INFORMATION: Announcement of NASA-Owned U.S. Patents in STAR

In accordance with the procedures agreed upon by Code GP-4 and Code NST-44, the attached NASA-owned U.S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No.: 4,377,169

Government or Contractor Employee: U.S. Government

NASA Case No.: LEW-13,107-1

NOTE - If this patent covers an invention made by a contractor employee under a NASA contract, the following is applicable:

YES [ ] NO [x]

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the specification, following the words "...with respect to an invention of...."
United States Patent

Banks

[54] ION BEAM SPUTTER-ETCHED VENTRICULAR CATHETER FOR HYDROCEPHALUS SHUNT

[76] Inventor: Bruce A. Banks, Olmsted Township, Cuyahoga County, Ohio, granted to Administrator of the National Aeronautics and Space Administration under the provisions of 42 U.S.C. 2457(c)

[21] Appl. No.: 272,407

[51] Int. Cl. ... A61B 27/00
[52] U.S. Cl. ... 604/8; 604/280
[58] Field of Search ... 128/348-350

ABSTRACT

The ventricular catheter 10 of the present invention comprises a multiplicity of inlet microtubules 12. Each microtubule has both a large opening 16 at its inlet end and a multiplicity of microscopic openings 18 along its lateral surfaces. The microtubules are perforated by a new and novel ion beam sputter etch technique. The holes are etched in each microtubule by directing an ion beam 20 through an electro formed metal mesh mask 28 producing perforations having diameters ranging from about 14 microns to about 150 microns.

This combination of a multiplicity of fluoropolymer microtubes, the numerous small holes provided in the lateral surfaces of the tubes, and the hydra-like distribution of the tubes provide a new and novel catheter. This structure assures a reliable means for shunting cerebrospinal fluid from the cerebral ventricles to selected areas of the body.

8 Claims, 6 Drawing Figures
ION BEAM SPUTTER-ETCHED VENTRICULAR CATHETER FOR HYDROCEPHALUS SHUNT

DESCRIPTION

Origin of the Invention

The invention described herein was made by an employee of the U.S. Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

TECHNICAL FIELD

This invention is directed to an improved cerebrospinal fluid shunt in the form of a ventricular catheter for controlling the condition of hydrocephalus by relieving the excessive cerebrospinal fluid pressure. The invention is further concerned with an improved method for fabricating the catheter and an improved method of shunting the cerebral fluid from the cerebral ventricles to other areas of the body.

The obstruction of cerebrospinal fluid flow pathways or its inadequate absorption via the arachnoid villi into the venous blood of the brain results in hydrocephalus. Surgical correction involves pressure controlled shunting of the cerebrospinal fluid. Typically, a perforated silicon rubber catheter is implanted in one of the lateral ventricles of the brain with its perforated tip located near the frontal horn. The cerebrospinal fluid passes through a pressure regulating valve and is then typically shunted to the right atrium of the heart or the peritoneal cavity.

The shunt will fail to function if the inlet ventricular catheter apertures become blocked. Shunt flow failure will also occur if the ventricle collapses due to improper function causing over drainage.

Heretofore, previously designed ventricular catheters have been found deficient as a result of high incidence of inlet blockage caused by the ingrowth of the choroid plexas, ventricular collapse over the catheter orifices, or hemorrhage, cellular, and fibrin debris. Multiple surgical revisions during the first several years after birth is common because of inlet blockage of the catheters.

Various geometry ventricular catheters have been proposed in which the inlet orifices are hidden or covered by complicated structures. The hidden inlet type geometries have not resulted in a decreased probability of blockage.

Prior Art

In the prior art U.S. Pat. No. 4,182,343 discloses a double ventricular drain tube having a double cavity. A rubber outer tube has one end which is sealed with the other end being open. This outer tube encloses a rubber inner tube that is shorter than the outer tube. One end of the inner tube is fixed to the inner wall of the sealed end of the outer tube and the other end of the inner tube is open. This inner tube may or may not be fixed to the inner wall of the outer tube. The outer tube and the inner tube, respectively, have a plurality of holes passing through their respective side walls. The holes passing through the outer tube side wall are positioned in such a manner so that they do not align with the holes in the side wall of the inner tube.

U.S. Pat. No. 3,595,241 discloses a medicosurgical tube having a swab member positioned inside the tube so constructed or arranged that it may be pulled through the tube and out the proximal end. In such a catheter, the lumen is positively protected throughout the tube length against the possibility of blood clots or other matter preventing liquid flow through the tube following the tube insertion procedure.

U.S. Pat. Nos. 3,753,439 and 3,823,782 disclose several types of surgical drains. These drains rely on relatively large holes in the tube wall, and a packing or net is utilized to prevent entry of material into the holes. None of the prior art patents discloses a catheter which would be suitable for insertion into the human brain.

DISCLOSURE OF INVENTION

The ventricular catheter of the present invention comprises a multiplicity of inlet microtubules. Each microtubule has both a large opening at its inlet end and a multiplicity of microscopic openings along its lateral surfaces.

The microtubules are perforated by a new and novel ion beam sputter etch technique. The holes are etched in each microtubule by directing an ion beam through an electro formed metal mesh mask producing perforations having diameters ranging from about 14 microns to about 150 microns.

This combination of a multiplicity of fluoropolymer microtubules, the numerous small holes provided in the lateral surfaces of the tubes, and the hydra-like distribution of the tubes provide a new and novel catheter. This structure assures a reliable means for shunting cerebrospinal fluid from the cerebral ventricles to selected areas of the body.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects, advantages and novel features of the invention will be more fully apparent from the following detailed description when read in connection with the accompanying drawings wherein:

FIG. 1 is an enlarged view of a ventricular catheter constructed in accordance with the present invention,

FIG. 2 is a schematic view showing apparatus for perforating the walls of the microtubules utilized in the catheter shown in FIG. 1.

FIG. 3 is an enlarged sectional view taken along the lines 3–3 in FIG. 2.

FIG. 4 is a scanning electron photomicrograph showing the outside surface of a sputter perforated microtube.

FIG. 5 is a scanning electron photomicrograph showing a sputter perforated microtube in section, and

FIG. 6 is a schematic view showing the direct shunting of cerebrospinal fluid from a lateral ventricle to the subarachnoid space using sputter perforated microtubules.

BEST MODE FOR CARRYING OUT THE INVENTION

Reffring now to the drawing there is shown in FIG. 1 a ventricular catheter 10 constructed in accordance with the present invention. Each catheter 10 comprises a plurality of pliable microtubules 12. A bundle of the microtubules 12 may be covered by a tubular sheath 14 which is connected to a conventional valved shunting system.

The microtubules 12 are of a fluoropolymer material and can be varied in number, diameter, wall thickness, length and material. Typical fluoropolymers that are satisfactory for the microtubules 12 are polytetrafluoroethylene and fluorocethylene propylene. Living cells of
Each microtubule 12 has an inlet end 16 which is preferably open and is of a larger diameter than each of the multiplicity of ion beam sputtered microscopic perforations 18 along a relatively long extent of the lateral surfaces as shown in greater detail in FIGS. 4 and 5. It is further contemplated that the inlet end 16 may be closed in certain embodiments.

The utilization of sputter etching to perforate the microtubules 12 facilitates the fabrication of catheters having two orders of magnitude increase in aperture density over that of conventional catheters shown in the prior art. This is evident because approximately 1100 apertures for each 20 μm in diameter can be placed along a 1 cm length of microtubule.

The catheter 10 is comprised of a bundle of one or more microtubules 12, each being only about 0.44 mm in diameter. The resulting large number of inlet apertures reduces the tendency for the shunt to draw in and trap debris or tissue which would then cause flow obstruction.

What is claimed is:

1. In a ventricular catheter for controlling the condition of hydrocephalus by relieving the excessive cerebrospinal fluid pressure, the improvement comprising a plurality of pliable microtubular members for conducting cerebrospinal fluid from the cerebral ven-
A ventricular catheter as claimed in claim 1 wherein the microtubular members are of a fluoropolymer material.

3. A ventricular catheter as claimed in claim 2 wherein the microtubular members are of a fluoropolymer material selected from the group consisting essentially of polytetrafluoroethylene and fluoroethylene propylene.

4. A ventricular catheter as claimed in claim 1 including a tubular sheath member for enclosing said microtubular members with said perforated portions of said microtubular members extending from one end of said sheath.

5. A ventricular catheter as claimed in claim 4 wherein the tubular sheath member is of a silicone rubber material.

6. A ventricular catheter as claimed in claim 5 wherein the tubular sheath member has a diameter of about 0.015 m.

7. A ventricular catheter as claimed in claim 6 wherein the microtubular members have diameters of about 0.44 mm.

8. A ventricular catheter as claimed in claim 7 wherein the one end adjacent to the perforations in each of the microtubular members has an opening therein that is substantially greater than each of said perforations.

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