

THE NEUROVASCULAR ISLAND PEDICLE FLAP

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Nine patients with irreparable damage to the nerves of the thumb, treated with a neurovascular island pedicle flap from the third or fourth finger to the defect thumb, have been re-examined 9 months to 8 years after the operation.

Eight patients had a 2-point discrimination of less than 15 mm corresponding to the flap and all had a positive Ninhydrin test. Two had complete cortical reorientation and three partial reorientation. Six found the function of the thumb to be good or fair. Three described the result as poor and three had to be reoperated because of contractures of the donor finger and/or thumb.

The method can be recommended for use in young, well motivated patients.

Key words: peripheral nerve damage; neurovascular island pedicle flap; reconstruction of the thumb; sensory loss in the hand

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In the treatment of peripheral nerve damage to the functionally important areas of the hand, the principle of transferring a skin flap with associated neurovascular pedicle from a functionally less important area has been employed in cases where the continuity of the nerve could not be restored.

The method was introduced by Moberg in 1955. Since then several minor modifications have been described (Littler 1960, Tubiana & Duparc 1961, Hueston 1965, Omer et al. 1970). Also radial-innervated skin from the dorsum of the hand and fingers has been employed (Gaul 1969, Holevich 1963).

While originally used for restoring sensation to the thumb, it has also been used to protect the little finger in irreparable lesions of the ulnar nerve (Ranney & Lennox 1978).

Several reports concerning the long-term results have been published (Murray et al. 1967, Omer et al. 1970, Krag & Bang

Rasmussen 1975). Most authors have found the results to be less than optimal.

As the indications and contraindications for the procedure have not been definitively established it was considered relevant to publish the results obtained in nine patients who during the last 8 years have had a neurovascular island pedicle flap transfer performed at the Department of Orthopaedic Surgery, Århus County Hospital. All the patients have therefore been re-examined.

PATIENTS AND METHODS

The age and sex of the patients is shown in Table 2 and the nature of the lesions in Table 1. All the patients had open, often dilacerated lesions, in several cases with associated damage to bones, joints and tendons.

The patient with the iatrogenic lesion sustained damage to the ulnar volar nerve during a resection of a recidivating epitheloid cyst.

The island transfer has in no case been performed as a primary procedure. The time elapsing between the accident and the transfer is shown in Table 2.

In one case (patient no. 2) we used the skin from the volar aspect of the proximal phalanx of the third finger, where the bones, joints and tendons were totally destroyed necessitating an amputation but the skin with vessels and nerves was left intact primarily. In the other cases a healthy finger has been used. The donor finger is stated in Table 2. In one patient (no. 5) the radial part of the pulpa was used, in the others the ulnar part. The operations were performed in a bloodless field, and under a general anaesthesia. By a volar incision the volar artery and nerve to the donor site were dissected free. The volar artery to the neighbouring finger and in some cases a dorsal perforant was divided between

ligatures. To obtain a sufficiently long pedicle the nervus digitalis palmaris communis was cleaved bluntly. After this an incision from the base of the pedicle to the ulnar aspect of the pulpa of the thumb was made, except in the first patient, where the flap was passed through a subcutaneous tunnel to the recipient site. Defective skin corresponding in size to the flap was removed and the flap was fixed with sutures. Hereafter the tourniquet was released to check the vitality of the flap and to secure haemostasis. The defect on the donor finger has in some cases been covered with the excised skin from the thumb, in other cases with a full thickness or a split skin graft taken from the elbow crease or from the femur. After the wounds had healed sensory training was started (patients nos. 1, 2 and 9). In this the blindfolded patient palpates, and tries to recognize objects of various forms and textures.

Table 1. The nature of the lesion

Pt. no.	Aetiology	Localization of lesion	Loss of thumb length	Associated lesions
1	moulding machine	thumb	distal phalanx	tendon the long flexor of the thumb
2	moulding machine	thumb	distal + part of proximal phalanx	nerve and flexor tendon to 2nd finger, partial amputation of 3rd finger. $\frac{1}{2}$ distal phalanx of 4th finger
3	iatrogenic	thumb	—	—
4	spike wound	thenar	—	tendon of the long flexor of the thumb
5	roller	thenar	—	severe skin lesion on volar and dorsum surfaces. Lesion of rad. coll. ligament in 1st metacarpophalangeal joint. Lesion of nervus digitalis palmaris communis 2
6	circular saw	thumb	—	severe skin lesion of the thumb, lesion of distal interphalangeal joint, tendon of the long flexor of the thumb
7	hand ball	thumb	—	open luxation of interphalangeal joint of thumb
8	grease gun	thumb	distal phalanx (secondary necrosis)	—
9	horse-riding accident	thenar	—	tendon of the long flexor of the thumb, adductor muscle of the thumb, severe skin lesion in 1st intertice

Table 2. Summary of patient's data, treatment and results

Patient no.	1	2	3	4	5	6	7	8	9
Sex	m	m	m	m	m	m	m	m	f
Age at accident	21	36	16	16	52	36	17	24	16
Months from accident to operation	24	11	9	8	9	4	6	24	5
Lesion of dominant hand	—	—	+	+	+	+	+	—	+
Donor finger	3	3	3	4	4	3	3	3	3
Observation time (years)	8	6½	5	4½	4	2	1	1	3/4
Work	ch	co	co	co	o	ch	co	ch	co
Change of dominant hand	—	—	—	—	+	—	—	—	—
Reorientation	+	+/-	+/-	—	—	—	+/-	—	+
Cold intolerance	(+)	(+)	(+)	(+)	++	—	—	+	—
Ninhydrin	+	+	+	+	+	+	+	+	+
2 pd flap area	14	6	12	7	—	6	4	8	4
Donor's ulnar neighbour	2	8	4	—	10	2	4	8	2
Picking-up: open eyes	0.8	0.5	1.0	0.9	0.7	1.1	1.0	0.4	0.8
Picking-up: closed eyes	1.0	0.4	1.0	0.6	0.4	0.8	0.8	0.3	0.8
Power: total grip	0.7	0.6	1.1	0.9	0.4	1.0	0.9	0.1	0.9
Power: pinch	0.9	0.9	1.0	0.8	0.3	0.8	1.0	0	0.8
Sharp/blunt discrimination	+	+	+	+	—	+	+	+	+
Touch	+	+	+	+	+	+	+	+	+
Temperature	+	+	+	+	—	+	+	—	+
Subjective judgement	G	G	F	P	P	F	G	P	G

Abbreviations:

Sex: m = male; f = female.

Work: ch = change; co = continued; o = out of work.

Subjective judgement: G = good; F = fair; P = poor.

2 pd = 2 point discrimination.

For further explanation: see text.

RESULTS

In no case has necrosis of the flap developed. In patient no. 9 anaesthesia of the radical aspect of the donor finger's ulnar neighbour was found after the operation. The anaesthesia vanished completely during the next 2 months.

In three patients it has been necessary to undertake corrective procedures. Patient no. 6 developed contractures of both the thumb and the donor finger, and callosities at the donor site; 4 months after the transfer a Z-plasty, excision of callosities and transplantation was made — with good results. In another patient (no. 4) an arthrodesis of the metacarpophalangeal joint of the thumb was made 11 months after the transfer because of contracture. The third patient required

excision of fibrous tissue from the donor site on four occasions, before a good result was achieved.

All nine patients have been re-examined by the author. The observation time was between 9 months and 8 years. The results are as stated in Table 2. Some of the points are commented upon below.

Dominant hand: One patient changed the dominant hand. He continued to write with the right hand, while other activities were transferred to the left hand.

Paraesthesia: Patient no. 5 complained of paraesthesia in the flap area when pressure was applied in the first interstice. Patient no. 3 complained of paraesthesia in the donor finger whenever the flap was touched.

Cold intolerance: One patient had severe cold intolerance; most patients mentioned a slight, not annoying cold intolerance.

Reorientation: Four patients had no cortical reorientation (-). Three stated that they felt stimuli of the flap as coming both from the thumb and from the donor finger (+/-). Two had complete reorientation (+), but stated that sudden, unexpected painful stimuli of the flap area were felt as coming from the donor finger. All patients with complete and partial reorientation stated that even several years after the operation the orientation was continuing to improve.

Ninhydrin test: In all patients a positive test was found in the flap area, although there was a great variation in the intensity of the reaction. Corresponding to the donor area all had a negative reaction.

Two point discrimination: The test was performed by an ergotherapist experienced in 2-point discrimination testing, and with no former knowledge of the patients.

Pain: It was noted whether the patients were able to distinguish between the sharp and the blunt end of a needle.

Touch: It was noted whether the patients could feel anything at all in the flap area.

Picking-up test: The test was performed with open and with closed eyes. During the test the index finger was covered with a rubber tip. For convenience, not the actual values, but the ratio healthy hand/operated hand is given. Thus values less than 1.0 indicate a poorer function.

Power: The total grip strength of the hand and the pinch between the thumb and index finger were measured with a dynamometer. The value of the healthy hand was fixed at 1.0 and the value of the damaged hand calculated as a proportion of this.

Mobility: The mobility of all the joints of the upper extremity was measured with a goniometer.

One patient, as mentioned above, had an arthrodesis of the metacarpophalangeal joint of the thumb. In this patient a contracture resulted in a lack of extension of 45° in the interphalangeal joint of the thumb. In all the other patients normal mobility was found, apart from the limitations in mobility which were caused by associated lesions from the original injury.

Trophic: All the flaps were vital, with no signs of atrophy.

Subjective judgement: The patient's own estimation of the functional value of the thumb is described as good (G), fair (F) and poor (P).

DISCUSSION

Six out of nine patients described the result as good or fair. It is seen that all these patients have complete or partial reorientation. A 2-point discrimination better than 15 mm is according to Moberg a condition of tactile gnosis. A value better than 15 mm was found in eight patients. No connection between the numerical value and the functional result was found; thus patient no. 1 had poor 2-point discrimination but was functionally among the best. The picking-up test is valuable but is very much affected by the sequelae of associated lesions. The intensity of the Ninhydrin test was not found to be related to function, 2-point discrimination or the picking-up test.

Three patients described the result as poor. The main complaint of patient no. 4 was the contracture which made the thumb sit in an awkward position for working. He is now recommended for a Z-plasty, which most likely will improve the result.

Patient no. 5 had a severe lesion of the hand necessitating placement of the

neurovascular pedicle in cicatricial tissue. He was 52 years old. The chances of a good result were therefore rather dubious but the operation was tried as a last resort.

Patient no. 8 had a severe grease gun lesion. Postoperatively he developed deficient sensibility in the fingers innervated by the median nerve, with a 2-point discrimination of 8 mm against 4 mm on the healthy hand. We have no explanation for this.

Major complaints from the donor finger were not found but in three patients with contractures or callosities reoperations were necessary before a good result was achieved.

Permanent disability due to the cleaving of nervus digitalis communis was not found but one patient had a transient anaesthesia of the adjoining finger, so the risk must be kept in mind.

Conclusions

1. The most important factor leading to a good result is cortical reorientation. Therefore the method can be recommended for young patients who are well motivated, and who are able to cooperate in the training of cortical reorientation.
2. Placing the pedicle in cicatricial tissue should be avoided.
3. Later corrective operations will often be necessary.
4. Postoperative sensory training is important.

APPENDIX

Since this article was written we have treated two more patients by this method. As a consequence of the importance of reorientation as shown in the article, sensory training was

started even before the sutures could be removed. The preliminary results are very encouraging. However, the observation time is as yet too short so that these two patients have not been included in the review.

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