SKIN FLAP METHODS IN THE UPPER EXTREMITY

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The great number and variety of congenital and acquired contractures and deformities of the upper extremity involving the skin offers a fertile field for the application of the various methods of skin plasties, the most suitable perhaps being those of the skin flap variety. In general, the technique of whole skin pedicled flap transposition, both local and remote, is a matter well established and universally recognized. In regard to details, however, especially as they concern the application of the method to the upper extremity, I think it well to mention a series of points, made by various observers and investigators upon anatomic as well as physiologic grounds, which are of considerable importance in the interest of operative results.

1. **The Flap.** Before selecting the site and position of the flap, its tension and circulatory condition must be considered. The natural lines of cleavage of the skin determine to a great extent the amount of retraction and shrinkage of the flap as it is raised from its bed. As much as feasible the long sides of it should be chosen parallel to the lines of tension, but as the diagram of cleavage line shows, this is not always practicable.

Of much greater importance for the outlining of the flap are its circulatory conditions. Pieri and Manchot have studied the skin circulation in the pertinent regions of the body and extremities with the object of determining the most suitable location of the flap from the viewpoint of its nutrition. The diagrams show that over the abdomen the free ends of the flap more or less converge toward the umbilicus, while in the upper extremity, in the upper arm and forearm, a more transverse position gives the best circulatory conditions. (Fig. 1.)

A broad pedicle is desirable in the interests of the vitality of the flap, and its length should not exceed two or three times the width. No more than one-fourth to one-third of the diameter need to be allowed for shrinkage in a medium sized flap, although in young, rapidly growing, and well nourished children the skin is under somewhat greater tension, and the flap will shrink more when severed from its surroundings.

Regarding the different types of pedunculated flaps, there were used the sliding flaps of the French method as well as the Indian method of pedunculated flaps with twisted pedicles, and the Tagliacotian or Italian...
method of abdominal flaps, the latter being used frequently, the former
methods only occasionally.

2. **The Bed.** A thorough resection of all scar tissue is necessary
before the bed is prepared to receive the transplanted flap. If transplan-
tation is made upon a fresh wound (and this was the case in the large ma-
jority), the most painstaking hemostasis is essential so as to avoid the
accumulation of blood or serum underneath the flap. The slightest bleed-
ing point should be secured by fine forceps, which may be removed after a
few minutes. In earlier operations, the error was made of being too con-
servative with the excision of scar tissue; this is apt to result in difficulties
for the flap when attached to the edges of the defect, and recurrence of
contractures occurs. The suture line should be laid in healthy skin.

![Figure 1](image)

**Fig. 1.**
Location of Abdominal Flaps. (Pieri)

3. **The Adaptation.** The flap, which should carry a substantial
amount of subcutaneous fat, must be placed without tension, and suturing
must be done with the greatest care. The writer uses horse hair prefer-
ably, not only because of the very accurate adaptation possible with it,
but also because its use precludes any undue tension upon the flap. The
introduction of silk or silkworm strands between the sutures and under the
flap promotes the drainage of serum and facilitates the contact of the
flap with its bed. C. H. Mayo advises scarification of the flap to prevent
venous engorgement. Stasis is just as detrimental to the vitality of the
flap as is incomplete arterial supply.

4. **Immobilization.** Absolute immobilization of the pedunculated
flap during the period between the first and second step is essential, and in
children, as well as in adults, a light plaster bandage over the dressings is
of advantage. A window is cut out over the flap to take care of the dressing.
This consists of strips of silk covered with sterile yellow vaseline laid over the wound and covered by gauze. The first dressing is usually done after three or four days, when the strips are carefully changed.

5. Liberation of the Flap. In the pedunculated flap, the time for liberation is given from ten days to three weeks. I prefer to wait for three weeks before cutting the pedicle. Only in exceptional cases when the nutrition of the flaps seems to be especially good, is the pedicle cut sooner.

6. After-treatment. After the flap has completely healed into its new bed one may institute very careful massage in order to promote nutrition in the flap and its free mobility under the underlying tissue. Of much greater importance is the post-operative splinting for the prevention of recurrences. In some cases of finger deformities we have used night splints for years. (Fig. 15.)

1. Finger Webs. In cases of syndactylism, several methods have been applied according to the individual need of the case. The most common has been the method of Didot which consists in the formation of a double trap-door flap, one on the volar and one on the dorsal side, with their bases opposite to each other. This flap method yields a comparatively good amount of skin for the covering of the raw surfaces, and it effectively prevents the reunion of the sides of the separated fingers. The only disadvantage found was that occasionally one does not succeed in preventing the web of the finger from wandering distally toward the mid-phalangeal joints. In order to meet this complication, we have lately employed Tubby's modification. Tubby tunnels the webbed fingers at the metacarpophalangeal junction by means of two small flaps, one raised on the dorsal and one on the volar side, with their bases pointing in opposite directions. These flaps are then drawn through to the opposite side, forming a tunnel which is kept patent by means of a glass rod. After this preparatory step the separation of the web may be carried out by the method of Didot.

In several instances, where the fusion of the third and fourth fingers was complete and the neighboring index fingers contracted, we used a shift flap method, a diagram of which explains the details. In these cases it was thought best to sacrifice one of the fused fingers by removing the phalanges and the metacarpal head, and to use the dorsal integument for the covering of the remaining finger. The volar portion of the skin was made into a flap, which was shifted to the third contracted finger after the latter had been straightened and the contracting scar had been thoroughly removed. It was felt that three good fingers on the hand in this case would be better than four contracted ones. Occasionally a pedunculated flap from the abdomen was used to cover the raw defects in syndactylism when
sufficient skin was not available by either of the foregoing methods. (Figs. 2, 3, 4, 5.)

2. **Thumb Webs.** The problem of separating the webbed thumb from the index finger was dealt with in two cases by the method of Pieri. He uses a Z-shaped incision. The middle portion of the incision runs over the crest of the web and of the two extremities; one runs along the side of the
second metacarpal dorsally and the other on the side of the basal phalanx of the thumb volarly. When these two flaps are separated they make two triangular flaps with their bases at the second metatarsal and the first phalanx of the thumb respectively, and each of these is swung around to cover the raw surfaces. (Fig. 6.)
Fig. 6.
Pieri's Method of Thumb Web Plasty.
3. Scar Contracture of Fingers and Palm. These cases were mostly patients with severe gasoline burns or rope burns, leaving very extensive and irregular scars and contracting the palm and fingers. A few cases were congenital contractures. Very extensive resection of the scar is necessary, and it should be carried out beyond the webs of the fingers. When the hand is then straightened, it leaves a defect very much larger than it would appear before operation. In the majority of these cases the Italian method was used with flaps taken from the abdominal wall according to Berger, Murphy, or from the breast according to Morestin. In younger children with abundant fat layer, one must be careful not to leave too much of it with the flap. In some instances the flap turned out too heavy because of the underlying fat layer, and some of it had to be resected subsequently. If the scar resection reaches distally beyond the webs of the fingers, secondary operations are necessary after this has healed in order to reconstruct the finger webs. (Figs. 7, 8, 9.)

4. Dupuytren's Contracture. Operative methods are indicated in all advanced cases, and all newer methods aim at complete excision of
Fig. 8.
Scar Contracture. Fingers and Palm. Italian Flap Method.

Fig. 9.
Scar Contracture. Fingers and Palm. Italian Flap Method.
the palmar fascia. In Tubby's method a longitudinal incision is made, from which by cross incisions flaps are raised and turned back. Transverse palmar incisions are used by Hutchison and Gill with the additional resection of the heads of the basal phalanges after dissection of the fascia. In two cases the writer has used the ulnar flap method of Lotheisen. The resection of the extensive connective tissue strands was carried out by raising a long flap from the ulnar side of the hand, under which all strands of connective tissue were carefully isolated and resected. Buttonholing of the flap occurs very easily. One should be careful not to lift the flap too far off toward the radial side; sloughing of the edges occurs very readily. Posterior finger splints were used in the after treatment to maintain correction. All tension upon the scar, all forcible and painful overcorrection was avoided. (Fig. 10.)
5. **Burn Contractures of the Wrist.** Contractures of the wrist following burns were encountered both as extension and flexion deformities. Here the Italian flap method has been especially useful. The flaps were almost always taken from the upper abdominal region, occasionally from the thoracic region. We have never tried Ombredanne's suggestion of taking the flap from the opposite side of the forearm. In extreme flexion contractures of the wrist the fingers go into hyperextension at the metacarpophalangeal joints and in acute flexion in the mid phalangeal joints, often producing trophic ulcers over the latter joints. In one instance, especially, the correction of the flexion deformity contributed greatly to the correction of the finger contractures. However, the dorsal subluxation of the metacarpophalangeal joints necessitated resection of the metacarpal heads before complete closure of the fingers became possible. (Fig. 9.)

6. **Elbow Contractures.** Elbow contractures following burns require the extensive resection of the contracting scar and the reconstruction of the cubital space. Berger advises flaps taken from the abdomen and Poncet those from the thorax. Morestin's method consists in the excision of scar and coaptation of the edges of the defect by suture in extreme flexion. In one case treated the abdominal flap gave very good satisfaction, allowing almost complete extension of the elbow. (Fig. 11.)

7. **Arm-Chest Adhesions.** More difficulty is encountered in the treatment of the so-called arm-chest adhesions. The width and thickness of the web, the firmness, depth, and mobility of the scar tissue and the condition of the skin in the neighborhood determine largely the difficulties of reconstruction.
FIG. 12a.
Arm-Chest Adhesions. Shift Flaps.

FIG. 12b.
Arm-Chest Adhesions. Shift Flaps.
Jobert and Chaput advocate the use of shift flaps taken from the thorax and back, while Défontaine uses anterior and posterior triangles for the reconstruction of the axilla. We have used the shift flap method in one instance to reconstruct the axilla, while in another, where the web was wider and more mobile, a Z-shaped flap similar to that used by Pieri was applied. Berger describes a similar method of Z-shaped incision. It seems that this procedure is applicable in wide and thin webs with movable skin,
since the flaps consist largely of scar tissue. The important point is the reconstruction of the axilla, which may be done either by shift flap or anterior and posterior triangles. In dressing these cases it is not necessary,

nor is it advisable, to apply extreme positions. Tension of the newly formed flap should be carefully considered and, if necessary, full abduction may be attained in steps. (Figs. 12a, b, c, 13.)

8. NEOPLASTY. For the neoplasty of the missing thumb several methods are available. The method of Nicoladoni consists in the exchange
of the missing thumb by the big toe of the other foot and he has reported two cases with excellent results. Joyce, Mannasse, Riedel, and Öhlecker have used a method of finger exchange by use of the fourth finger of the left hand implanted upon the base of the missing stump. Pieri uses the method of phalangization by separating the metacarpal of the thumb from that of the index finger and enveloping both sides by means of Z-shaped
Fig. 14e.
Neoplasmy of Thumb.

Fig. 15.
Some of the Splints Used in Postoperative Treatment.
flaps described. Klapp, Lyle, Verall, and Wierzejewski have reported
cases successfully operated upon by this method.

A third method is that of a flap taken from the chest and made into
a roll of skin by suturing the long edges to each other. A piece of the rib
or a graft from the tibia (Albee) is implanted into the roll. The operation
is completed in two or three steps, (Albee, Ritter, Schepelman).

One case of congenital defect of the thumb was operated upon by the
writer in the manner described. A flap was taken from the thorax of the
opposite side, and a piece of the rib separated and imbedded in the flap.
At the same sitting the free end of the flap was implanted into the prepared
bed of the missing thumb. Liberation of the flap was carried out after
twenty days. (Figs. 14a, b, c.)

SUMMARY

Forty-seven extremities were operated upon by the various flap meth-
ods on forty patients.

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<thead>
<tr>
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<th>Good</th>
<th>Poor</th>
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<tbody>
<tr>
<td>1. Syndactylism</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>2. Thumb webs</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>3. Contractures of fingers and palm</td>
<td>7</td>
<td>10</td>
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<tr>
<td>4. Dupuytren</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5. Contractures, wrist</td>
<td>3</td>
<td>1</td>
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<tr>
<td>6. Elbow web</td>
<td>1</td>
<td>1</td>
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<tr>
<td>7. Arm-Chest</td>
<td>2</td>
<td>1</td>
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<td>8. Neoplasty</td>
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Analyzing the causes of failures in groups 1 and 3 (syndactylism and
palm and finger contractures), the only ones large enough to permit of con-
clusions, there were errors in judgment as well as in technique. Errors in
judgment occurred chiefly in the selection of local flaps, shift flaps, etc.,
when pedunculated flaps after the Italian method would have been better.
Errors in technique consisted mostly in undersizing of the flaps when pedun-
culated, in undue tension of local flaps, and in allowing wound secretion
to accumulate under the flaps, and in formation of bases of flaps too narrow
for adequate nutrition. Since all these points were given due regard in
later operations the operative results have become much more satisfactory.