

TACTILE GNOSIS IN FREE SKIN GRAFTS IN THE HAND

By IVAN B. MATEV, M.D.

Institute of Orthopaedics and Traumatology, Sofia, Bulgaria

Out of a total number of 258 patients treated over the last 20 years for post-burn flexion contractures of the digits, eight cases have been studied in detail for several years in the follow-up clinic. They were treated in early childhood, between the second and fifth year of life (Matev, 1960). The intervention consisted of release of the contractures and resurfacing of the resultant defects over the palm and digits with free full-thickness skin grafts, taken from the subumbilical region of the abdomen. The grafts were placed onto a layer of subcutaneous tissue or directly onto the tendon sheath itself. The postoperative course was uneventful and all the grafts took completely. The children were reviewed at regular intervals and additional minor adjustments were carried out as required in all cases between the ages of 5 to 15 years. During these operations small pieces of skin graft were taken from various sites on the palm and fingers and studied histologically with particular attention to the demonstration of nerve bodies and nerve endings (Kadanoff *et al.*, 1966). Repeated clinical investigations were made to assess the quality of sensitivity in the skin grafts with the latest follow-up examination being carried out some 13 to 19 years after the original skin graft (Figs. 1 to 3).

Characteristics of the free skin grafts. All the grafts showed a varying degree of pigmentation which made them easily distinguishable from

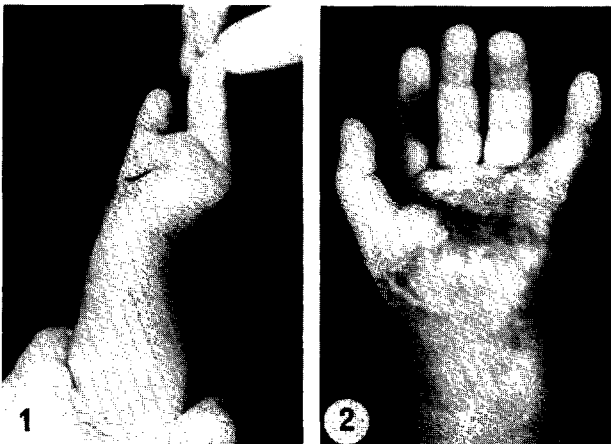


FIG. 1. An 18-month-old child sustained a hot-stove burn 3 months previously. At operation the contractures of the fifth finger and the palm were released and the large defect was covered with a full-thickness graft, taken from the abdominal wall.

FIG. 2. The same child 5 years after operation.

Address for reprints: Professor I. B. Matev, Institute of Orthopaedics and Traumatology, Boulevard P. Mapevov 56, Sofia 1614, Bulgaria.



FIG. 3. Sixteen years after operation. Note the pigmentation of the graft. The grafted area has perfect sensibility and tactile gnosis along with very slight hyperaesthesia.

the adjacent normal hand skin (Fig. 3). Skin creases were seen at the sites of their normal localisation, but were not as deep or firmly fixed as the creases in the undamaged skin. Sweat secretion was poor by comparison with that of the normal palmar skin and was less than that observed at the donor site on the abdominal wall. The epidermis of the skin grafts was thinner and softer compared with the surrounding skin, but thicker than the epidermis of the donor site. The grafts had tiny hairs, much finer than those observed at the donor site.

Sensitivity. Repeated investigation of skin graft sensitivity showed the presence of all types of normal sensory function including tactile gnosis, against a background of very slight hyperaesthesia. Tests for two-point discrimination gave equal values or close to those recorded for identical zones in the opposite hand (Figs. 4 to 6).

Regardless of the perfect functional adaptation, these free grafts, unlike the grafts placed on the dorsum of the hand, differed morphologically from the surrounding undamaged skin (Figs. 7 and 8).

HISTOLOGICAL FINDINGS

The specimens were treated according to the pyridine modification of Bielshovsky's silver-impregnation method. Encapsulated receptors were not discovered in any of the specimens examined except in those taken from the marginal parts of the graft together with the operative scars (Fig. 9). Only nerve fibres and nerve endings were seen profusely concentrated and arrayed in a palisade pattern around the hair roots (Figs. 10 and 11).

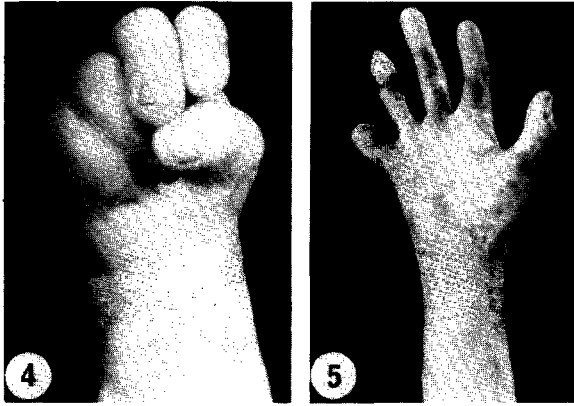


FIG. 4. Severe flexion contracture of the digits and wrist of a 2-year-old child as a result of a thermal burn sustained 6 months previously. First the wrist and then at a second operation the palm and digits were resurfaced with full-thickness free grafts from the subumbilical region.

FIG. 5. Condition 5 years after operation.



FIG. 6. Fifteen years after operation. The hand had good function with sensation and tactile gnosis over the palmar and digital surfaces.

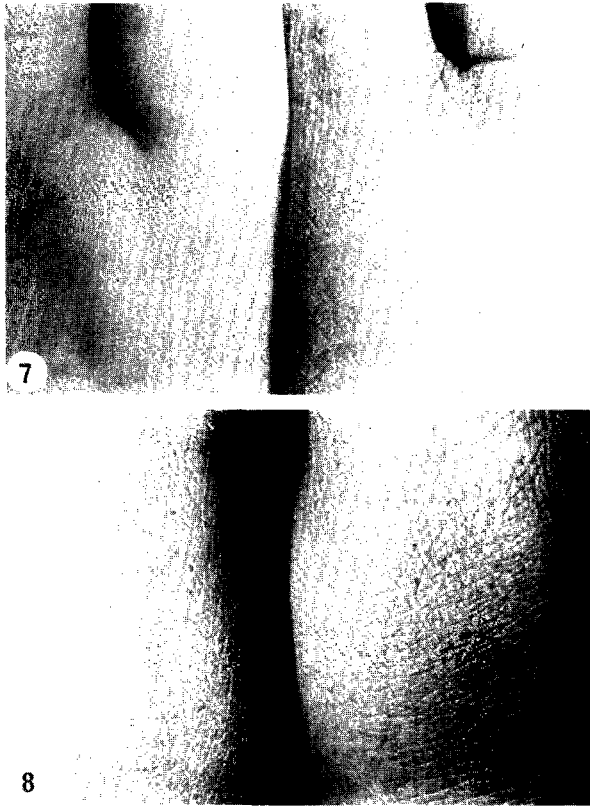


FIG. 7. The distal ulnar-palmar area of both hands. Compare the creases in the graft with those in the normal hand. Sixteen years after the operation two-point discrimination in this area is 8mm for the sound hand and 10mm for the grafted hand.

FIG. 8. The dorso-radial aspect of both hands in a 28-year-old woman, operated on 12 years previously. After correction of a burn contracture of the MP joints, a full-thickness free skin graft taken from the subumbilical region was put on the dorsum of the left hand. Unlike grafts on the palmar surface, it is almost impossible to detect which is the treated side.

DISCUSSION

Sensory reinnervation of skin grafts has been studied by many authors (Lofgren, 1951; Napier, 1952; Moberg, 1958; Kirov, 1962; Mannerfelt, 1962; Matev, 1965; Kadanoff *et al.*, 1966, 1968) and the opinions set forth are by no means unanimous.

In the series of patients reported on, we established a highly differentiated sensitivity, including tactile gnosis, in the free grafts situated on the palmar aspect of the hand. Sensory function was superior in the more distal areas of the skin grafts and was of optimal quality in the fine-hair bearing zones (Fig. 12). The clinical evidence correlated well with the histological study, which showed an absence of encapsulated receptors and the presence of nerve fibres and endings aggregated rather densely around the hair roots of these grafts. In a separate study of 15 free grafts and 14 pedicle flaps, taken from the abdomen, back and thigh, and transplanted to the palmar aspect of

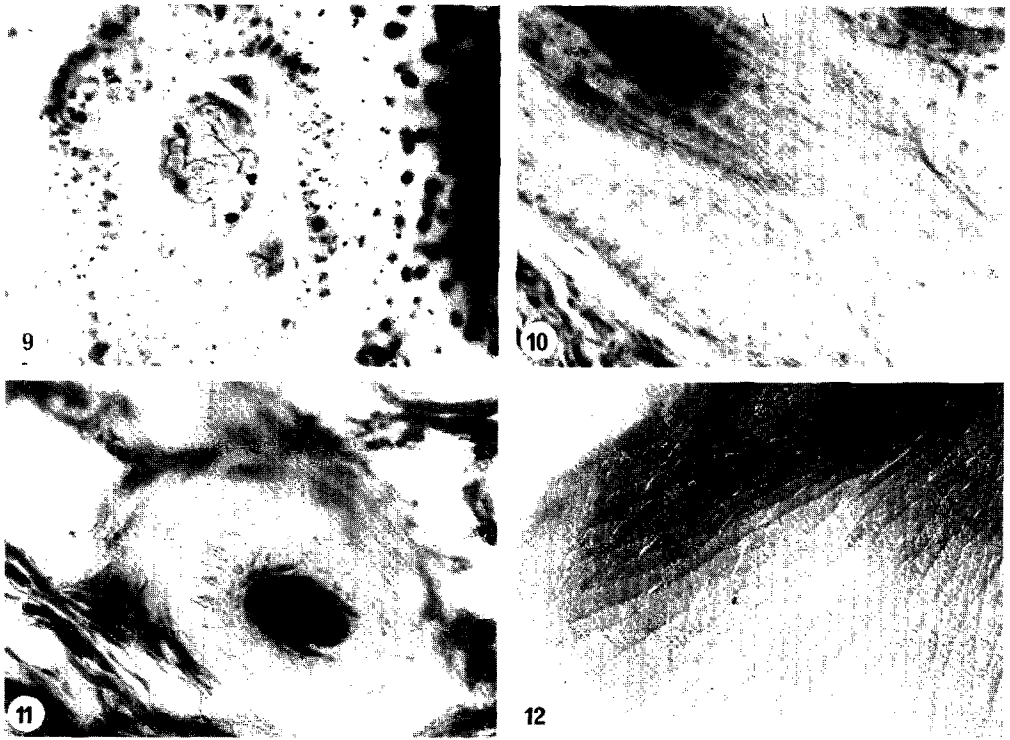


FIG. 9. Encapsulated receptors, like this Meissner corpuscle, were found only in specimens taken from the border of the graft together with the operative scar ($\times 320$).

FIGS. 10 and 11. In the specimens taken from the grafts themselves only nerve fibres and nerve endings, profusely concentrated and arranged in a palisade pattern around the hair roots, could be seen ($\times 320$).

FIG. 12. Sensation is most highly developed in the fine-hair bearing zones of the grafts.

the hand over a period ranging from a few months to fourteen years, we also failed to show any encapsulated receptors (Kadanoff, Wassilev and Matev, 1968). These observations accord with the findings of Ridley (1970).

The comparative study of our clinical and histological observations shows that the sensation of temperature, touch, pain, shape, and tactile gnosis may be mediated by simple nerve endings in the absence of the encapsulated corpuscles of Meissner, Krause, Ruffini etc. In this light our studies support the conclusions reached by Sinclair (1967), namely that the presence of specific sensory organs is by no means indispensable for the varied modalities of skin sensation. Similar inferences were also made by Wynn-Parry and Salter (1976) on the basis of experience with sensory re-education after median nerve lesions. In the present study it is of interest to note that tactile gnosis was established in the thick free grafts taken from the abdominal skin and transferred to the palmar surface of the hand during infancy. We failed to discover tactile gnosis in similar grafts among patients operated on at an older age. It is clear that reproduction of highly differentiated sensitivity may occur at a simple nerve ending through the mechanism of continuous natural readaptation during the growth period in children. However, a precondition

for such a reproduction is that both nerve fibres and nerve endings are formed and already included in the sensory pathway before awareness of the various skin sensitivity modalities has begun. Formation of new cortico-peripheral junctions is no doubt facilitated by the adaptability of the nervous system during childhood.

REFERENCES

- KADANOFF, D., WASSILEV, W. and MATEV, I. B. (1966). Über die regenerierten Nervenfasern und Nervenendigungen in Hautnarben und Hauttransplantaten beim Menschen. *Anatomischer Anzeiger (Jena)*, **118**, 503.
- KADANOFF, D., WASSILEV, W. and MATEV, I. B. (1968). Die Wiedererlangung der Sensibilität und die Reinnervation der gestielten und der freien Hauttransplantate beim Menschen. *Morphologisches Jahrbuch*, **112**, 484.
- KADANOFF, D., WASSILEV, W. and MATEV, I. B. (1975). Die Ausbildung der Haare und die Wiederherstellung ihrer Innervation in den Hauttransplantaten beim Menschen. *Zeitschrift für Mikroskopisch-Anatomische Forschung (Leipzig)*, **90**, 16.
- KIROV, A. A. (1962). Restoration of the various types of sensitivity and nerve endings in free skin grafts after extensive burns. *Acta Chirurgiae Plasticae*, **4**, 213.
- LOFGREN, L. (1951). Recovery of nervous functions in skin transplants with special reference to the sympathetic functions. *Acta Chirurgica Scandinavica*, **102**, 229.
- MANNERFELT, L. (1962). Evaluation of functional sensation of skin grafts in the hand area. *British Journal of Plastic Surgery*, **15**, 136.
- MATEV, I. B. (1960). Severe burn flexion contractures of the hand in early childhood. *Acta Chirurgiae Plasticae*, **2**, 285.
- MATEV, I. B. (1965). Flexion contractures in the hand and fingers after burns. Dissertation, Sofia (in Bulgarian).
- MOBERG, E. (1958). Objective methods for determining the functional value of sensibility in the hand. *Journal of Bone and Joint Surgery*, **40-B**, 454.
- NAPIER, R. (1952). The return of pain sensibility in full-thickness skin grafts. *Brain*, **75**, 147.
- RIDLEY, A. (1970). Biopsy study of the innervation of forearm skin grafted to the finger tip. *Brain*, **93**, 44.
- SINCLAIR, D. (1976). "Cutaneous sensation." London and New York: Oxford University Press.
- WYNN-PARRY, C. B. and SALTER, M. (1976). Sensory re-education after median nerve lesions. *The Hand*, **8**, 250.