Department of Plastic and Reconstructive Surgery

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General Summary

Research in the Department of Plastic and Reconstructive Surgery is focused on 4 basic areas: 1) the etiology and treatment of craniofacial anomalies, 2) the etiology and treatment of hand and foot anomalies, 3) the mechanism of wound healing and the grafting of skin and bone, and 4) microsurgical transplantation. The staff of the department comprises surgeons representing virtually all areas of plastic surgery and clinicians from related disciplines. For this reason, the department provides the stimulating atmosphere necessary for productive research. The participation in research studies provides plastic surgery residents and postresidency fellows important experience and expands their understanding of anatomical and physiological factors involved in these special areas of surgery.

Research Activities

Gene analysis and staged surgical procedures in patients with syndromic craniosynostoses
Apert syndrome, or acrocephalosyndactyly, is an autosomal dominant disease caused by allelic mutations of fibroblast growth factor receptor 2 (FGFR2). Two regions (Ser 252 Trp and Pro 253 Arg) of the FGFR2 gene are believed to be responsible for craniosynostosis syndromes. Four types of monoclonal antibody, which respond only to the peptides derived from mice with mutation in Pro 253 Arg, have been successfully prepared.

Gene transfer into limb bud using electroporation technique
Electroporation was used to transfer genes into the extremities of cultured mammalian embryos. Ell Std-ddy mice were anesthetized with ether. Embryos, together with the placenta and embryonic membranes, were dissected from the surrounding decidua. The yolk sac, amnion, and chorioallantoic placenta were preserved in Hank's balanced salt solution. The pEGFP-N1 vector (0.1 μl) was injected into the yolk sac. The extremities were grasped with forceps-type electrodes and electroporated with 3 pulses of 30 to 50 V for 50 milliseconds. After the amnion had been removed, the embryo was placed in a bottle filled with mouse serum solution. Ninety-five percent O_2 and 5% NO_2 were supplied to the bottle via a tube 4 times a day. The embryo was cultured at 37°C and rotated at 30 rpm for 24 hours. The placenta was removed, and the embryo was fixed in 4% paraformaldehyde. Frozen sections were prepared with liquid nitrogen and observed with fluorescent microscopy. Green fluorescent protein was observed throughout the entire body with 50 V and in more restricted areas with 40 V and 30 V. The embryos that were electroporated with 30 V showed gene transfer localized to the

epidermis and dermis.

Distraction osteogenesis

The use of distraction osteogenesis in reconstruction continues to expand and evolve. The effects of the various rates and frequencies of distraction have been studied, and a rate of 1 to 2 mm per day is adequate for the craniofacial skeleton. Division of the daily distractions into smaller, more frequent distractions accelerates bone formation. We have developed a device with a built-in motor that can produce continuous distraction. Results of experiments using newly developed devices are being analyzed.

Morphologic study of bone conduction mechanism

Fewer experiments of artificial bone osteoconductivity have involved the cranium than the extremities. An experimental study of osteoconductivity of β-tricalcium phosphate (β-TCP) in cranial bone defects was performed. Bone regeneration in full-thickness circular defects (10 mm in diameter) created bilaterally in the parietal bones of adult female Japanese white rabbits was evaluated. The animals were divided into 3 groups: in group A, a β-TCP disk (9.5 mm in diameter, 2.0 mm in thickness) was inserted into the bone defect; in group B, β-TCP granules (approximately 0.1 g) were inserted; and in group C, nothing was inserted. The periosteum was repaired, and care was taken to avoid damaging the dura. Bone regeneration was assessed with visual inspection, roentgenometry, and intensity and histological findings. In conclusion β-TCP has good biocompatibility with cranial bone.

Tissue engineering

Flaps with a mucosal lining are extremely useful for nasal, oral, tracheal, and urogenital reconstruction. Fascia lined by mucosal tissue was developed as a new reconstructive material. Sublingual mucosa was obtained from Japanese white rabbits, and separated mucosal cells were subcultured twice for 4 weeks. The cells were transplanted to the fascia of the femoral muscles in the same rabbits. The fascial tissue and the muscular tissue were removed 1 week after transplantation. The specimen was stained with hematoxylin and eosin and subjected to immunohistochemical examination for cytokeratin, a specific marker of mucosal cells. The growth of mucosal tissue was confirmed histologically. Fasciomucosal complex tissue was developed. Fascia proved to be a useful scaffold that cross-links between the transplanted mucosa and the muscle.

Hemodynamic analysis of capillary blood vessels in patients with diabetes

The increase in the prevalence of diabetes has led to an increase in the prevalence of diabetic foot gangrene. Below-knee or above-knee amputation should be put off as long as possible by means of both conservative and surgical treatments. Other than the ankle-arm pressure index and the cardio-ankle vascular index, few effective methods for predicting diabetic foot lesions have been reported. Videomicroscopic analysis of blood flow through capillaries in the eponychium of the toes of patients with diabetes indicates the stage of microangiopathy and may predict diabetic foot lesions. The effectiveness of prophylactic treatment with a 5-hydroxytryptamine type 2A receptor

antagonist will be investigated with this examination system.

Publications

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