CONNECTIVE TISSUE OF CAPSULES FORMED AROUND LAVSAN* AFTER PROLONGED IMPLANTATION

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UDC 617-089.843-74:615.468.67

An experimental study of capsules formed around Lavsan mesh prostheses between 7 days and 5.5 years after implantation showed considerable changes in the morphology in metabolism of the connective tissue of the capsule in the course of prolonged implantation possibly attributed to liberation of low-molecular-weight products from the implants which have a harmful action on the tissues surrounding the implant.

KEY WORDS: *endoprostheses; Lavsan; morphology.*

To evaluate allograft material correctly it is extremely important to know not only the original toxicological characteristics of the synthetic polymer, but also the effects which products of biological destruction of endoprostheses may have on the surrounding tissues during long periods of implantation.

The object of this investigation was to study some of the characteristics of the functional state of the connective tissue of capsules of Lavsan mesh prostheses during prolonged implantation.

EXPERIMENTAL METHOD

Mesh prostheses woven from MRTU-26-06-127-67 Lavsan thread were implanted subcutaneously into rabbits weighing 2.5-3 kg. Between 7 days and 5.5 years after implantation the grafts were removed together with surrounding tissues and studied by histological and histochemical methods. The results of investigation of the capsules were compared with the results of the study of a scar formed after mechanical trauma.

EXPERIMENTAL RESULTS

Capsule formation around Lavsan mesh prostheses takes place 3 weeks after implantation. After 1 month the prosthesis is surrounded by a capsule consisting of two separate layers. The peripheral layer consists of elongated fibroblasts and bundles of collagen fibers, oriented parallel to each other along the surface of the prosthesis. In addition, each thread of the Lavsan prosthesis is surrounded by a sleeve of granulation tissue, composed of fibroblasts, histiocytes, macrophages, foreign-body giant cells, lymphocyte-like cells, eosinophils, and neutrophils (Fig. 1). At this stage the capsule is well vascularized. In the peripheral mature layers of the capsule glycoproteins are predominant, whereas in the granulation tissue around the Lavsan mainly acid mucopolysaccharides are found.

After 3 months the number of eosinophils and lymphocytes is increased in the cells of the granulation tissue and more mature connective tissue, and perivascular edema and foci of fatty tissue appear between the threads of the prosthesis; glycoproteins accumulate irregularly in the cells of the granulation tissue and in the granules of the mast cells.

*Soviet polyester (polyethylene terephthalate) — Consultants Bureau.

Laboratory of Polymers in Medicine, A. V. Vishnevskii Institute of Surgery, Academy of Medical Sciences of the USSR, Moscow. (Presented by Academician of the Academy of Medical Sciences of the USSR M. I. Kuzin.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 84, No. 9, pp. 366-368, September, 1977. Original article submitted November 10, 1976.

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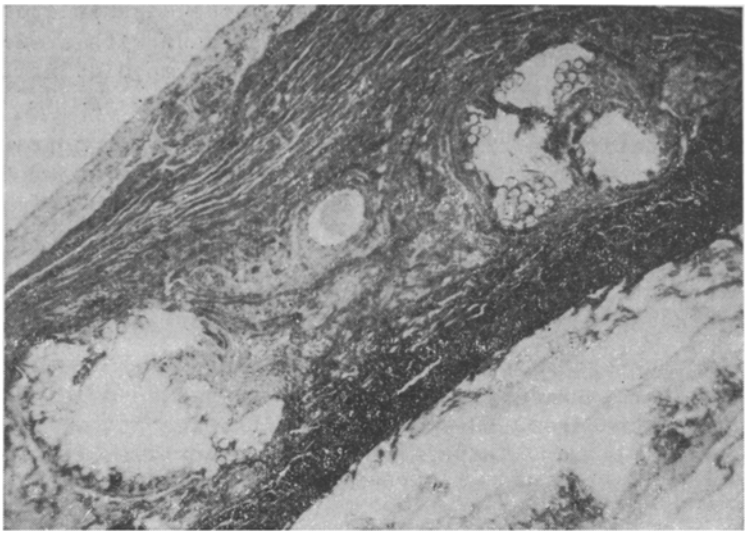

Fig. 1. Capsule around Lavsan mesh prosthesis 1 month after implantation. Inner layer of capsule composed of granulation tissue cells, outer layer of bundles of collagen fibers oriented along prosthesis. Van Gieson, 80 ×.

By 6 months the manifestations of perivascular edema and cellular infiltration (with plasma cells and lymphocytes) are reduced, and the fatty tissue begins to be replaced by fibrous tissue. At these same times, signs of involution of connective-tissue structures appear in the mature layers of the capsule. Glycoproteins predominate among the mucopolysaccharides. Hyaluronic acid, irregularly distributed as grains and in the diffuse form, can be seen in the layers of young connective tissue and in the granulation tissue between the lateral surfaces of the Lavsan thread. In the immediate proximity of the Lavsan sulfated forms of acid mucopolysaccharides accumulate. In the granulation tissue a low level of phosphatase activity remains, that of alkaline phosphatase being higher.

Fig. 2. Capsule around Lavsan mesh prosthesis 5 years after implantation. Mass of mature connective tissue is edematous, loose in structure, and discontinuous in places. Islands of fatty tissue can be seen. Small quantity of granulation tissue lies between Lavsan threads. Hematoxylin–eosin, 200 ×.

In the next stages of implantation (up to 2 years) the capsule around the Lavsan mesh prosthesis is composed of completely viable connective tissue with a small quantity of granulation tissue near the Lavsan. Perivascular foci of lymphoid infiltration are seen only occasionally near the Lavsan threads.

Two years after implantation an irregular accumulation of glycoproteins and acid mucopolysaccharides starts to appear in the substance of the capsule. Metabolic disturbances are accompanied by changes in the morphology of the capsules. Foci of fatty tissue appear in the substance of the capsules. Partial fragmentation of bundles of collagen fibers is reflected in changes in the staining properties of the collagen (the appearance of a yellowish color on staining by Van Gieson's method and a decrease in resistance to collagenase). The capsule at these times is still moderately well vascularized.

With an increase in the period of implantation (after 2.5–3 years) thrombosis is observed in some vessels of the capsule. Many vessels are replaced by scar tissue and, although as well as atrophy of the vessels some new capillaries are formed, the number of normally functioning vessels is less than in the earlier periods of implantation. The layer of mature connective tissue in the capsule becomes thinner and looser in texture and fragmentation of the bundles of collagen fibers is intensified. Most mucopolysaccharides are acid in type. A moderate amount of glycoproteins is also detectable. Alkaline phosphatase activity remains in the endothelium of only some of the vessels. No acid phosphatase can be found. The distribution of the substances tested for at these times was characteristically uneven.

In the late stages of implantation, up to the final period of observation (5.5 years), the fibers of the Lavsan mesh prosthesis are surrounded by a layer of mature connective tissue and a small quantity of granulation tissue with macrophages and foreign-body giant cells insinuated between the individual Lavsan filaments. Zones of fatty tissue still remain in the body of the capsule. The mass of mature connective tissue is loose in texture, irregular in thickness, and discontinuous in places (Fig. 2). When stained by Van Gieson's method the bundles of collagen fibers appear yellowish in color. Besides dying vessels, newly formed capillaries can also be seen. The distribution of mucopolysaccharides in the tissue of the capsule is irregular. The acid mucopolysaccharides are predominant. Phosphatase activity is low. Alkaline phosphatase is a little more active than acid, in the endothelium of the blood vessels, and in the granulation tissue.

The scheme of interaction between Lavsan mesh implants and the tissues of the body in the initial period of implantation thus corresponds to the general scheme of a foreign body reaction and it ends with encapsulation of the protheses. The slow destruction of the allograft can be assumed to be accompanied by liberation of low-molecular-weight products which have a harmful action on the tissues surrounding the prostheses.