When the balloon in the balloon catheter disclosed in Patent Literature 4 is inflated, the balloon inflates not only to cause an increase in the outer diameter thereof, but also to extend in the longitudinal direction of the balloon catheter. Therefore, the fluid volume required for inflating the balloon in order to achieve a desired inflated diameter will be increased, as compared to a usual case. Further, when the balloon catheter is configured such that it can be used in combination with a guide wire, the inner cylinder shaft needs to have at least two lumens. This causes an increase in the outer diameter of the inner cylinder shaft, and a decrease in the clearance between the outer diameter of the inner cylinder shaft and the inner diameter of the outer cylinder shaft, as a result of which the area of the flow path of the balloon lumen is decreased. An increase in the fluid volume in the balloon and a decrease in the area of the flow path of the balloon lumen result in the problem of decelerating the inflation and deflation speed of the balloon. As a result, in the case of treating cardiac valvular stenosis, for example, there is a possibility that the blood flow needs to be blocked for a longer period of time.

[0013]

Due to the above mentioned circumstances, means for solving a number of problems associated with a balloon catheter including a balloon made of a flexible material, all at once, have not yet been disclosed.

[0014]

Therefore, embodiments of the present invention provide a balloon catheter in which the volume of the balloon upon deflation can be reduced without decelerating the speed of inflation and deflation of the balloon.

Solution to Problem

[0015]

The present inventors have found out, as a result of intensive studies, the

following embodiments of the present invention.

According to a first aspect of the present invention, there is provided a balloon catheter, including: an outer cylinder shaft having flexibility; a holding member for an operator to hold during operation, the holding member being connected to the proximal end portion of the outer cylinder shaft; a sealing member which maintains liquid tightness, the sealing member being incorporated in the holding member; an inner cylinder shaft having flexibility; a tube having a Rockwell hardness of R 115 or more, a flexural modulus of from 3.0 to 4.5 GPa, and a thickness of from 0.06 to 0.12 mm; a push-in member connected to the proximal end portion of the inner cylinder shaft; a pull-out prevention member connected to the push-in member; and a balloon composed of an elastic material and connected to each of the distal end portion of the outer cylinder shaft and the proximal end portion of the inner cylinder shaft; wherein the tube is inserted over the inner cylinder shaft over the area thereof except for the connecting portion between the balloon and the inner cylinder shaft.

In an embodiment, the clearance between the inner diameter of the tube and the outer diameter of the inner cylinder shaft is from 0.01 to 0.1 mm.

In an embodiment, the inner cylinder shaft has a tensile elastic modulus of from 500 to 1,400 MPa, a thickness of from 0.1 to 0.23 mm and a yielding strength of 25 MPa or more.

In an embodiment, the tube and the inner cylinder shaft are fixed with each other only at the proximal end portion of the tube and the proximal end portion of the inner cylinder shaft.

In an embodiment, the tube and the inner cylinder shaft are fixed with each other only at the distal end portion of the tube and the distal end portion of the inner cylinder shaft.

In an embodiment, the push-in member has a shape of a pipe with varying outer diameter; wherein the transition portion where the outer diameter is varying, of the push-in member has a tapered shape, and the respective outer diameters of the pipe are configured to decrease in the direction from the proximal end side toward the distal end side of the pipe; and wherein the pull-out prevention member is provided on the pipe portion of the push-in member at a position where the first change in the outer diameter occurs in the direction toward the distal end side, in a state where the balloon is at its equilibrium length.

According to a second aspect of the present invention, there is provided a balloon catheter for ablation, including: the balloon catheter according to the first aspect; an electrode lead wire capable of conducting a high frequency current and provided in the space between the inner cylinder shaft and the outer cylinder shaft and; a temperature sensor lead wire for transmitting the temperature in the balloon to the outside, the temperature sensor lead wire being provided between the space between the inner cylinder shaft and the outer cylinder shaft; and a lead wire cladding tube through which the electrode lead wire and the temperature sensor lead wire are inserted so that the electrode lead wire and the temperature sensor lead wire are led into the space between the inner cylinder shaft and the outer cylinder shaft, from the outside; wherein the electrode lead wire and the temperature sensor lead wire are made of metals different from each other, and are in contact with each other in the interior of the balloon; and wherein the lead wire cladding tube is in the form of a pipe including a portion with varying outer diameter, and is provided on the distal

side from the handle portion of the push-in member so as to be slidable while maintaining liquid tightness via the sealing member.

Advantageous Effects of Invention

[0016]

According to embodiments of the present invention, when a tube having a Rockwell hardness of R 115 or more, a flexural modulus of from 3.0 to 4.5 GPa, and a thickness of from 0.06 to 0.12 mm is inserted over the inner cylinder shaft over the area thereof except for the connecting portion between the balloon and the inner cylinder shaft, it is possible to improve the buckling resistance strength of the shaft portion of the catheter against the restoring force of the balloon, which force is generated due to extending the stretch distance of the balloon during the insertion of the catheter into the body, without impairing the trackability of the shaft portion to the curvature of a blood vessel.

Brief Description of Drawings

[0017]

FIG. 1 is a schematic side view in the longitudinal direction of a balloon catheter according to an embodiment of the present invention.

FIG. 2 is a schematic side view in the longitudinal direction of a balloon catheter according to another embodiment of the present invention.

Description of Embodiments

[0018]

The balloon catheter according to an aspect of the present invention is characterized by