Vascular prosthetic devices

Biological prosthetic devices

Transplants from non-vascular tissues

The creation of vascular prostheses from other than vascular tissue became the subject of research by many workplaces in the second half of the last century. The purpose was to find an adequate replacement for vessels with small lumen and low flow. The experiments were performed mainly on dogs and pigs with an attempt to use pericardium, muscle tissue, peritoneum, ureter, diaphragm or small intestine. Most surgeries resulted in rupture or thrombosis within a few weeks. The use of these xenografts has also proved problematic due to the time and technical complexity of creating a suitable prosthesis.

Arterial allotransplants

The use of arterial allotransplants increased at the end of the last century, mainly due to the development of modern immunosuppressants and the establishment of the banks for storage of processed transplants. The arterial stem from aorta descendens to arteria femoralis is most often used for transplantation.

Allotransplants are stored at a low temperature of 1-4 ° C. Subsequently, antibiotics and heparin are added to the prepared grafts. They are normally used within 48 hours, but can be stored for up to 30 days.

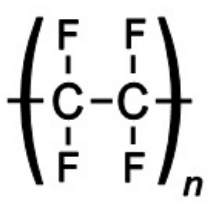
Artificial vascular prostheses

Artificial vascular prostheses are commonly used as bypass in peripheral stenosis operations or to access the bloodstream for hemodialysis. Their length is limited for prostheses with diameter less than 10 mm, so they are not used for myocardial revascularization. The basic precondition for their applicability is the biological compatibility of the recipient with their material. These are usually bioinert polymers - Teflon (polytetrafluoroethylene) and dacron (polyethylene terephthalate), rarely polyurethane (Lycra), in the clinical study stage is the use of polyetherurethane urea for small-diameter prostheses. When used in areas of the body caudally from the ligamentum inguinale, the use of artificial prostheses has worse results than autologous biological prosthesis. However, sometimes a suitable blood vessel is not available in the patient and in that case Teflon replacements are used. Artificial vascular prostheses are sometimes crimped (transversely constricted), which helps to bend the prosthesis more easily and reduces the risk of constriction, but increases flow resistance and the risk of thrombus formation. There are currently several types of vascular replacements on the market from various companies, based on both Teflon and dacron with bound carbon or heparin to reduce the risk of thrombogenesis. At the testing stage, attempts are being made to use hirudin, tissue plasminogen activator or other substances. It is also possible to cultivate endothelium cells on an artificial replacement or to bind nitric oxide to the replacement. The individual replacements also differ in the degree of porosity.

Physical properties

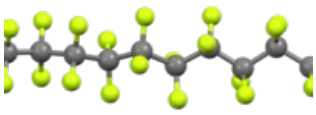
The most important physical properties of healthy arteries are strength and flexibility. These are mainly influenced by the proportional representation of the three basic layers of the arterial wall, which change considerably during the artery. Another parameter that can affect these properties is the fixation of the arteries to their base, or various pathological phenomena - especially arteriosclerosis. In the case of vascular prostheses, it is necessary to maintain, above all, strength in order to avoid ruptures, as well as flexibility in terms of pressure regulation. Other parameters can be influenced by choosing a suitable graft, which is divided according to the method of production into woven and knitted, made of dacron, and cast Teflon prosthesis. In terms of strength, currently used artificial prostheses usually achieve much better or at least the same parameters as a healthy blood vessel in a given place. However, the elasticity, expressed by the compliance value, which reaches values around 6 for arteries, is only about 4.5 for vena saphena magna autograft, about 1.5 for dacron and 2 for Teflon.

Polytetrafluorethylene (teflon)



Polytetrafluorethylene formula

Polytetrafluorethylene (PTFE) is known under its original trade name as Teflon. It is a white, highly *hydrophobic thermoplastic fluorocarbon* ', its coefficient of friction is the third lowest of all known substances, it is also an excellent dielectric. For the purpose of construction of vascular prostheses, its flat-shaped form with the trade name "Gore-Tex" is used. The smooth walls of PTFE prostheses are less thrombogenic than in the case of dacron, but at the same time they must be reinforced due to the higher risk of strangulation. Due to the production by casting, these substitutes are minimally porous. As a result, they do not grow into the tissue and are not even covered with fibrin, which is of no practical importance for their durability in the patient's body. This material is usually used for prostheses with a

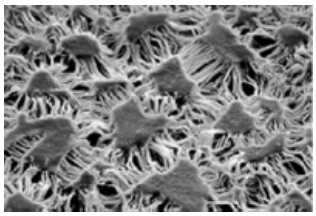


Structure of polyethylene

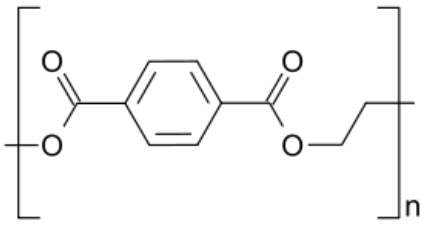
diameter of less than 10 mm, where a possible post-implantation reduction in flow rate plays a greater role and at the same time flexibility is not a priority. It can also be used together with your own blood vessel as a composite replacement.

Samples of vascular prostheses made from Gore-Tex

Polyethylene terephthalate (PET, PETE, PES), under the trade name Dacron, is a "thermoplastic polyester" with an extensive use in the textile industry and as a packaging material in the food industry. Vascular prostheses are made from its fibrous modification, they are either *knitted or woven* '. Knitted prostheses are more porous and they bleed more, so their breathability must be temporarily regulated by blood clotting the patient. On the other hand, woven prostheses can be frail, so the choice of a specific model is a matter of choice for the surgeon. Dacron prostheses are used for large vessel operations, especially aorta in its entirety. There are currently dacron substitutes on the market with an inner wall coated with collagen, gelatin or albumin to reduce blood loss or with antibiotics to eliminate the risk of infection.



Structure of Goretex in scanning electrone microscope



Polyetylen-terephtalate formula

Complications of the use of vascular prostheses

- Obstruction of the prosthesis - often caused by hyperplasia of neointima, scarred vascular tissue
- Infection of the prosthesis – rare complication (1–2 %) with very serious consequences. It usually occurs during the surgery. It often requires reoperation and removal of the prosthesis.
- Aneurysm in the place of anastomosis – caused by partial or complete rupture of the anastomosis. They are usually asymptomatic, but can cause problems by opression of surrounding structures. The remedy is to insert a short bypass.
- Erosion extending to adjacent structures - such as aortoenteric fistula - usually occurs months to years after the introduction of the vascular prosthesis. The possibility of a diagnosis of aortoenteric fistula should be considered in any patient with a vascular replacement in the abdominal area and with bleeding into GIT.

History of vascular prosthetic devices

The development of vascular prostheses has been recorded since the end of the 19th century. In 1898, Jaboulay and Briau first used an arterial transplant in experiments on dogs. In the same year, he used the first venous autograft Gluck. In 1906, the first resected bulge of the arteria poplitea was replaced with a transplant from the vena poplitea. In 1907, an autograft from vena saphena magna was used as a replacement for a resected bulge on subclavian artery. Fresh arterial allotransplants were also experimented with at that time. Although their results were promising, they were not used in the practice at the time. Gentlemen Carrel and Guthrie, who were working on how to preserve arterial allografts, wanted to change that. Their research laid the foundations of the field, which began to develop several decades later.

A major point in development was World War II, during which great progress was made in materials, anesthesia, anti-infective measures and patient care. Attention in vascular prostheses has turned to preserved arterial allografts. In 1945, Blakemore and the Lord proposed the establishment of a vascular bank. It was not founded until three years later by Gross, who in the same year replaced the resected coarctation of thoracic aorta with a preserved arterial allograft. In 1951, Kunlin began a very successful era of venous grafts, which are still used successfully. In the following years, biological as well as artificial vascular prostheses progressed. At present, vascular prostheses are an integral part of vascular surgery.

Links

Related articles

- Arterial reconstruction
- Bypass

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