KnE Materials Science

SMBIM Conference Proceedings
Shape Memory Biomaterials and Implants in Medicine (2017), Volume 2017

Knowledge E
Engaging minds

Conference paper

Peculiarities of Interaction Deserosed Organ and the Parietal Peritoneum of the Implants with Porous NiTi (Experimental Study)

A.N. Vusik[1], G.Ts. Dambaev[1], I.V. Suhodolo[1], V.E. Gunther[2,3], V.V. Skidanenko[1], M.V. Shvedova[1]*, V.R. Latypov[1], N.E. Kurtseitov[1], N.A. Vusik[1], N.Yu. Fimushkina[1]

*Corresponding author:
M.V. Shvedova, email: shvedovamv55@gmail.com

[1] Siberian State Medical University, Tomsk, Russia
[2] Tomsk State University, Tomsk, Russia
[3] Research Institute of Medical Materials and Implants with Shape Memory, Tomsk, Russia

Received: 23 March 2017
Accepted: 9 April 2017
Published: 16 July 2017

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the SMBIM Conference Committee.

OPEN ACCESS

1 Introduction

We studied some patterns of interaction porous NiTi implants with parietal peritoneum and deserosed gland, liver and the diaphragm in an experiment, and in the period from 7 to 160 days. We described the stages fill the newly formed tissue implant and characterized this structure , given the structure of the newly formed tissue characterization based on the study of its histological structure, data, electron microscopy and thin sections studies using Metallurgical Microscopes.

Experimental and clinical studies in traumatology, maxillofacial surgery, vascular surgery, operative gynecology proved that made from superelastic alloys on the basis of the TiNi, porous implants are biologically inert, quickly germinate border fabrics, not subject to corrosion and can be subjected to an alternating strain which does not exceed 2% for several million cycles without breakage. Capillary action defined pore diameter is shown rapid impregnation of the cavernous structure of the implant tissue fluid. As a result, the entire inner surface of the implant, the area is much greater than its external dimensions, it becomes a matrix for migrating and breeding here cellular elements. The character formed in the pores of the implant tissue is evaluated differently. Most believed that connective tissue implant germinate, regardless of with which organs and tissues it borders. Some studies indicate that migrating into the pores of the cellular elements of the implant may

have different tissue accessory (e.g., osteoblasts), which leads subsequently to the formation of appropriate pores (e.g., bone) tissue. [1, 2, 3].

2 Experimental

The objective of the study was to examine patterns of germination experiment of porous implants from superelastic alloys based on TiNi peritoneum and omentumdeserosed surface, the liver and the diaphragm.

Studies carried out on laboratory animals 58. Ten rats and rabbits six performed a laparotomy, the fixation of the implant to the porous diaphragm. Ten rats and rabbits were performed laparotomy twelve, porous implant fixation to the liver. Five rats performed a laparotomy, a porous implant fixation to the parietal peritoneum along the right side channel. Patterns of germination of the implant in the groups listed in the terms traced to 160 days. Ten rats and five rabbits were performed laparotomy, porous implant fixation to the greater omentum. Patterns of germination implant traced in terms of up to 84 days.

Under anesthesia performed Upper midline laparotomy. Used for implantation of porous TiNi implants of oval plates 0.5 sm in diameter, thickness 0,05-0,08 sm previously sterilized in 96 ° alcohol. Location overlay implant thoroughly rubbed rough gauze ball for deserosed surface (except in cases where the implant was recorded specifically to the peritoneum). On deserosed hepatic portion of the diaphragm or the greater omentum was fixed porous implant. The wound is sutured in layers.

3 Results and discussion

Grossly, starting from the 7th day, between the porous implant and the biological tissue appeared loose, easily shared planar adhesions. As the post-operative period seam became increasingly durable character and, starting from 20-25 days, they can be divided only by acute. At all stages of implant fixation research in the area there was no macroscopic signs of inflammation (edema, vascular injection).

For microscopic examination climbed porous implant is fixed thereto tissue site. Complex implant tissue was fixed 24-48 hours in 12% formalin solution, followed by:

- soft-tissue component is cut off with a razor strictly on the border of "tissue-implant", made his coloring with hematoxylin-eosin and Einarson coloring with subsequent histological examination;

- fragments of tissue with a sharp object removed from the pores of the implant and, after appropriate training, have been studied by electron microscopy;

-porous implant sprouted its tissue sections were prepared and their subsequent study on metallographic microscope "Epitip".

Given the complexity of the histological studies and morphological verification tissue growing into small (millimeter) the pores of the implant, we have formed a set of tissue samples (peritoneum, liver, diaphragm, omentum). Tissue samples were fixed in 10% formalin, embedded self-hardening plastic "Protakril-M" and polished on a grinding machine using the skins of different grits, and then examined and photographed in reflected light on the metallographic microscope "EPITIP" with increasing X90-h360 as well as and thin sections of porous implants.

The study submitted tissue samples showed that the study by using metallographic microscope in reflected light reveals the specific organ and tissue structure: fine-grained - for liver, mesh - for the fat part of the greater omentum.

Patterns of germination biological tissue cavities of porous implant shown in Fig. 1-6 for example, the gland and liver. The data suggest that even at 7 days in the pores of the implant defined areas of tissue that have no apparent resemblance to the "prototype" (cloth, bordering the implant), operating since the lumen is not more than 15-20% (Fig. 1, 4). The remaining free part of the pores of the implant most likely soaked tissue fluid. Subsequently, the process of filling pores intensive biological tissue, and the 24th-40th days filled cloth is not less than 35-40% of the internal volume of the implant in terms of 60 days or more pores of the implant are filled with 85-90%. At this point, the newly formed (or sprouted) fabric has undeniable similarities with the "prototype" in many fields of view; it has its own structure (Fig. 2, 3, 5). In the more remote (up to 160 days) as possible, the process of filling the internal structure of biological tissue implant, although in these times of 5-10% of the internal volume of the implant remains blank (Fig.6). One can not, however, exclude the possibility that spaces in the cavities, visible in photographs (Fig. 3, 6) in the later periods after implantation are associated with retraction of tissue during fixation in formalin or mechanical damage to the specimen are explained in preparing thin section.

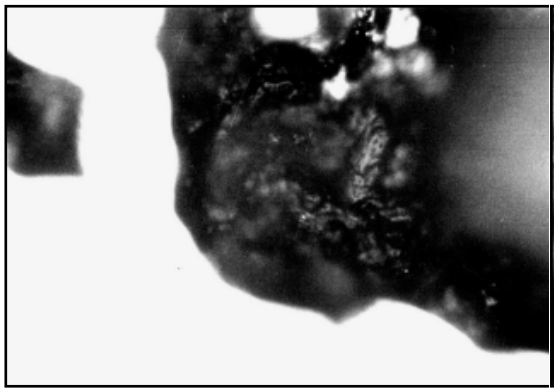


Fig. 1. Fig- thin section from the porous implant TiNi 7 days after implant fixation to the greater omentum rats. Incr. h720

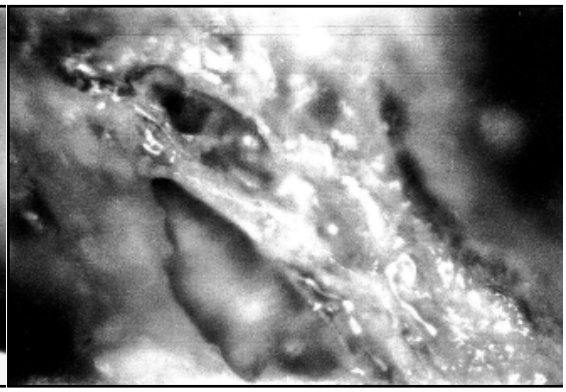


Fig. 2. Fig- thin section from the porous implant TiNi 24 days after implant fixation to the greater omentum rats. Incr. h360

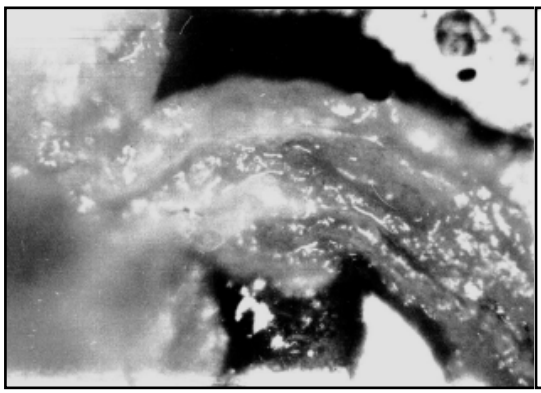


Fig. 3. Fig- thin section from the porous implant TiNi 40 days after implant fixation to the greater omentum rats. Incr. h360

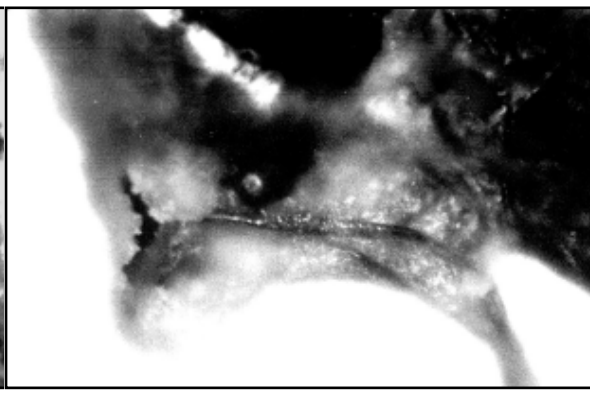


Fig. 4. Fig- thin section of a porous implant of TiNi on the 7th day after the fixation of the implant to the rat liver Incr. h360

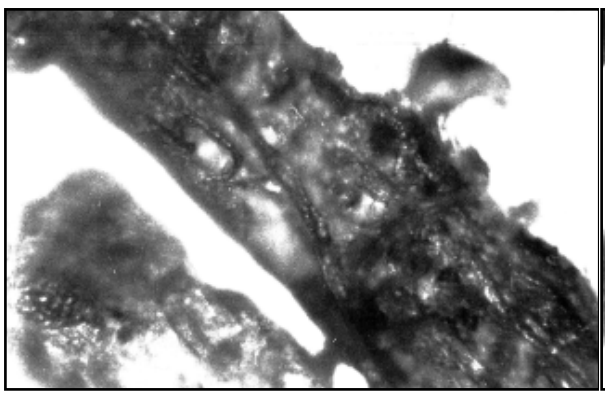


Fig. 5. Fig- thin section from the porous implant TiNi 40 hours after fixation of the implant to the rat liver. Incr. h360

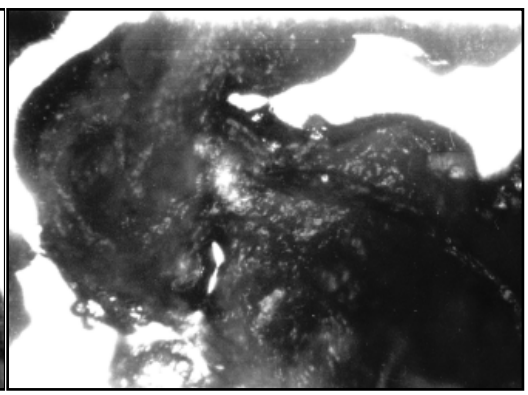
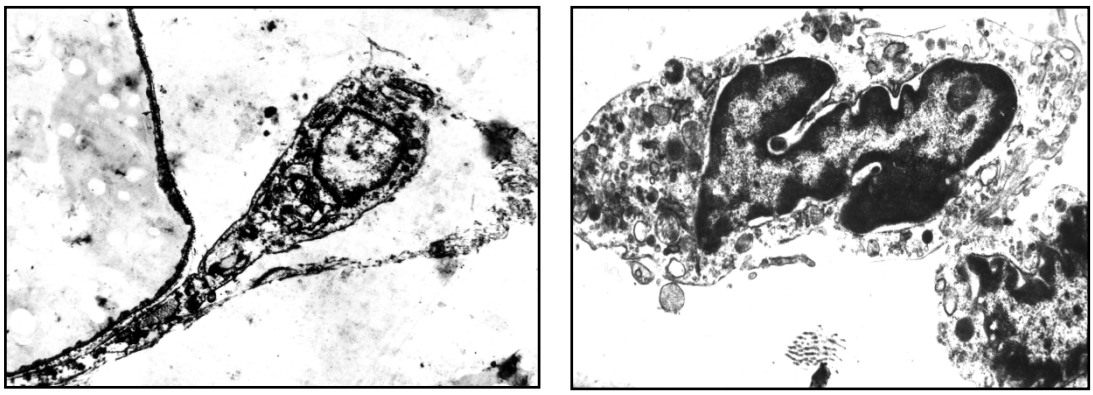


Fig. 6. Fig- thin section from the porous implant TiNi 160 days after the fixation of the implant to the rat liver. Incr.h360

Histological examination of the contents of the implant since the early (20-24 days) postoperative period indicates the predominance in the tissue "germs" fibroblasts, pericytes, and macrophages (Fig. 7, a, b). In this period is an already well defined blood capillary (Fig. 8). The base material of tissue "germ" clearly defined fibrillar structure with a predominance of collagen fibers (Fig.9).

After 40-45 days, in addition to the above elements, contained in the cavities of the implant centers of the newly formed tissue activated processes of vasculogenesis. The capillaries become typical somatic symptoms, their number increases considerably (Fig. 10). In addition, starting at the specified terms, as a part of the tissue "germs" easily identified elements of the "mother tissue": striated muscle fibers and fat cells when frenopeksy at omentopeksy (Fig. 11, 12).

In the long-term period after the start of the experiment (160 days) of the implant pores of 85-90% are newly formed tissue. The latter includes fibrous and cellular elements of connective tissue, blood vessels, adipose tissue (in cases omentopeksy) and striated muscle tissue (in cases frenopeksy). Morphofunctional state of the specific cellular elements identified in the pores of the implant, assessed as a whole as usual. The only exception is the presence of different size vacuoles in the sarcoplasm of striated muscle. This is probably due to the lack of implementation of the specific tissue functions. It is noted that in long-term follow, along with the "mature" elements maternal tissues and vessels in the tissue "germ" is still detected newly formed capillaries (Fig. 13).



a b

Fig. 7. The electron fragment newly formed tissue in the implant pores of TiNi through 20 days after the fixation of the implant to the liver: a - fibroblasts in the connective tissue basic substance, incr. h3600; b - monocyte in the connective tissue basic substance, incr. h10.000

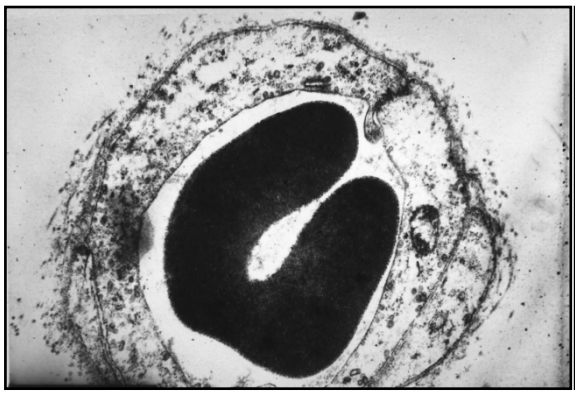


Fig.8. The electron fragment of the newly formed tissue in the pores of the implant from TiNi. Capillaries in tissue germ on the 20th day after the fixation of the implant to the porous diaphragm. Incr. h14.000

Fig. 9. The electron fragment of the newly formed tissue in the pores of the implant from TiNi. Collagen fibrils in the tissue germ 20 days after fixation of porous implant to the greater omentum. Incr. h7200

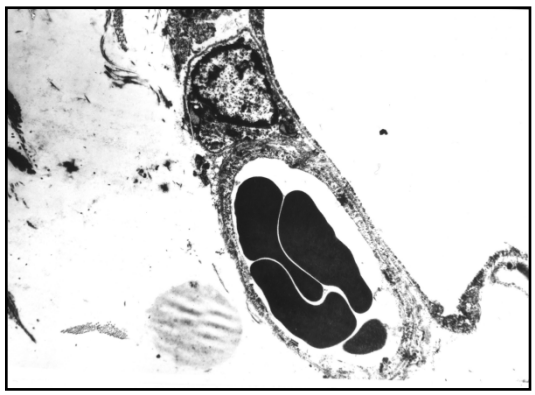


Fig. 10. The electron fragment of the newly formed tissue in the pores of the implant from TiNi. Capillaries somatic type is in 45 days after fixation of the implant to the liver. Incr.h 600

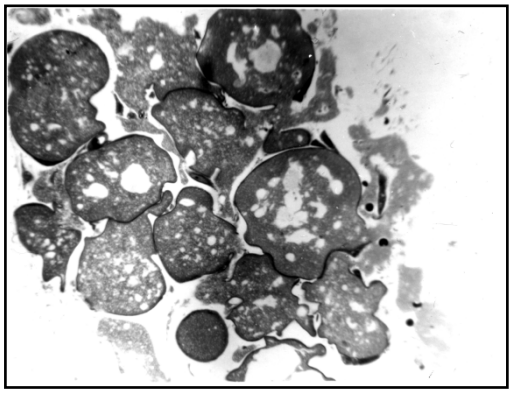


Fig. 11. Semifine slice tissue fragments that fills the pores of the implant TiNi on the 100th day after the fixation of the implant to the diaphragm. Visible striated muscle tissue with a large number of vacuoles in the sarcoplasm myocytes. Stained with toluidine blue. Incr. h180

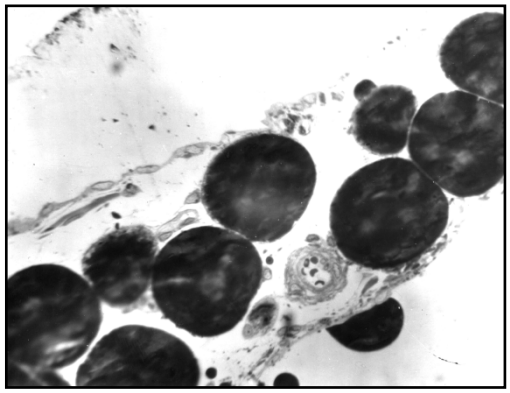


Fig. 12. Semifine cut fabric piece that fills the pores of the implant TiNi 120 days after implant fixation to the seal (visible adipose tissue). Stained with toluidine blue. Incr. h180

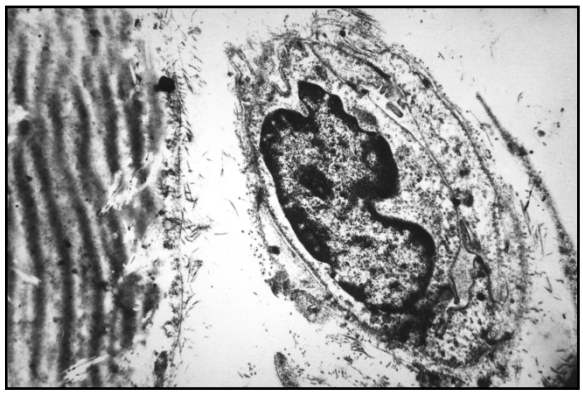


Fig. 13. The electron fragment of tissue through 160 days after the fixation of the implant porous TiNi to the gland. We can see formed in the tissue "germs" capillary. Incr. h7.300

4 Summary

Porous implants made of superelasticTiNi actively grow biological tissue when they are implanted in the abdominal cavity and fixation to the liver, diaphragm, omentum, parietal peritoneum:

- complete filling of the implant since the newly formed biological tissue occurs landmark: in time for 7-10 days with a cloth filled with 15-20% of the internal volume of the implant has, in terms of 40-45 days – 60%, in terms of 60 days or more – 85-90%; 10-15% of the internal volume of the implant remains unfilled cloth always;

- the process of filling the pores of the implant biological tissue occurs as by tissue ingrowth on a plane "Border tissue - implant", and due to the formation in the pores of the implant new lesions not associated with the "parent" body;

- newly formed in the pores of the implant biological tissue is mixed in the structure: along with fragments of connective tissue in the pores of the implant revealed fragments of adipose tissue (at omentopeksy) and striated muscle tissue (if frenopeksy); the newly formed fragments of liver tissue in the pores of the implant during all periods of observation are not available; feature of the newly formed tissue is a high degree of vascularization, and actively proceed neovaskulogenesis processes and long-term follow.

References

[1] I.G. Kutsenko, Plastic defects recto-vaginal septum porous NiTi, Dis.... cand.med. Science [in Russian], Tomsk, 1995.

[2] A.K. Dubrovsky, Complex treatment of chronic diffuse liver diseases, Modern problems of surgical hepatology, in: Proceedings of the Fourth Conference surgeries-hepatologists, (1996) 440.

[3] V.E. Gunther, V.I. Itin, L.A. Monasevich, Y.I. Pascal et al., The shape memory effect and their use in medicine [in Russian], Science, Novosibirsk., 1992.