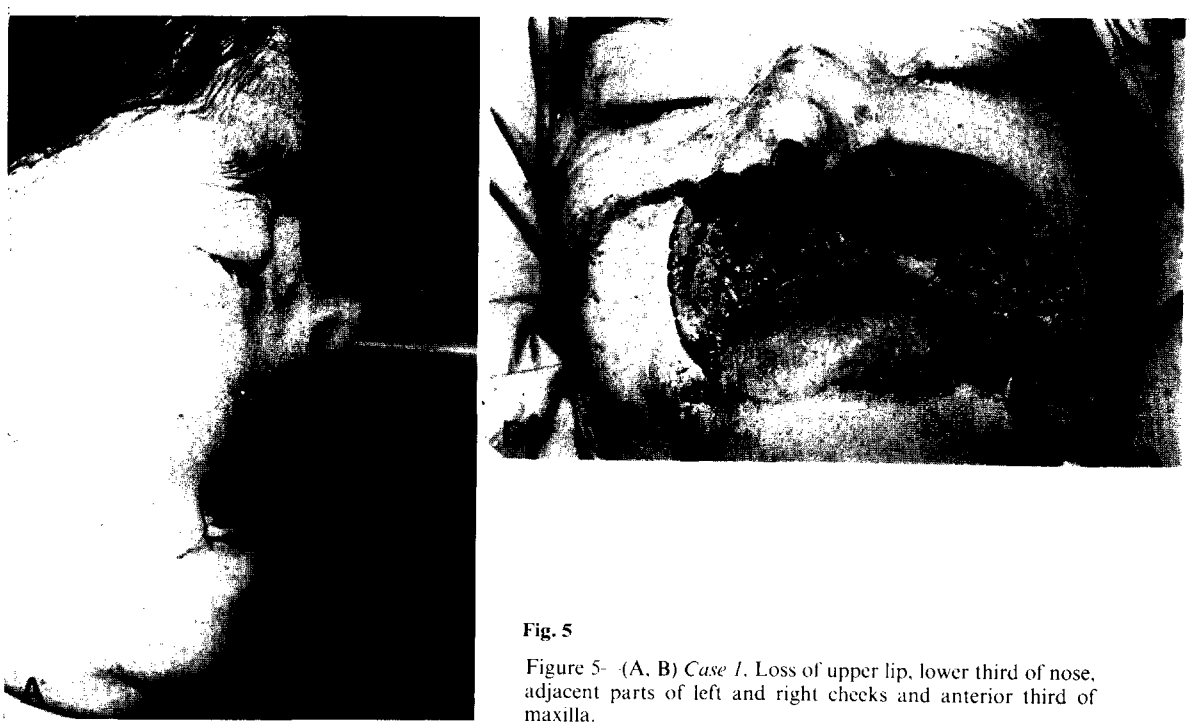

Fig. 5

Figure 5- (A, B) *Case 1.* Loss of upper lip, lower third of nose, adjacent parts of left and right cheeks and anterior third of maxilla.

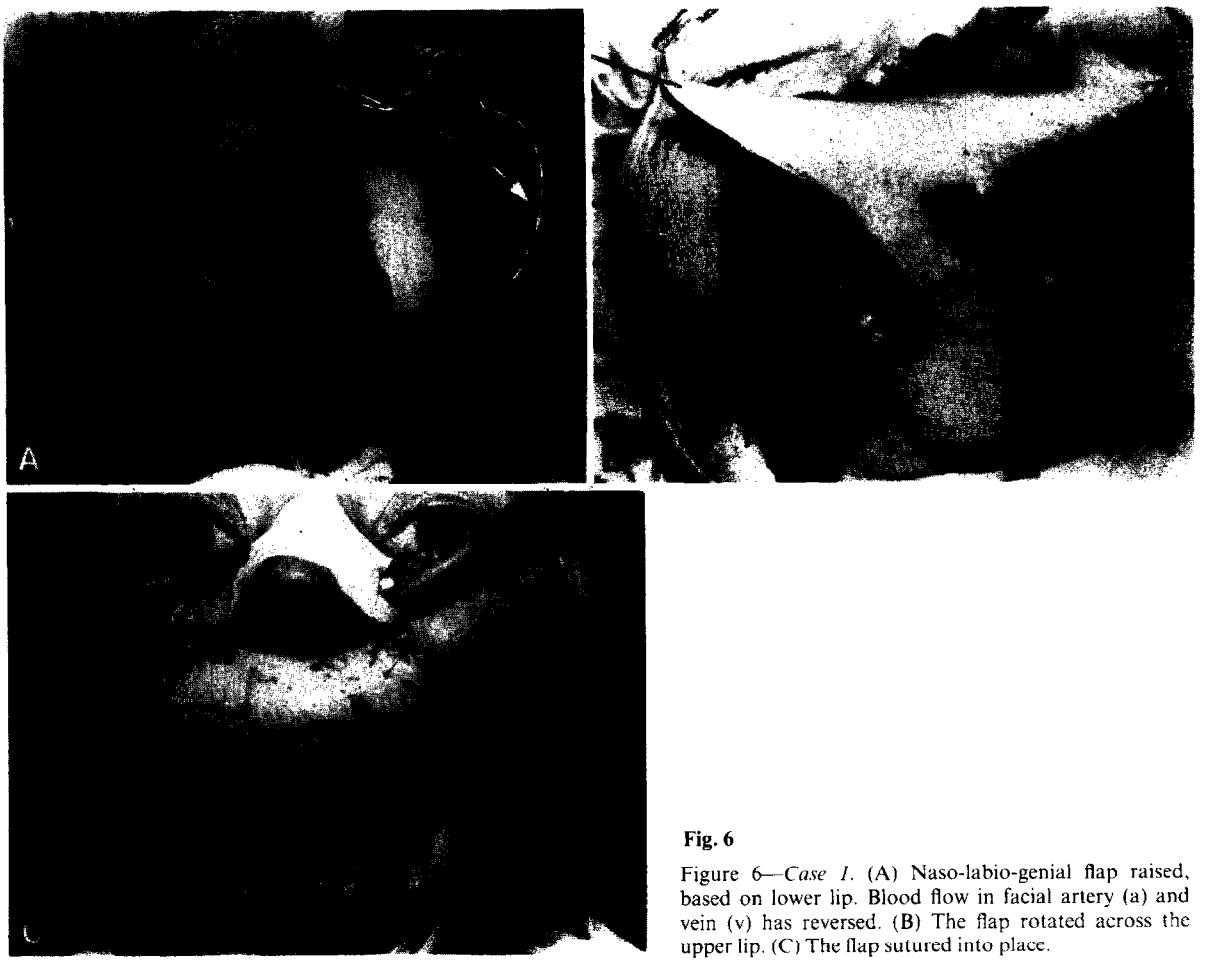

Fig. 6

Figure 6—*Case 1.* (A) Naso-labio-genial flap raised, based on lower lip. Blood flow in facial artery (a) and vein (v) has reversed. (B) The flap rotated across the upper lip. (C) The flap sutured into place.

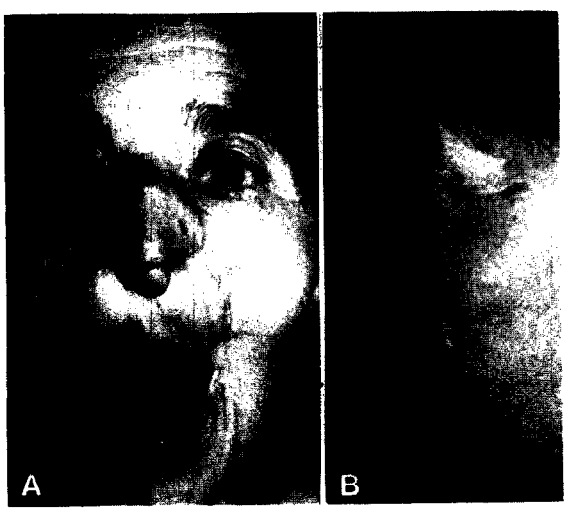

Fig. 7

Figure 7—(A, B) *Case 1.* The final result. The columella has been reconstructed with the flap pedicle. The patient can open his mouth without any limitations.

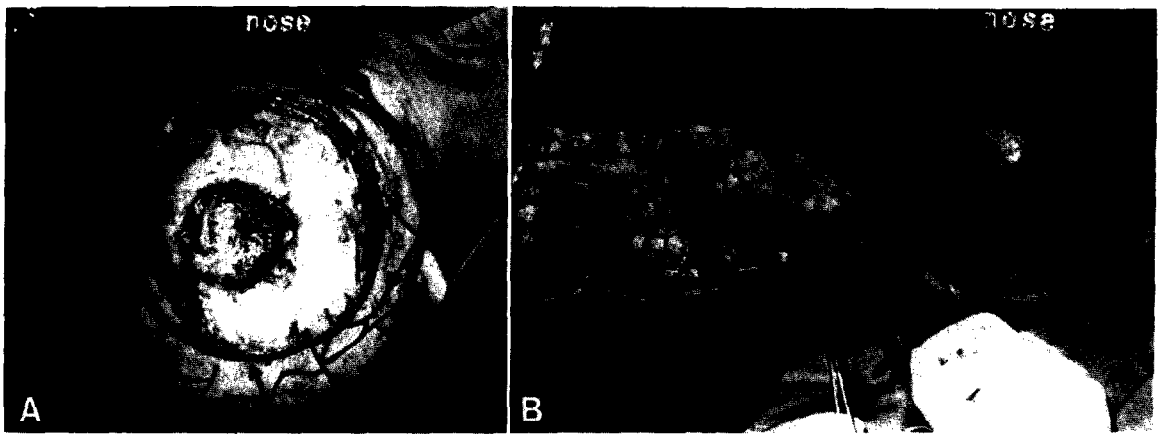

Fig. 8

Figure 8—*Case 2.* (A) Scalp defect after removal of a basal cell carcinoma. The normal direction of the blood through the superficial temporal artery (2), the posterior auricular artery (3) and the occipital artery (4) is shown by the arrows. (B) After raising a scalp flap the direction of circulation is reversed through the occipital arteries (4), the posterior auricular arteries (3) and the posterior branch of the superficial temporal artery of the opposite side (2) through their anastomoses (arrow).

Fig. 9

Figure 9—*Case 3.* Loss of the lower two-thirds of an ear. The postauricular artery (a), the postauricular veins (v).

Case reports

Case 2

A man of 42 years of age had a basal cell carcinoma of the scalp excised. It involved bone and the defect was closed with a large posterior scalp flap based on the left superficial temporal artery (Fig. 8). Blood reached the tip of the flap through anastomoses with the posterior auricular and occipital arteries and flowed in a reverse direction in these vessels within the flap.

Case 3

A girl of 18 lost the lower two-thirds of her left ear due to radiotherapeutic treatment of a cavernous angioma (Fig. 9). It was reconstructed with a flap of retroauricular skin based on the margin of the defect, which received its blood supply from the superficial temporal artery (Figs 10–12), flowing in the opposite direction to the normal.

Case 4

A man of 22 years of age suffered a traumatic amputation through the distal interphalangeal joints of the index and middle fingers of the left hand (Fig. 13). The fingers were lengthened using bone grafts covered by distally based flaps of dorsal skin (Figs 14 and 15). The circulation of blood in these flaps was reversed compared to the original direction.

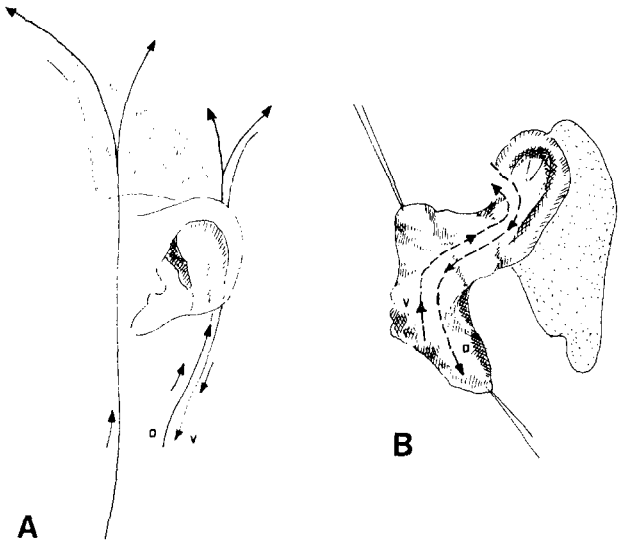

Fig. 10

Fig. 11

Figure 10—*Case 3.* (A) The direction of the circulation in the skin of the retroauricular region. The blood flows through the post-auricular artery (a) upwards and through its venae comitantes (v) downwards. The direction of flow in the superficial temporal artery is also shown. (B) A flap based on the margin of the defect, consisting of the remaining skin on the posterior surface of the concha and adjoining retroarticular skin. *The arterial and venous circulation changed direction as the flap was raised.* Figure 11—*Case 3.* The flap raised.

Fig. 12

Figure 12—*Case 3.* Final result.

Fig. 13

Figure 13 *Case 4.* Traumatic amputation of the index and middle fingers of the left hand at the level of the distal interphalangeal joints.

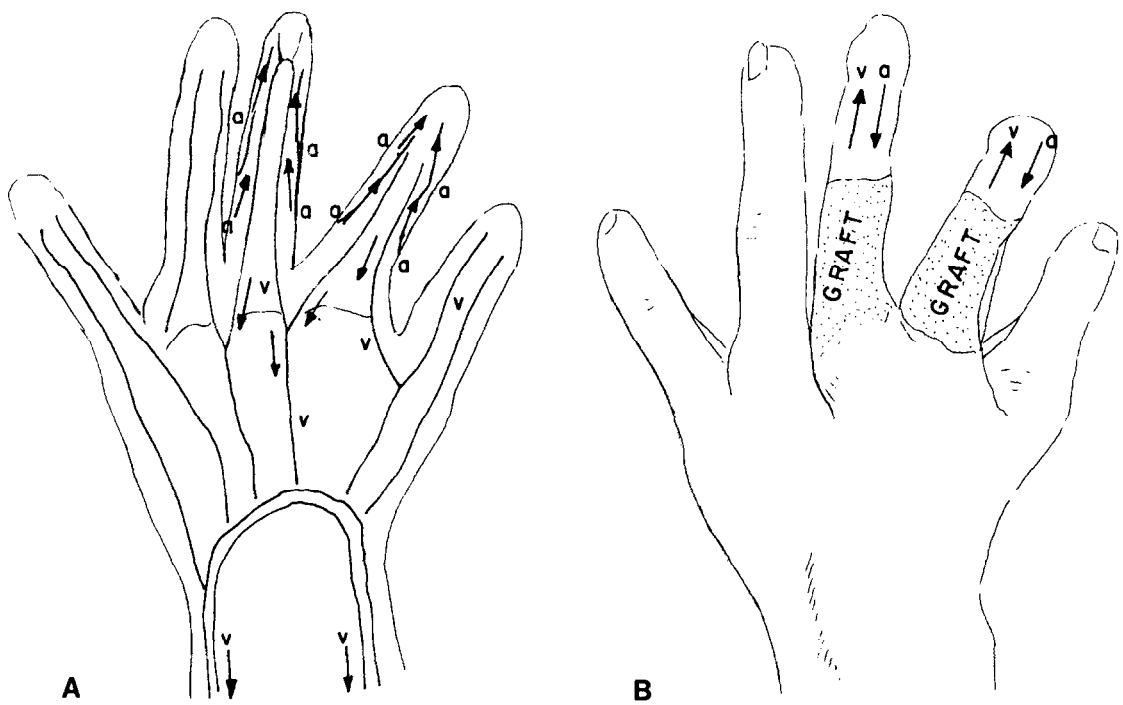

Fig. 14

Figure 14—*Case 4.* (A) The direction of arterial and venous circulation of the skin of the dorsum of the fingers. The arterial circulation (a) is from the dorsal branches of the digital arteries. The veins drain proximally through the dorsal cutaneous veins (v) of the finger. (B) Once the distally based flap of the dorsal skin of the fingers has been raised, the circulation changes direction.

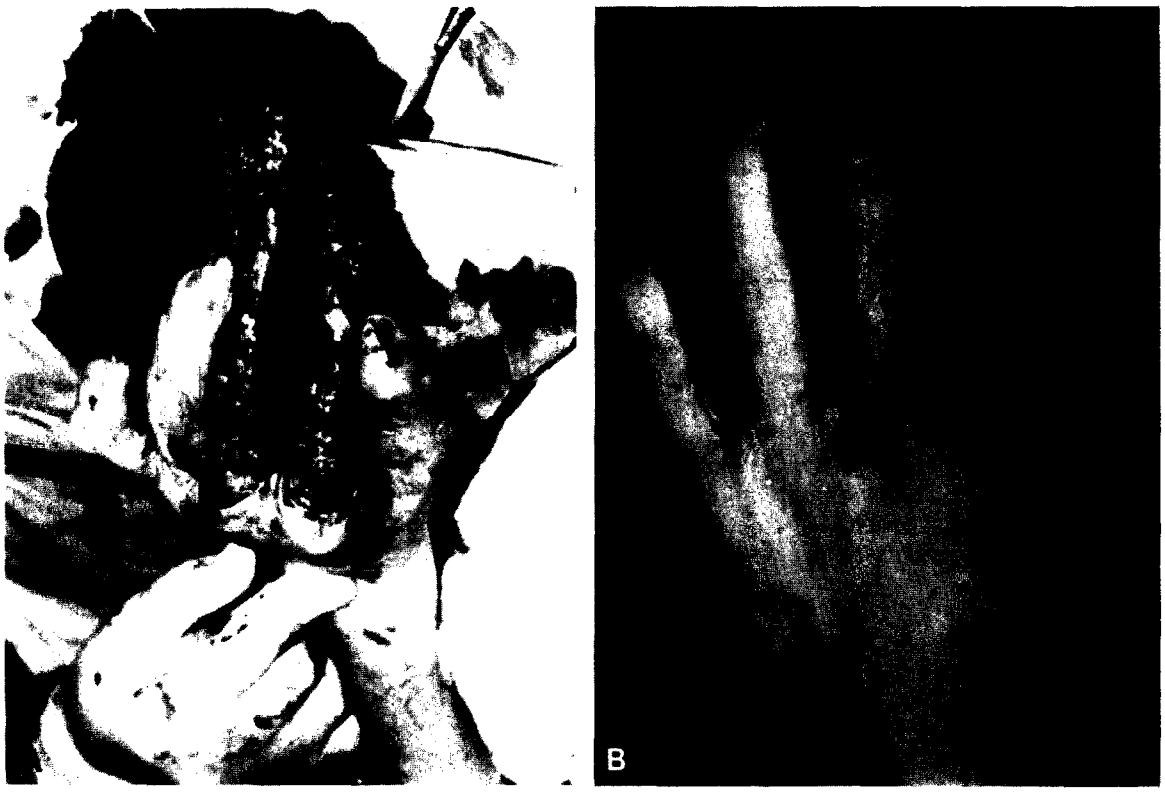

Fig. 15

Figure 15—*Case 4*. Left. The dorsal cutaneous flaps have been lifted and bone grafts (A) have been placed in the distal end of the middle phalanges. Direction of the arterial circulation (a), direction of the venous circulation (v). Right. Final result.

I hope that this paper may help to give the plastic surgeon a better understanding of the circulation of flaps, as used for centuries, and may encourage him to design many new flaps by the rational application of the principle of reversing the direction of blood flow in arteries and veins.

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