MORPHOLOGY OF REGENERATION OF THE URINARY BLADDER AFTER REPAIR WITH A LYOPHILIZED HOMOGRAFT

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In clinical practice most plastic operations on the urinary bladder are performed with the aid of autografts from the large and small intestine [1, 6, 9, 10-13]. In some investigations alloplastic materials have been used [2, 7, 8]. However, both these methods have disadvantages.

Attempts to use homografts have not proved successful because the grafts was rejected. The use of conserved homografts [3, 14] has given more encouraging results.

This paper describes a morphological study of the urinary bladder after plastic repair of the organ with a lyophilized bladder homograft.* Such grafts have been used experimentally and clinically, especially in orthopedic and traumatological practice.

EXPERIMENTAL METHOD AND RESULTS

Altogether 22 experiments were performed on dogs. The bladder was replaced by a homograft after resection of $\frac{2}{3}$ of its volume, down to Lieutaud's triangle; in 3 experiments partial replacement of the bladder wall was carried out after excision of a circular portion measuring 5 × 5 cm in the apical region. The graft was wrapped in omentum on a pedicle. The condition of the graft was studied at various periods after transplantation (from 1 to 11 months). Histological investigations were made of the central areas of the graft and its junction with the recipient's bladder.

Ten animals developed peritonitis complicated by liquefaction of the graft. Twelve animals withstood the operation perfectly satisfactorily. After 2 weeks the diuresis regained its normal level. In no case were adhesions formed between the bladder and the surrounding organs. The greater omentum formed a thin shroud around it as far as the junction with the graft. Visually the line where the bladder and graft joined was hardly perceptible. The overall size of the bladder was reduced.

Histological examination 1 month after the operation showed growth of the mucous membrane of the recipient's bladder over the inner surface of the graft, so that is gradually became covered with an epithelium having the features of transitional, although with far fewer layers than in the recipient. The epithelium was infiltrated by leukocytes and its cells had no sharply defined borders — in some places they were destroyed. Beneath the epithelium lay the connective-tissue basement, rich in mucoid substances, especially in their acid forms. It was infiltrated by numerous cells (especially around the blood vessels and immediately under the epithelium). Among the cells were many polyblasts, polymorphonuclear leukocytes, lymphocytes, and plasma cells (Fig. 1). Foci of calcium deposition were seen, and near them were cells resembling osteoclasts or foreign body giant cells.

In the layer corresponding to the muscular layer of the graft zones of lyophilized smooth muscle persisted for a long time. Both from the junction between the graft and the recipient's bladder, and from the side of the enveloping omentum, the zones of lyophilized smooth muscle tissue were invaded by the recipient's fibroblastic (granulation) tissue. This fibroblastic tissue was rich in undifferentiated cells and newly forming blood vessels (Fig. 2). As it grew, in its path it simultaneously liquefied and adsorbed the graft tissue, filled the space thus made available, and then underwent maturation.

* The grafts were lyophilized in the laboratory of the Central Institute of Traumatology and Orthopedics by a method developed at the Institute for the treatment of soft tissues [5].

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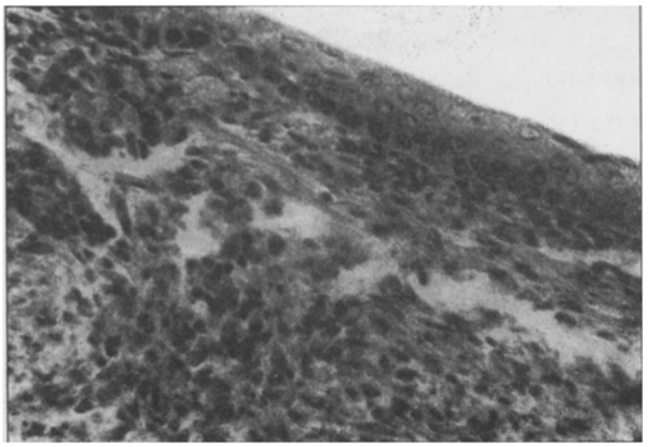

Fig. 1. Epithelization of the graft. Infiltration of the connective-tissue basement. One month after operation. 200 ×.

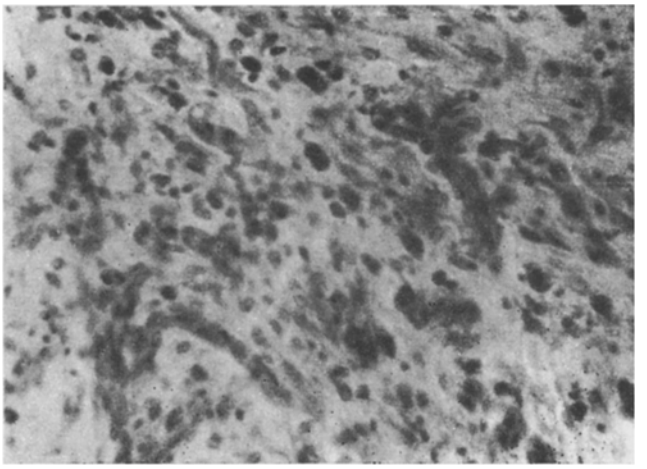

Fig. 2. Fibroblastic tissue growing into the graft from the side of the omentum. Newly forming blood vessels. One month after operation. 200 ×.

As a result of the transformations described above, 4 or 5 months after the operation, the entire inner surface of the graft facing the lumen of the bladder was covered by a mucous membrane. Its connective-tissue basement still remained rich in cells, but fewer neutrophilic leukocytes were present among them. The areas corresponding to the muscular layer of the graft were to a large extent replaced by young connective tissue. At the border with the recipient's bladder, small bundles of smooth muscle fibers were present in this connective tissue, but neither cells of myoblast type nor mitoses were seen in them. It may accordingly be concluded that the connective tissue invading the graft mechanically displaced a certain number of muscle cells. Osteogenesis continued in the graft.

From 8 to 11 months after the operation the graft was smaller in size than initially. Its wall consisted of fibrous connective tissue, covered on its inner side with epithelium closely resembling typical transitional epithelium in its morphological properties. No infiltrating cells were present in this connective tissue. In the foci of osteogenesis the signs of active osteogenesis were clearly visible: an abundance of osteoblasts and of blood vessels of sinusoid type, and the presence of primitive bone marrow between the bony trabeculae (Fig. 3). Small bundles of smooth muscle fibers were present in the connective tissue of the graft, especially at its border with the recipient's bladder.

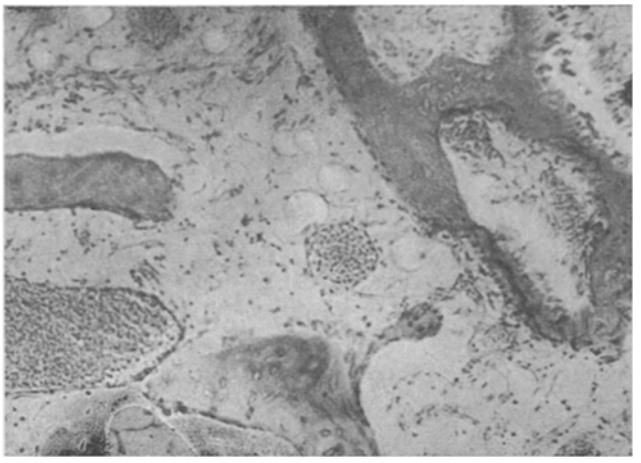

Fig. 3. Formation of bone tissue in the graft. Eleven months after operation. 200 ×.

It may be concluded from the results of these experiments that when the urinary bladder is repaired by the technique described above, the animals tolerate the presence of a large lyophilized graft satisfactorily. The newly formed bladder is capable of fulfilling the function of a reservoir for the urine for a long time.

The progress of the tissue changes in the graft showed a number of special features: foci of lyophilized tissues persisted in the graft; the further from the junction with the recipient's bladder the larger these foci were and the longer the time during which they were observed, especially in the layer corresponding to the original muscular layer of the graft. Parallel with this, the process of replacement of the lyophilized tissues of the graft by the recipient's tissues continued — the graft was invaded by connective tissue and epithelium spread over the surface facing the lumen of the organ. The lyophilized elements of the graft underwent absorption in the course of this process. In the early stage an intensive cellular reaction was observed in the graft, especially in the zone corresponding to the connective tissue basement of its mucous membrane, in the form of infiltration by polymorphonuclear leukocytes and to some extent by plasma cells derived from the recipient. In the late stages after grafting a tendency was observed for this cellular reaction to subside and it changed in character: the predominant cells began to be round cells and lymphocytes. The constant and active process of osteogenesis in the graft is a specific feature of plastic operations with lyophilized homografts, seriously jeopardizing the outcome of the operation. Although many investigations of this problem have been made (5, 11, etc.), the cause of the ossification has not been discovered.

The lyophilized homograft of the urinary bladder is thus a biological skeleton on which the process of replacement by the recipient's tissues may gradually take place. A disadvantage of the method is that only connective and epithelial tissues take part in this replacement, but not muscle tissue, so important to the normal function of the urinary bladder. However, for smaller defects than these created in these experimental models, even replacement of this type can be necessary and well worth while.

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