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CIRCULATION, REINERVATION AND HISTOMORPHOLOGIC CHANGES IN FREE FLAPS

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Summary. *At the Clinic for Plastic Surgery and Burns of the MMA, we examined 33 patients with transferred 5 cutaneous, 18 miocutaneous and 10 osteocutaneous free flaps of which 10 were on the foot, 13 on the lower leg and 10 on the face. We analyzed blood circulation (patency of arterial microanastomosis and perfusion) of transferred free flaps (1-3), sensitivity recovery, function of the sebaceous and sweat glands, as well as histomorphologic changes in the skin of the transferred free flaps during the period of 6 up to 36 months after the free flap transfer and compared with the same characteristics of the skin and tissue of the surrounding recipient region.*

Key words: *Free flaps, microvascular anstomosis, circulation, microcirculation, reinervation, sebaceous glands, sweat glands, histological changes*

Introduction

Microvascular tissue transfer provides for a single-act surgical procedure in any part of the body. Anatomic, morphologic, histological, physiologic and other characteristics of the donor region represent the biological value of a free flap, which differ from the corresponding characteristics of the recipient region. During microvascular tissue transfer, free flap tissue is exposed to various pathophysiologic processes: temporary ischemia, anaerobic metabolism, inflammation, denervation and reinervation processes, which all have significant impact on the above-mentioned tissue characteristics of the transferred free flap. A wide spectrum of indications for free flaps presupposes different aims in microvascular reconstruction. The need for adequate local tissue perfusion (1,2,3) in a complex fracture of long bones of lower extremities or for sensibility of transferred flaps in the regions of feet, palms, face, chest, genitals, etc. requires adequate choice of free flaps by microvascular reconstructive surgeons. Our principal objective was to assess biologic value of various free flaps transferred in different regions, against the biologic tissue characteristics of the surrounding recipient region.

Methods

At the Clinic for Plastic Surgery and Burns, Military Medical Academy, we assessed 33 patients with transfers of 5 cutaneous, 18 myocutaneous and 10 osteocutaneous free flaps, out of which 10 for foot region, 13 for lower leg and 10 for face. Our analyses involved the following: macro- and microcirculation, recovery of sensitivity, functional recovery of sebaceous and sweat glands, and histomorphologic changes in the skin of transferred free microvascular flaps during the period of 6 to 36 months after transfer. Using the Seldinger arteriography the patency of arterial microvascular anastomosis was evaluated (Fig. 1), while flap perfusion was measured with radioactive Tc-99m (MAA HSA) (Figs. 2, 3). Sensibility to touch was tested with Von Fery esthesiometer (Fig. 4), and senses of hot and cold with

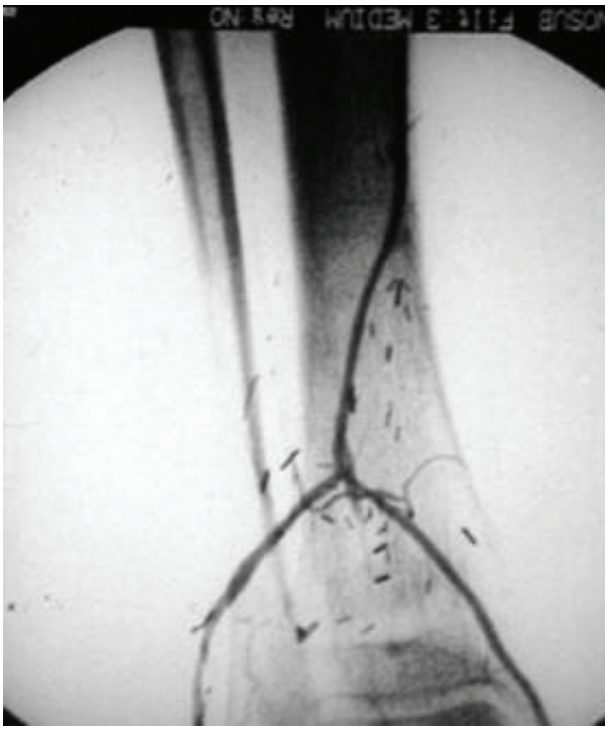

Fig. 1. Patent microvascular anastomose

Fig. 2. Free latissimus dorsi flap transferred to the foot

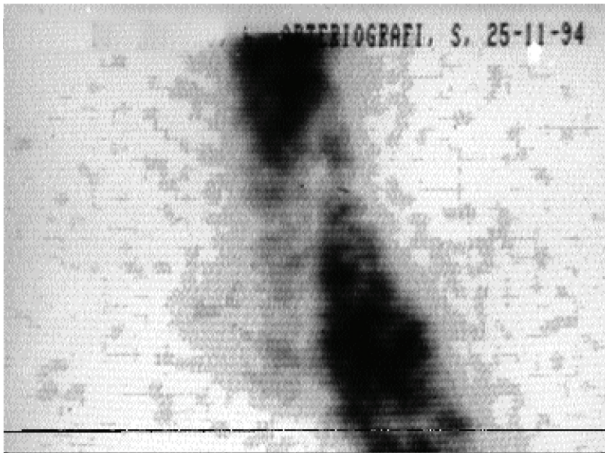

Fig. 3. Increased collection of radiopharmaceutical agent compared to the surrounding recipient region

thermoesthesiometer (Fig. 5) (temperature of +40°C for hot, and +15°C for cold) (4-6). Pain was tested using the Bernard's diadynamic currents of 100 MHz frequency and 1-15 mA intensity (Fig. 6). The quality of recovered sensibility was tested using the two-point discrimination test (Fig. 7) (7). The function of sebaceous glands was assessed with Herman-Prose test (Fig. 8), while the ninhydrin test was used to test the function of sweat glands (Fig. 9). Histopathologic changes in the transferred free microvascular flaps were inspected using light microscopy after the application of various histochemical and immunochemical staining techniques (8).

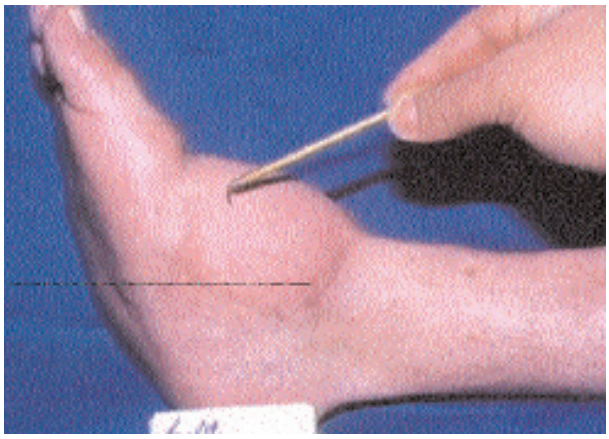

Fig. 4. Sense of touch testing with Von Fey esthesiometer

Fig. 5. Sense of hot test

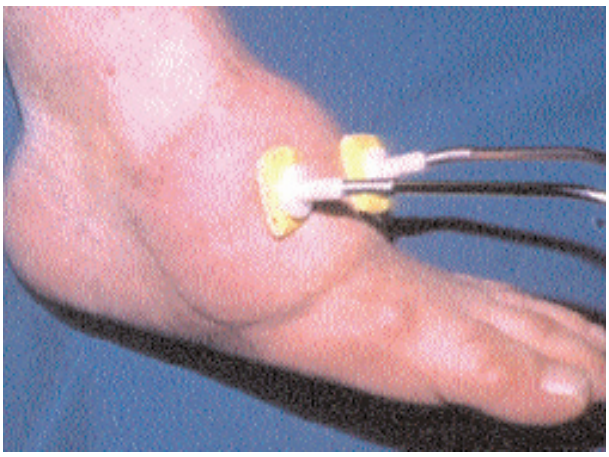

Fig. 6. Sense of pain testing with Bernard's diadynamic currents

Fig. 7. Two-point discrimination test

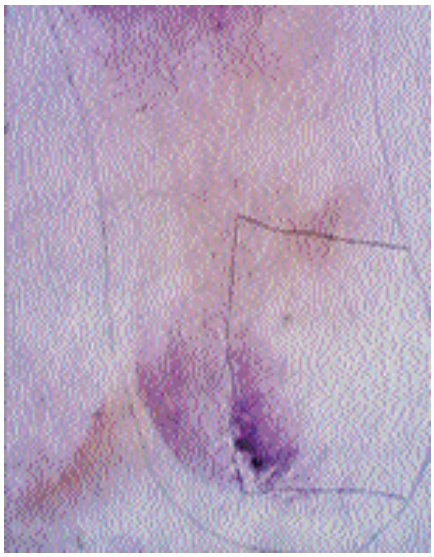

Fig. 8. Ninhydrin test, demonstrating weaker activity of the sweat glands

Fig. 9. Herrman-Prose test to assess the function of the sebaceous glands

Results

Patency of the arterial anastomosis was preserved in all transferred flaps at 15 months after free tissue transfer, while arteriography demonstrated stenosis of microanastomose in 2 cases. On radionuclide arteriography, radiopharmaceutical agent was 2.3 times more concentrated in the transferred flap tissue than in the surrounding recepient region. Sensibility tests demonstrated that the sense of touch was for the first time noted after 6 months and fully established 30 months after transplantation. The sense of hot was for the first time observed after 18 months, being fully established 36 months after transplantation. The sense of cold was for the first time observed after 6 months, being fully established after 36 months. Pain was for the first time detected by way of 10.11 mA diadynamic current application 12 months after operation. Two-point discrimination test was performed 36 months after transplantation and demonstrated that the distance of 46 mm at which two points were discriminated was present in 37.5% of the patients. The function of sebaceous glands in the free flap was present in 98% of the glands in the recipient and 99% of the glands in the donor region. The function of sweat glands was detected 12 months after operation; however, the functional level of the corresponding glands in the recipient region was not achieved even 36 months after operation. Histomorphologic results demonstrated a significant difference in skin texture in the free skin flaps, characterized by hypotrophy and hyperkeratosis of the epidermis (Fig. 10), hypotrophy of the sebaceous and sweat glands (Fig. 11),

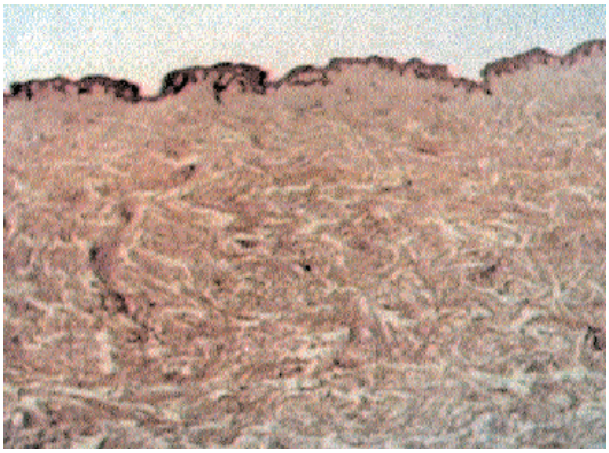

Fig. 10. Epidermal hypotrophy

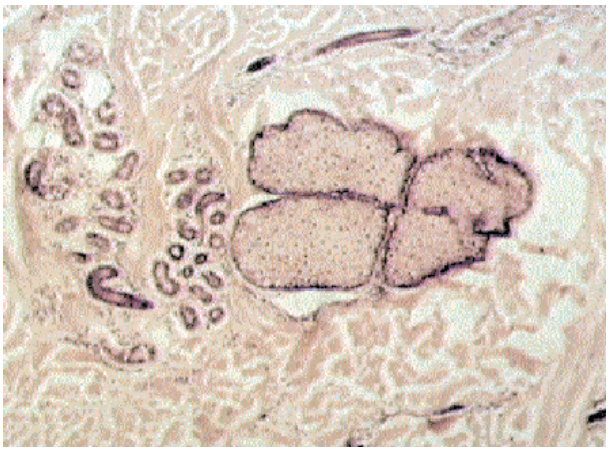

Fig. 11. Hypotrophy of the sebaceous and sweat glands

disturbed, irregularly distributed, edematous or hyaline degeneration of dermal collagen fibers. Blood vessels in transferred free flaps showed the signs of "lymphocytic vasculitis" (Fig. 11), while nerve fibers are degeneratively altered or normal (Figs. 12, 13).

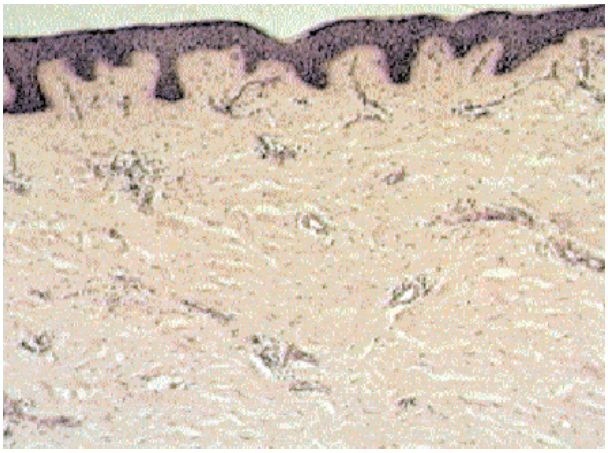

Fig. 12. Blood vessels in the flap - lymphocytic vasculitis

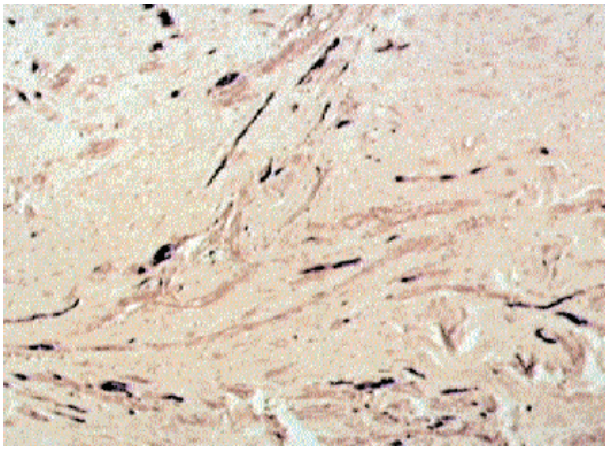

Fig. 13. Degenerated nerve fibres in the flap

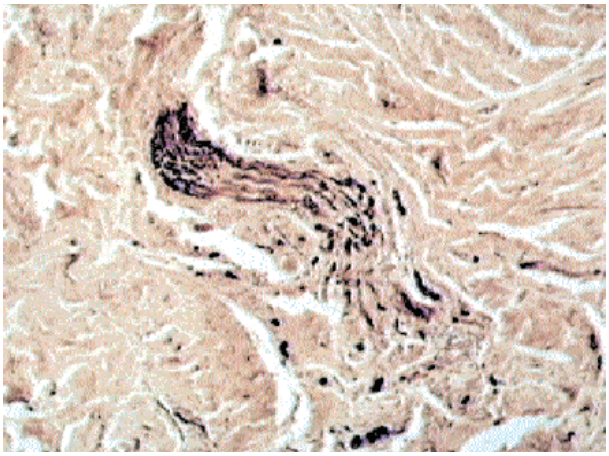

Fig. 14. Preserved nerve structure in the flap

Conclusion

Blood vessels within the transferred free flaps preserved the anatomy of its own vascular network, providing 2.3 times better perfusion of the flap tissue compared to the surrounding recipient region. The tests utilized demonstrated that all the senses (touch, pain, hot and cold) partially regained their functionality, but even 36 months after surgery the high level of quality of sense was not achieved in the recipient region. The function of

sebaceous glands was poorer compared to the recipient region, probably as the consequence of denervation processes. The function of sweat glands was in correlation with cutaneous reinnervation processes, occurring in the form of nerve spreading from the surrounding tissue. Histopathologic changes in free flaps probably occurred as the result of denervation and inflammatory processes during microvascular tissue transfer.

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CIRKULACIJA, REINERVACIJA I HISTOMORFOLOŠKE PROMENE U SLOBODNIM REŽNJEVIMA

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Kratak sadržaj: *Na Klinici za plastičnu hirurgiju i opekotine VMA pregledana su 33 pacijenta kod kojih su učinjeni transferi 5 kožnih, 18 miokutanih i 10 osteokutanih slobodnih režnjeva, od toga za regije stopala 10, potkolenice 13 i lica 10. Učinjene su analize makro- i mikro cirkulacije (prohodnosti arterijske mikroanastomoze i perfuzije tkiva) u transferiranim slobodnim režnjevima (1-3), oporavka senzibiliteta, funkcionalnog oporavka lojnih i znojnih žlezda, kao i histomorfoloških promena u koži transferiranih slobodnih mikrovaskularnih režnjeva tokom perioda od 6 do 36 meseci nakon učinjenog transfera i dobijeni rezultati su poređeni sa karakteristikama kože i tkiva recipijentne okolne regije.*

Ključne reči: *Slobodni režnjevi, mikrovaskularne anastomoze, cirkulacija, mikrocirkulacija, reinervacija, lojne žlezde, znojne žlezde, histološke promene*