

SELF-EXPANDING VASCULAR ENDOPROSTHESIS
AND DEVICE FOR ITS APPLICATION

The present invention concerns the medico-
5 chirurgical field, in particular arterial disease, but
also, in a more general manner, disease of other
anatomical channels, such as the veins, the bile ducts
and urinary ducts, and it relates to a self-expanding
vascular endoprosthesis with permanent elasticity and
10 with low shortening, as well as to the device for its
application.

In the present state of the art, there are
already endoluminal arterial prostheses which are
referred to in the international medical literature by
15 the English term "stent".

These prostheses are of two types:

- some made of non-elastic metal material,
expandable from the inside outward under the action of
an inflatable balloon;
- 20 - others made of elastic metal material, these
consisting of metal meshes;
they are introduced tensioned into the lumen of the
vessel and their diameter increases when the
longitudinal extension is relaxed.

25 These prostheses have various disadvantages:

- those of the first type require to be
carefully fitted on a balloon since, once they are
expanded, they can no longer be withdrawn;
- those of the second type do not have this
30 disadvantage, but the structure of their meshes
necessitates a considerable longitudinal extension in
order to reduce their diameter, which is an essential
condition in order to be able to introduce them into a
vessel; once introduced, their retraction inside the
35 vessel is also very considerable, resulting in fitting
difficulties and in friction on the walls of the said
vessel over a length of several centimetres.

In order to avoid the need for too great an
extension and the friction on the walls, the endo-



prosthesis according to the invention is constructed in accordance with a specific geometry which is the basis for its novelty.

5 The endoprosthesis according to the invention is characterized essentially in that it is cylindrical on the whole and is formed by the assembling of longitudinal shafts of even number, made of solid and elastic materials, to which there are joined, transversely at a defined angle, ribs which are also
10 elastic and which form, between two adjacent shafts, regular scales, the various scales joined longitudinally forming a widely openworked cylinder.

The endoprosthesis according to the invention consists of the assembly of unitary elements comprising
15 three shafts: starting from the two outer shafts, transverse elastic ribs join the intermediate shaft at a convergent angle, the said transverse ribs being in an open "V" shape, forming, with the intermediate shaft, a "fishbone" structure.

20 When longitudinal tractions are exerted on the outer shafts and the intermediate shaft in opposite directions, the "v"s close, bringing the outer shafts closer to the intermediate shaft. The longitudinal displacement of the shafts is very slight to obtain the
25 closure of the "V"s and the closing together of the shafts.

The tractions exerted on the entire prosthesis by pulling the adjacent longitudinal shafts in opposite directions provoke a decrease in the diameter of the
30 cylinder by closing the said shafts together. It is therefore possible to pass from a widely openworked cylindrical tube of a given radius to a tube of smaller radius by means of a slight extension and by means of a slight longitudinal displacement of the shafts.

35 The structure of the "V"-shaped ribs being elastic, the tube resumes its initial shape when the traction is relaxed.

The diameter of the prosthesis according to the invention is a function of the anatomical channel to be



equipped, and it can vary from a few millimetres to a few centimetres, while its length is also adapted according to the requirements.

5 The present invention includes the prosthesis which has just been described, but also its application system, made up of two concentric cylinders of small diameters, the distal end of the endoprosthesis being fixed to the end of the cylinder of smaller diameter, and its proximal end to the end of the cylinder of
10 greater diameter.

By pulling on the cylinder of greater diameter, the endoprosthesis is extended in order to reduce its diameter. Thus tensioned, it can be brought to the desired location; it is then relaxed in order to push
15 back the walls of the artery. It can be tensioned again in order to displace it, if necessary, as long as it is not disconnected from the application system. During introduction and displacement, the whole assembly can be covered by a third cylinder which protects the
20 prosthesis and prevents any catching on the walls of the vessels.

The endoprosthesis according to the invention is made of a material capable of maintaining a permanent elasticity, so as to be able to spread open
25 the walls, for example of an artery, and remain in place despite the flow of the blood stream and any widening of the diameter of the vessels due to their inherent elasticity and alternating variations in pressure.

30 The material employed can be an elastic metal, an alloy, or a plastic material capable of maintaining its elasticity over time.

The endoprosthesis according to the invention can moreover be covered either with a biological
35 coating or with a protective substance offering little adherence to the blood or bile, or other liquid having to flow across it.

On account of its geometry, the prosthesis according to the invention has the advantage of being



elastic, self-expanding with little shortening, and foldable as long as it is not disconnected from its application system.

5 The present invention will be better understood from reading the following description of some of its embodiments, illustrated in the attached drawing, it being understood that this description is not of a restrictive nature as regards the invention.

In the attached drawing:

10 - Figure 1 represents a partial view of a unitary element of the endoprosthesis according to the invention;

- Figure 2 represents the same element after extension;

15 - Figures 3, 4 and 5 represent endoprostheses which are obtained by longitudinal juxtaposition of 2, 3 or 4 unitary elements, respectively, from Figure 1;

- Figure 6 represents in perspective, with partial sectioning, a system for application of the
20 prosthesis according to the invention.

- Figure 7 represents in perspective, with partial sectioning, the application system in Figure 6, on which the endoprosthesis is fixed;

25 - Figure 8 represents in perspective, with partial sectioning, the same application system on which the endoprosthesis is tensioned;

30 - Figures 9a, 9b and 9c represent, in cross-sections, before, during and after extension, the position of the principal shafts about the central shaft of the application system; Figure 9c showing the position of the shafts when the prosthesis has been placed in an artery;

- Figure 10 represents the ring formed by the transverse ribs of the unitary element in Figure 1;

35 - Figure 11 represents a detailed view of the assembly of ribs and shafts of the endoprosthesis according to the invention.

If reference is made firstly to Figures 1 and 2, it will be seen that a unitary element 1 of the



endoprosthesis according to the invention consists of two outer shafts 4 and 5 which are joined to an intermediate shaft 3 by means of ribs 2 which are arranged in Vs in the same direction, like a fishbone or herringbone.

In order to tension this unitary element 1, it is necessary to stress the adjacent longitudinal shafts in the opposite direction, that is to say the shafts 4 and 5 in the opposite direction to the shaft 3. The "V"s all being arranged in the same direction, the lengthening is minimal when the element 1 is stretched out, in contrast to the existing meshed prostheses whose meshes form rhombi which lengthen on traction, each lengthening adding to that of the adjacent rhombus in such a way that a very considerable overall lengthening is eventually obtained.

Figure 2 shows the element 1 flattened under the effect of the tractions, in opposite directions, on the outer shafts 4 and 5 and the intermediate shaft 3.

Referring to Figures 3, 4 and 5, it will be seen that the assembling, by longitudinal juxtaposition, of 2, 3 or 4 unitary elements 1 makes it possible to obtain elastic cylinders 53, 54, 55 whose tractions on the adjacent shafts, in opposite directions, allow the diameter to be reduced. The relaxing of the traction in a vessel of suitable calibre allows the endoprosthesis to remain firmly applied on its walls (see Figure 9c) on account of the elasticity of its ribs. The "V" shape of the ribs permits a uniform circular elasticity on account of the spreading force which they apply at their base, the assembly of contiguous "V"s forming a uniform ring whose internal lumen is circular and uniform (see Figure 11).

For its introduction, for example into a blood vessel where the intention is to hold the walls spaced apart, the endoprosthesis is placed on the application system 7 represented in Figures 6 to 8, which allows it to be brought to the desired location.



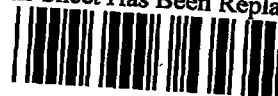
The application device 7 consists of two concentric cylinders 8 and 9 sliding one upon the other. The distal part of the inner cylinder 8 is equipped with studs 81 on which is fixed one end of the endoprosthesis 54, the other end of which is fixed on the outer cylinder 9 equipped at its distal end with the same number of studs 91.

By sliding the outer cylinder 9 on the inner cylinder 8, the endoprosthesis 54 is stretched out, reducing its diameter. By relaxing the tension, the increase in its diameter allows it to fasten on the wall of the vessel 10 (see Figure 9) which it holds open.

The endoprosthesis 54 is fixed on the application device 7 at orifices which are arranged at its ends and which are formed by the closing together, during assembling of the unitary elements 1, of notches 51 formed at the ends of the said unitary elements 1, as can be observed in Figure 11.

In this same Figure 11, it will be seen that the transverse ribs 2 can be equipped with notches 21 in the vicinity of their ends in order to facilitate the closure of the angles which they form with the shafts 3, 4 and 5 during positioning of the endoprosthesis.

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1. Vascular endoprosthesis intended to support the walls of anatomical channels, characterized in that it is formed by the assembling, by longitudinal juxtaposition, of unitary elements (1) including flexible and elastic longitudinal shafts (3, 4, 5) which are joined to each other via transverse ribs (2) which are also flexible and elastic and which are fixed on the intermediate shaft (3) in such a way as to form "V"s with the said shaft (3), the assembly constituting a fishbone structure, the assembling of which by juxtaposition forms an openworked cylinder (53, 54, 55).
2. Endoprosthesis according to Claim 1, characterized in that it is made of a material chosen from the group formed by metals, metal alloys and plastic materials.
3. Endoprosthesis according to Claim 1, characterized in that it is equipped at its ends with orifices (51) which allow it to be fixed to an application device (7).
4. Application device (7) for the endoprosthesis according to any one of the preceding claims, characterized in that it consists of two concentric cylinders (8, 9) which are each equipped at the distal end with studs (81, 91) of equal number and which can slide one upon the other in such a way as to stretch out and flatten the prosthesis (54) for the purpose of positioning it in the channel (10) where it is to be installed.

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