Conference paper

Ultimate Venous Hemostasis Method

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Abstract

Porous nitinol plate germinated by nerve, connective tissue cells and capillaries is biomechanically and biophysically compatible with vein based on study above. It becomes a mechanical carcass to form a blood vessel wall in defect area, so designed technic provides fast and safe hemostasis with bloodstream recovery.

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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.

Introduction

The problem of effective great vessels damage management was and still is one of most actual objectives of emergency surgery. Vessel injuries mostly associate with extremity trauma and penetrative abdomen injury. Lack of time for performing emergency surgery is the main feature of such cases. Isolated injuries of great veins take up to 30.5% in structure of total injuries quantity, combined ones from 22.1% to 84.7% at peacetime and from 3.7% to 41.7% at wartime. Trauma of long tubular bones connected with artery injury in 63% and vein damage in 100% cases [1]. Specific cases include iatrogenic injuries during laparotomic or laparoscopic operations next to major veins and mistakes during any diagnostic or medical procedures associated with catheter injections. The necessity for emergency vessel reconstruction may arise in any surgical or traumatological hospital. Such surgical interventions are performed in urgent conditions, they directed to the fastest hemostasis and to provide blood vessel passability for extremity (organ) conservation and sometimes a patient's life.

Surgery of veins has some specific features because of low pressure in veins, slow bloodstream through them, «tenderness» of the wall and predisposition to thrombosis. Significant technical difficulties, damages during operation and risk of severe complications are main reasons of discreet attitude towards reconstructive major vein operations. There are a lot of techniques of blood vessel defect closure: from various methods of vascular suture, usage of autotransplant and xenotransplant to different alloprostheses. Large vein suture is incomparably harder than artery suture. Frequency of postoperative major veins thrombosis fluctuates from 20% to 50% and more. Each method has its own advantages and disadvantages. Generally,

How to cite this article: S.V. Bystrov, A.O. Ivchenko, O.A. Ivchenko, A.I. Chiryev, E.V. Gavrilin, (2017), "Ultimate Venous Hemostasis Method," in *Shape Memory Biomaterials and Implants in Medicine*, KnE Materials Science, page 436–439. DOI 10.18502/kms.v2i1.831

outcomes after surgical treatment of vein trauma still remain unsatisfactory, mortality rate is from 4.3% to 50.3% [2].

One of directions to find a solution of this issue is usage of implantable materials. It is necessary to overcome the problem of biomechanical compatibility at the border between implant and patient's tissue for long and durable functioning of implant. Prostheses consisting of nikelid-titan based composites satisfy the demands. They have optimal combination of specific weight, strength, plasticity and demonstrate high elastic properties. Living tissues easily germinates and function in nikelid titanium porous structure. Thanks to that fact, wide possibilities of using them in different medical fields including vascular surgery are opened.

1 Experimental

The aim of this study was to develop a closure technique of major veins defect using nikelid titanium porous plate in case of mechanic injuries. Plasty of vein wall defect was carried out by nikelid titanium plate with adjusted physic and geometric characteristics regarding to the blood vessel wall. The plate had 1.5 times bigger length than defect and had 1/3 or 1/2 of vessel circumference. The trough-like plate with 0.4mm thickness, 60±2% porosity and 50-500 mcm diameter pores was used. Porous surface of the plate provide its roughness that contributes to adhere the plate to vascular adventition.

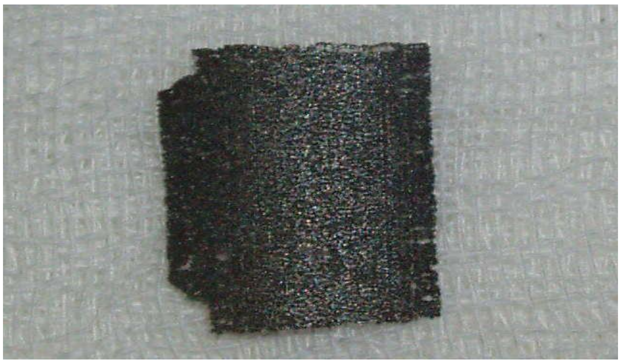

Figure 1 – Porous nikelid titaium plate for inferior vena cava defect closure.

Plasty was performed on defect of inferior vena cava infrarenal part (Fig.2).

Tests by using section were performed in 1.5 and 3 months after surgical intervention to analyze regeneration and to control germination through pores of nickelid titanium plate. TiNi porous plate strip was visualized on the surface of section (Fig. 3).

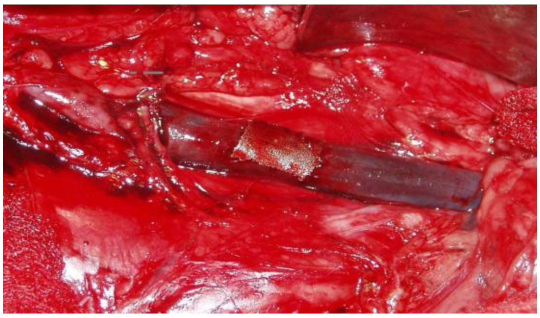

Figure 2 – Inferior vena cava defect is closed by porous TiNi plate

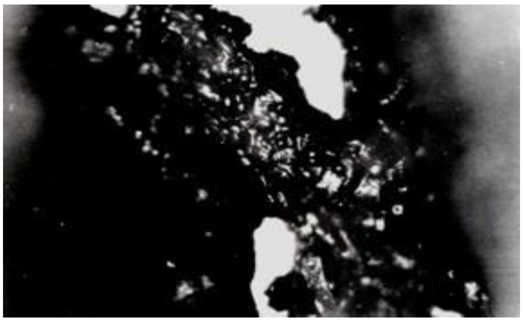

Figure 3 – Microsection of TiNi porous plate

2 Results and discussion

Tissue germinates through pores of implant in 1.5 months after operation, but connection between them is weak. Surrounding implant tissue and newly formed tissue in implants pores have different contrast and structure. After 3 months the tissue in pores is well-formed and matches up with mature one; the tissue copies relief of pore, interacts with their walls well and has a strong connection. Basically, the tissue completely fi ls pores, however, emptiness in the center and near pores wall is observed. Structural fi e of tissue is identical in almost all of pores. Durable connection is registered on boarder between implant and living tissue. Observing for neointima development dynamics, we noticed that precise differentiation of cells and tissues is directly proportional to postoperative time. Functional layer composed of musculo-elastic fi es locates under epithelial cells that cover most of the internal capsule surface in 1.5 months. Connective tissue tightly fi ls plate pores, blood vessels are indicated and free nerve endings appear by this time. Lack of infl tion around porous plate is also noticed. Complete neointima development ends in 6 months after operation. Unlike other plastic materials elastic porous plate that biophysically and biochemically compatible creates a durable carcass of new blood vessel wall and is not. There are no thrombosis in any sections made in different time.

Summary

TiNi porous plate germinated by nerve, connective tissue cells and capillaries is biomechanically and biophysically compatible with vein based on study above. It becomes a mechanical carcass to form a blood vessel wall in defect area, so designed technic provides fast and safe hemostasis with bloodstream recovery.

Acknowledgments

TiNi-based medical materials and implants (porous plate) were developed and manufactured at the Research Institute of Medical Materials and Implants with shape memory (Tomsk).

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