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Foreign Body Reaction Associated With Diamond-Like Carbon Coated Surgical Polypropylene Meshes.

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ABSTRACT

The work represents results of experimental and clinical investigations of tissues foreign body reaction with diamond-like carbon (DLC) coated surgical polypropylene meshes. It was determined that in comparison with other similar material, DLC surgical meshes had better biocompability and biointegration into the close connective tissue of the anterior abdominal wall of rats while encapsulation 180 days after enthesis (thickness of foreign body granulema in groups DLC and PP – 55.7±5.6 and 115.2±11.7 and μm, respectively, p=0.005; foreign body giant cells – in DLC group are absent at all the examination terms, ine PP group – 5.34±0.64 across one fiber section of implant).

Keywords: hernia mesh, diamond-like carbon, foreign body granulema, foreign body giant cells.

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INTRODUCTION

Application of different means for plastics of anterior abdominal wall by using synthetic materials made a breakthrough in herniologie and became a "gold standard" in ventral hernia repair [1, 2]. Nevertheless, in the recent times, in literature there are more and more information that hernia mesh started the series of complicated histopathological processes being the body response reaction to the foreign body enthesis [3-8]. Body reaction to implant is mainly determined by its surface behavior: chemical composition, structure and morphology [9]. In this regard, existing means for regulating biological properties of medical goods are directed to change physical and chemical properties of the surface by using physical, chemical and physical-and-chemical methods of modification.

METHOD

The work is performed at 120 laboratory rats Wistar, 2.5-5 months old, 250-300 g weight. The main group (n=60) comprised animals with enthesis of DLC coated surgical polypropylene meshes. Control group (n=60) comprised animals with enthesis of polypropylene (PP) meshes without coating. Prostheses (1.5×1.5 cm) were placed aseptically under skin without additional fixing. Animals were removed from the experiment at the 7th (n=20), the 21st (n=20), and 180th (n=20) day in each group respectively. Samples preparation for histologic study and microslide production are performed at the certified equipment of Leica (Germany) company.

MAIN PART

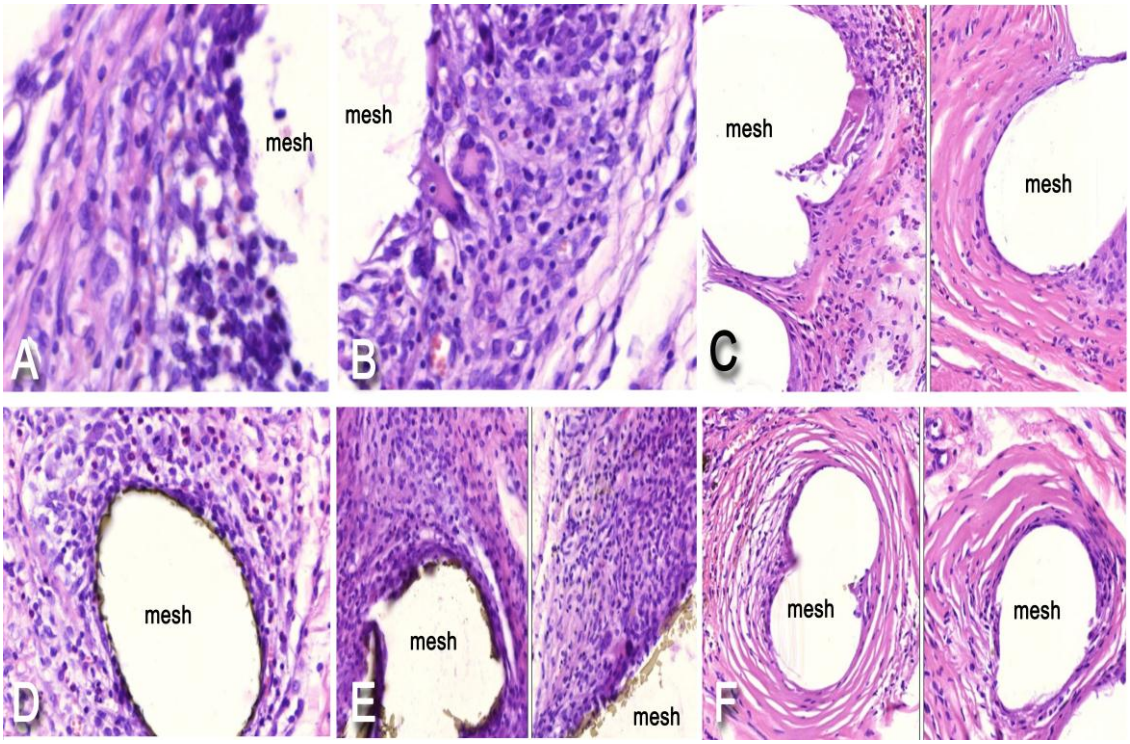

Figure 1: Foreign body reaction associated with underskin enthesis of polypropylene meshes in experimental animals (A, B, C – PP group at the 7th, 14th, and 180th day after operation respectively; D, E, F –DLC group at the 7th, 14th, and 180th day after operation respectively; mesh – fiber cross section of the mesh prosthesis). Coloring with hematoxylin and eosin. Photomicrography. × 400.

In PP (control) group, at the 7th day after operation, a zone of infiltrating cells appeared (there is predomination of polymorphonucleocytes – 45-60%, small lymphocytes-type cells – 20-25%, hystiocytic elements – 20-25%) (Fig. 1A). In the internal infiltrate layer, there are giant multinucleate cells of foreign bodies. Not numerous cells of new fibroblast type are detected in the infiltrate external zone. Capillary tubes within the infiltrate are evenly spread, are located concentrically around the mesh structures of implant. 14 days after operation, granulation tissue is formed around the implant, initial signs of foreign body granulema.

Infiltrate comprises inflammation elements (polymorphonucleocytes, lymphocytes, hystiocytic elements) making together about 40-60%. Among lymphocytes, there are polymorphonucleocytes (mainly eosinocytes) and lymphocytes (15-20% of each) in equal amount. Around implant, there are giant multinucleate cells of foreign bodies (Fig. 1 B). 180 days after enthesis, at all the surfaces, there is a formed connective tissue in the shape of capsule of 115.2±11.7 μm thickness (Fig. 1 C). Its structure is not even. There is predomination of the formed dense fiber, partially vitreous, connective tissue with few cells of fibrocyte-type. In the interweaving zones of implant elements, there is moderate leucocytic infiltration with great contents of eosinocytes. In the same zones, there is a moderate amount of blood capillaries. Sheets of epithelioid hystocydes are located in segments at the capsule internal surface. In DLC group, at the 7th day after operation, around the implant, there is an even zone of granulation tissue with less density of cell composition in comparison with PP group (Fig. 1 D). Infiltrate width is 100-150 mcm, there are fibroblasts (55-70%), leucocytes and hystiocytic elements (30-45%). At the 14th day, a regular layer of granulation tissue is formed around the implant (Fig. 1 E). There is predomination of fibroblasts (60-70%), leucocytes in equal amount (10-15%) are represented by polymorphonuclear elements and small lymphocytes, hystiocytic elements make 5-10%. In 180 days, there is a completed encapsulation of material (capsule thickness is 55.7±5.6 μm) (Fig 1. F). Elements of inflammation infiltrate, epithelioid hystocydes at the capsule internal surface, and foreign bodies giant cells are absent.

AFTERWARDS

In order to improve biocompability of medical implants, diamond-like carbon meshes became widely used. Thanks to their high hardness, low friction factor, chemical inertness and good biological properties, diamond-like carbon meshes are used for covering implants being in contact with blood (heart valve, blood vessels prostheses, stents) and operating at great loads (major joints prostheses, tooth implants, etc.) [10]. Our investigations of tissues reaction to enthesis of mesh polypropylene endoprostheses for surgical repair of ventral hernia with DLC covering compared to the similar material without this covering have discovered considerable differences. They were determined at the 7th day after enthesis and were marked by earlier formation of fibroblast element. At the 14th day, fibroblasts with morphological signs of functionally active forms made 60-70%; there were formed zones of shapeless and fiber components of intercellular substance. One of the main difference was absence of macrophages and formation of foreign body's cells at all the terms of giant cells transformation of [11-13].

CONCLUSIONS

Meshes for surgical hernia repair with DLC coating in comparison with similar material without such coating have better biocompability and biointegration into the close connective tissue of the anterior abdominal wall of rats after enthesis.

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