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Embolectomy catheters for treating stroke and other small vessel thromboembolic disorders
Embolektomiekatheter für Schlaganfälle und andere kleine thromboembolische Gefäßerkrankungen
Cathéters d’embolectomie pour traitement des accidents cérébrovasculaires et d’autres troubles thromboemboliques des petits vaisseaux

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Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to medical devices, and more particularly to thrombolectomy catheters for removing blood clots or other matter from the lumens of blood vessels or other anatomical conduits.

BACKGROUND OF THE INVENTION

[0002] Various types of thromboembolic disorders, such as stroke, pulmonary embolism, peripheral thrombosis, atherosclerosis, and the like, are known to occur in human beings and other mammals. Such thromboembolic disorders are typically characterized by the presence of a thromboembolus (i.e., a viscoelastic blood clot comprised of platelets, fibrinogen and other clotting proteins) which has become lodged at a specific location in a blood vessel.

[0003] In cases where the thromboembolism is located in a vein, the obstruction created by the thromboembolus may give rise to a condition of blood stasis, with the development of a condition known as thrombophlebitis within the vein. Moreover, peripheral venous embolisms may migrate to other areas of the body where even more serious untoward effects can result. For example, the majority of pulmonary embolisms are caused by emboli that originate in the peripheral venous system, and which subsequently migrate through the venous vasculature and become lodged with the lung.

[0004] In cases where the thromboembolus is located within an artery, the normal flow of arterial blood may be blocked or disrupted, and tissue ischemia (lack of available oxygen and nutrients required by the tissue) may develop. In such cases, if the thromboembolism is not relieved, the ischemic tissue may become infarcted (i.e., necrotic). Depending on the type and location of the arterial thromboembolus, such tissue infarction can result in death and amputation of a limb, myocardial infarction, or stroke. Notably, strokes caused by thromboemboli which become lodged in the small blood vessels of the brain continue to be a leading cause of death and disability, throughout the world.

[0005] In modern medical practice, thromboembolic disorders are typically treated by one or more of the following treatment modalities:

a) pharmacologic treatment wherein thrombolytic agents (e.g., streptokinase, urokinase, tissue plasminogen activator (TPA)) and/or anticoagulant drugs (e.g., heparin, warfarin) are administered in an effort to dissolve and prevent further growth of the clot;

b) open surgical procedures (e.g., surgical embolectomy or clot removal) wherein an incision is made in the blood vessel in which the clot is lodged and the clot is removed through such incision-sometimes with the aid of a balloon-tipped catheter (e.g., a "Fogarty Catheter") which is passed through the incision and into the lumen of the blood vessel where its balloon is inflated and used to extract the clot out of the incision; and,

c) transluminal catheter-based interventional procedures wherein a clot removing/disrupting catheter (e.g., a suction-type catheter having a suction tip, clot-capturing type catheter having a clot capturing receptacle (e.g., a basket, coil, hook, etc.), or clot disrupting catheter having a clot disrupting apparatus (e.g., an ultrasound probe or laser)) is percutaneously inserted and advanced through the patient’s vasculature to a location adjacent the clot. The suction tip, clot capturing receptacle or clot disrupting apparatus is used to aspirate, capture & remove, disrupt or ablate the offending clot.

[0006] Each of the above-listed treatment modalities has its own set of advantages and disadvantages. For example, pharmacologic treatment has the advantage of being non-invasive and is often effective in lysing or dissolving the clot. However, the thrombolytic and/or anticoagulant drugs used in these pharmacologic treatments can cause untoward side effects such as bleeding or hemorrhage. Also, in cases where time is of the essence, such as cases where an arterial thromboembolism is causing severe tissue ischemia (e.g., an evolving stroke or an evolving myocardial infarction) the time which may be required for the thrombolytic drugs to fully lyse or dissolve the blood clot and restore arterial blood flow may be too long to avoid or minimize the impending infarction.

[0007] Open surgical thrombus-removing procedures can, in many cases, be used to rapidly remove clots from the lumens of blood vessels, but such open surgical procedures are notoriously invasive, often require general anesthesia, and the use of such open surgical procedures is generally limited to blood vessels which are located in surgically accessible areas of the body. For example, many patients suffer strokes due to the lodging of blood clots in small arteries located in surgically inaccessible areas of their brains and, thus, are not candidates for open surgical treatment.

[0008] Transluminal, catheter-based interventional procedures are minimally invasive, can often be performed without general anesthesia, and can in some cases be used to rapidly remove a clot from the lumen of a blood vessel. However, such catheter-based interventional procedures are highly operator-skill-dependent, and can be difficult or impossible to perform in small or tortuous blood vessels. Thus, patients who suffer strokes due to the presence of clots in the small, tortuous arteries of their brains may not presently be candidates for catheter-based, transluminal removal of the clot, due to the small size and tortuosity of the arteries in which their clots are located.

[0009] In concept, the transluminally deployable clot
A. Embolectomy Catheters of the Present Invention

[0016] An embolectomy catheter device of the present invention generally comprises; a) an elongate, pliable clot penetrating catheter which is advanceable, distal end first, through the clot or other obstructive matter (e.g., thrombus, thromboembolus, pieces of detached atherosclerotic plaque, foreign matter, etc.) which is to be removed, and b) a matter capturing receptacle which is deployable from the distal end of the catheter alter it has been advanced through the obstructive matter, to capture and facilitate removal of the obstructive matter. The matter capturing receptacle is initially disposable in a first or stowed configuration wherein the receptacle is in a radially collapsed condition and contained upon or within the catheter or otherwise sufficiently compact to pass through the clot or other obstructive matter. Thereafter, the matter capturing receptacle is deployable (e.g., advanceable, projectable and/or expandable) from the catheter such that it assumes a second or expanded configuration wherein the receptacle may receive and at least partially surround the distal aspect of the clot or other obstructive matter so as to facilitate extraction and removal of the blood clot or other obstructive matter along with the catheter.

[0017] A guidewire lumen extends longitudinally through only a distal portion of the catheter. In this embodiment of the catheter, the guidewire lumen extends through the matter capturing receptacle such that the catheter (with its matter capturing receptacle in its collapsed or stowed configuration) may be advanced over a guidewire which has previously been passed through the vessel-obstructing clot or other obstructive matter. Such arrangement of the guidewire lumen additionally allows the embolectomy catheter to be exchanged (e.g., removed and replaced with another embolectomy catheter or another type of catheter) if such exchange should become necessary or desirable. This ability to allow the guidewire to remain positioned through the offending clot or other obstructive matter may serve to ensure that the catheter or its replacement can be re-advanced through the clot or other obstructive matter to its desired position.

[0018] The matter capturing receptacle of the catheter may comprise a distal obstructive matter-engaging portion (e.g., a coil, basket or concave member) of porous construction (e.g., a woven, coiled or mesh structure formed of wire, fiber or fabric), which is attached to the catheter by way of one or more proximal struts (e.g., connector members (e.g., a plurality of thin wires or struts). Initially, with the matter capturing receptacle disposed in its first (e.g., collapsed or stowed) configuration, the distal end of the catheter is advanced through the clot or other, obstructive matter. After the catheter has been advanced through the clot or other obstructive matter, the matter capturing receptacle is moved to its second (e.g., expanded or operative) configuration, such that the distal obstructive matter

SUMMARY OF THE INVENTION

[0014] According to the present invention there is provided an embolectomy catheter device for removing a blood clot or other obstructive matter from a blood vessel as claimed in claim 1.

[0015] The present invention generally comprises an embolectomy catheter device for removing blood clots or other matter from the lumens of blood vessels or other anatomical conduits of a mammalian body. The embolectomy catheters of the present invention are particularly suitable for use in removing clots or thromboemboli from small arteries of the mammalian brain to prevent or minimize the severity of stroke.
- engaging portion 16 of the receptacle will contact and/or at least partially surround the distal aspect of the clot or other obstructive matter. The distal obstructive matter
- engaging portion of the receptacle is preferably of permeable construction to permit blood to flow therethrough, but is sufficiently dense (i.e., sufficiently impermeable) to prevent the clot or other obstructive matter from passing therethrough. In this manner, the distal obstructive matter-engaging portion of the receptacle is useable to retract or draw the clot or other obstructive matter, in the proximal direction, from its then-present location. The proximal strut(s) which extend between the receptacle to the catheter are typically of radially splayed or outwardly angled configuration and is/are preferably configured, oriented and positioned so as to slice, cut or otherwise pass through the matter of the clot or other obstructive matter, when deployed at a site distal to the clot or other obstructive matter and subsequently retracted in the proximal direction. To assist such proximal strut(s) in passing through the clot or other obstructive matter, energy (e.g., radio-frequency energy, vibration, heat, etc) may be applied to the proximal strut(s) during their proximal retraction through the clot or other obstructive matter.

[0019] A contrast medium injection port may be formed on the proximal portion of the embolectomy catheter, to allow radiographic contrast medium (e.g., dye) to be injected through the catheter while a guidewire remains positioned within the guidewire lumen.

B. Rapid Exchange Microcatheter Useable in Conjunction with Embolectomy Catheters of the Present Invention

[0020] Further, there is disclosed a rapid exchange microcatheter which comprises a small diameter flexible microcatheter of a type commonly used in neuroradiology procedures (e.g., Prowler™ microcatheter, Cordis Endovascular Systems, Miami Lakes, Florida), which has greater flexibility at or near its distal end than at or near its proximal end, and which includes in accordance with this invention, the addition of a guidewire passage port formed in the sidewall of the catheter, at a spaced distance (e.g., 0.5-35 cm) from its distal tip. A guidewire deflector is formed with the main lumen of the catheter adjacent to the guidewire passage aperture, to deflect the proximal end of a guidewire out of the guidewire passage aperture as the catheter is advanced over the guidewire. The formation of such guidewire passage aperture and guidewire deflector allows a guidewire to be passed through only a distal portion of the catheter lumen. This lumen arrangement allows the microcatheter to be exchanged (i.e., removed and replaced by another microcatheter or an embolectomy catheter of the above-summarized design) while the operator holds the guidewire in place by grasping the exteriorized proximal end of the guidewire—even in instances where a standard length guidewire (i.e., not an “exchange-length” guidewire) is used.

C. Methods for Removing Clots or Other Matter from Blood Vessels

[0021] Also described herein is a method for treating ischemic stroke caused by a thromboembolism (the method not forming part of the present invention) which has become lodged in a small blood vessel of the brain (i.e., blood vessels located in, on or around the brain). The method may be carried out using the rapid-exchange microcatheters and the embolectomy catheters of the present invention. The preferred method generally comprises the steps of:

A. percutaneously inserting a guidewire (alone or in combination with a guide catheter) into an intracranial blood vessel, using the Seldinger technique or other appropriate method of percutaneous guidewire placement;
B. advancing a microcatheter over the guidewire, or separately from the guidewire, through the vasculature until the microcatheter is near the site at which the blood clot or other obstructive matter is located;
C. passing radiographic contrast medium (e.g., dye) through the microcatheter under radiographic visualization to verify the exact location of the obstructive matter and/or to map the vascular anatomy in the area of the obstruction;
D. advancing the guidewire (or a separate small guidewire) through the microcatheter until such guidewire becomes located in a desired operative position relative to the obstructive matter (e.g., such that its distal end has fully or partially traversed or passed through the thromboembolism or other obstructive matter);
E. withdrawing and removing the microcatheter while substantially maintaining the small guidewire in its operative position (e.g., preventing the guidewire from moving so far as to loose the access to the obstructive matter that the presence of the guidewire provides);
F. advancing a matter-capturing type embolectomy catheter (such as an embolectomy catheter of the present invention) which has an obstructive matter-capturing receptacle deployable therefrom, over the operatively positioned guidewire until the distal end of the embolectomy catheter has advanced fully or at least partially through the obstructive matter (e.g., has penetrated through an obstructive thromboembolism);
G. optionally injecting radiographic contrast medium through a lumen of the embolectomy catheter to guide or verify the positioning of the embolectomy catheter relative to the lodged blood clot or other
Thus, by the above-summarized method, the blood clot or other obstructive matter which is causing an ischemic (i.e., thrombotic or embolic) stroke is removed and arterial blood flow is restored to the region of the brain which had become ischemic due to the lodging on the offending blood clot or other obstructive matter within the blood vessel.

Further elements, objects and advantages of the present invention will become apparent to those of skill in the art upon reading and understanding of the following detailed description of preferred embodiments and consideration of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a human patient (an “over-the-wire example) of an embolectomy catheter.

Figure 1a is a perspective view of the embolectomy catheter device of Figure 1 operatively positioned upon a guidewire, and having its obstructive matter-capturing receptacle disposed in an expanded configuration.

Figure 2a is an enlarged longitudinal sectional view of the distal end of the over-the-wire embolectomy catheter of Figure 1 with its obstructive matter-capturing receptacle in a first or stowed position.

Figure 2b is an enlarged, broken, longitudinal sectional view of the distal end of the over-the-wire embolectomy catheter of Figure 1 with its obstructive matter-capturing receptacle disposed in a fully expanded configuration.

Figure 2c is a cross-sectional view through line 2c-2c of Figure 2a.

Figure 2d is a cross-sectional view through line 2d-2d of Figure 2a.

Figure 2d’ is a cross-sectional view through line 2d-2d of Figure 2a, modified to show an alternative mode of constructing the guide bores In the distal tip member, through which the wires which form the obstructive matter-capturing receptacle extend.

Figure 3a is an enlarged, broken, longitudinal sectional view of the distal end of the over-the-wire micrcatheter of the prior art.

Figure 3b is an enlarged, broken, longitudinal sectional view of the distal end (i.e., another over-the-wire embodiment) of an embolectomy catheter.

Figure 3b’ is a cross-sectional view through line 3b’-3b’ of Figure 3b.

Figure 3c is an enlarged, broken, longitudinal sectional view of the distal end of a rapid exchange micrcatheter.

Figure 3c’ is a cross-sectional view through line 3c’-3c’ of Figure 3c.

Figure 3d is an enlarged, broken, longitudinal sectional view of the distal end of a third embodiment (i.e., a rapid exchange embodiment) of an embolectomy catheter of the present invention.

Figure 3d’ is a cross-sectional view through line 3d’-3d’ of Figure 3d.

Figure 3e is an enlarged, longitudinal sectional view of the distal end (i.e., another rapid exchange example) of an embolectomy catheter.

Figure 3e’ is a cross-sectional view through line 3e’-3e’ of Figure 3e.

Figure 3f is an enlarged, longitudinal sectional view of the distal and (i.e., another rapid exchange example) of an embolectomy catheter.

Figure 3f’ is a cross-sectional view through line 3f’-3f’ of Figure 3f.

Figure 4 is a perspective view (i.e., a rapid exchange embodiment) of an embolectomy catheter of Figure 3d having a guidewire operatively inserted through its guidewire lumen and its obstructive matter capturing receptacle In its deployed, radially expanded position.

Figure 5 is a perspective view of a first alternative obstructive matter-capturing receptacle which may be incorporated into any of the embolectomy catheters of the present invention.

Figure 5’ is an enlarged view of portion 5’ of Figure 5.

Figure 5” shows an alternative construction for portion 5’ of Figure 5.

Figure 5a is a distal end view of Figure 5.

Figure 5b is a perspective view of a second alternative obstructive matter-capturing receptacle which may be incorporated into any of the embolectomy
catheters of the present invention.

Figure 5b" is a perspective view of a second alternative obstructive matter-capturing receptacle of Figure 5b having a clot captured therewithin and with its support spines being partially retracted into the catheter.

Figure 5b is a perspective view of the second alternative obstructive matter-capturing receptacle of Figure 5b having a clot captured therewithin and with its support spines being further retracted into the catheter so that the obstructive matter capturing receptacle is drawn partially around the captured clot. Figure 5c is a perspective view of a third alternative obstructive matter-capturing receptacle which may be incorporated into any of the embolectomy catheters of the present invention.

Figure 6 is a perspective view of an optional guide catheter having a proximal obstructive matter containment apparatus operatively deployed therefrom, and an embolectomy catheter of the present invention operatively inserted therethrough.

Figure 7 is an elevational view of a variant of the helical basket type obstructive matter capturing receptacle of the catheters shown in Figures 1, 2b and 4, such variant being constructed of metal ribbon rather than wire.

Figure 7a is a cross-sectional view through line 7a-7a of Figure 7, illustrating the manner in which the metal ribbons may be twisted to enhance the ability of the proximal strut portions to the obstructive matter capturing receptacle to cut through the thromboembolic material.

Figures 8a-8f are step-wise showings of a procedure wherein i.e., an over-the-wire embodiment of an embolectomy catheter is used to remove a blood clot from a small blood vessel of a mammalian body.

Figures 9a-9d are step-wise showings of a procedure wherein i.e., a rapid exchange embodiment of an embolectomy catheter of the present invention is used to remove a blood clot from a small blood vessel of a mammalian body.

[0025] The particular examples and embodiments shown in these drawings, and additional embodiments of the invention, may now be better understood by reading and understanding the following detailed description wherein specific reference is made to the structures and steps illustrated or shown in the drawings.

DETAILED DESCRIPTION OF THE INVENTION

[0026] Referring now to the drawings, wherein the showings are for the purpose of describing and illustrating exemplary embodiments of the present invention, and not for the purpose of limiting the scope of the invention.

A. Over-The-Wire Examples of the Embolectomy Catheter Device:

[0027] Figure 1 shows a human patient in whom an over the wire example of the embolectomy catheter device 10 has been inserted for the purpose of removing a thromboembolus or blood clot from a small arteri at a small arteri located in the patient’s brain. Prior to introduction of the catheter device 10 the offending clot had been located by angiography or other imaging means, and a small (e.g., 0.15-0.25mm (9.006-0.010inch) outer diameter) guidewire GW was inserted into the patient’s femoral artery and advanced into the artery of the brain in which the clot is located and at least partially through the clot. Thereafter, the catheter device 10 was advanced over the previously inserted guidewire GW to a position were the distal end of the catheter device 10 is near the clot.

First Example

[0028] As shown in Figures 1-2e, the over-the-wire catheter device 10 comprises an elongate, pliable catheter 11 having a clot capturing receptacle 14 deployable from its distal end DE, as shown. The obstructive matter-capturing receptacle 14 is formed of a plurality (e.g., 2 or more) wire members 20 which are initially retractable to substantially straight configurations and a first (i.e., stowed) position, within the catheter 11. (See Figure 2a) When it is desired to deploy the obstructive matter capturing receptacle 14, the preformed wire members 20 are advanced in the distal direction such that the emerge from the constraint of the catheter 11 and resiliently assume a second (i.e., operative) configuration wherein the proximal portions of the wire members form a helical basket 16 having an open proximal mouth or rim 17, as shown in Figure 2b. When in such operative configuration (Figure 2b), the helical basket 16 is sufficiently porous to allow blood to flow therethrough, but sufficiently dense to engage and withdraw in the proximal direction, a thromboembolism. A nose cone 30 is positioned on the distal ends of the wire members 18. The proximal portions 18 of the elongate wire members 20 act as connecting members between the helical basket 16 and the catheter 11. These proximal portions 18 of the wire members 20 are of sufficiently small diameter or are otherwise configured to be retracted through a thromboembolism, without causing substantial disruption or segmentation of the thromboembolism. In some examples energy (e.g. heat, vibration, etc) may be applied to the proximal portions 18 of the wire members 20 to facilitate their retraction through the thromboembolic material without causing substantial disruption or segmentation of the thromboembolism.

[0029] The wire members 20 of which the capturing receptacle 14 is formed may be of any suitable material such as elastic, superelastic or shape memory alloy wire. The distal portions of these wire members are preformed to the shape of the helical basket 16 but are sufficiently
elastic to assume substantially straight configurations when retracted through the guide bores 26 and into the catheter 11 and maintained in a taut state under a small amount of proximally directed pressure. (See Figure 2a) However, when these preformed wire members are extended or advanced through the guide bores 26 and out of the distal end DE of the catheter 11, and relieved of the surrounding restraint of the catheter 11 and the proximally-directed tension, they will resiliently self-coil into the generally frustoconical shape of the helical basket 16.

To facilitate the desired advancement and retraction if these preformed wire members 20, the proximal ends of these members 20 are attached to the distal end of a longitudinally slideable actuator 24 which is positioned within the lumen 22 of the catheter body 12. A hollow actuator lumen 22a extends through the actuator 24 and is in axial alignment with the lumen 22 of the catheter body 12. The shaft of the actuator 24 has a wire braid or coil 25 formed therein to impart stiffness and strength. A distal tip member 28 is formed on the distal end DE of the catheter body 12. such distal tip member 28 having a hollow tip member lumen 22TM which extends longitudinally through the center thereof, and four (4) wire passage bores 26 which also extending longitudinally therethrough, at radially spaced-apart locations (i.e., the 3, 6, 9 and 12 o’clock positions). The distal tip member 28 may be formed of material which is more rigid than the catheter body 12 and may have a proximal portion 40 of reduced diameter which is inserted into the distal end DE of the catheter body lumen 22, as shown in Figures 2a, 2b and 2d. Each of the four (4) preformed segments 20 which form the obstructive matter capturing receptacle 14, when advanced out of the catheter body 11 must pass through a respective one of the wire passage bores 26 formed in the catheter tip member 28. Figure 2d’ shows an alternative construction of the distal tip member wherein four (4) cut-out notches 26A,T are formed at the 3, 6, 9 and 12 o’clock positions to serve as discrete guide wire passageways for the individual wire segments 20, in lieu of the wire passage bores 26.

A proximal actuator shaft 24’ extends to a housing 13 formed on the proximal end of the catheter, and such proximal actuator shaft 24’ may be manually advanced and retracted to control deployment and retraction of the obstructive matter capturing receptacle 14. A contrast medium injection port 15 is also formed on the proximal housing 13, for injection of radiographic contrast medium through the lumen 22 and out of the distal end DE of the catheter 11. In this regard, it is preferable that the outer diameter of the guidewire GW be at least slightly less than the inner diameter of the lumen 22 to permit some radiographic contrast medium to pass through the lumen 22 and out of the distal end of the catheter even when the guidewire is positioned within the lumen. Also, radiographic contrast solutions (i.e., dyes) of minimal viscosity may be selected to enhance the ability of the contrast medium to pass through the lumen 22 while the guidewire GW is positioned therewithin.

When the actuator 24 is withdrawn in the proximal direction, it will pull the wire segments 20 in the proximal direction, through the wire passage bores 26 and into the lumen 22 of the catheter. When the actuator 24 is fully retracted, as shown in Figure 2a, the segments 20 will be drawn fully through the wire passage bores 26 and will assume substantially straight configurations, and the nose cone 30 mounted on the distal end of the obstructive matter capturing receptacle will be in direct abutment with the catheter tip member 28 such that the hollow nose cone lumen 22NC is in axial alignment with the distal tip lumen 22DT and the lumen 22 of the catheter body 12.

Second Example

Figures 3b and 3b’ show a second example of an over-the-wire catheter device 10’ which differs from the first embodiment 10 in several ways. For example, the obstructive matter-capturing receptacle (not shown) of this second example is formed by only two (2) wire members 20’ instead of four (4) as in the first example 10. Also, the catheter 11’ of this second example incorporates an elongate distal segment 270 of reduced diameter and increased flexibility—similar to that of the commercially available microcatheters (e.g., Prowler™ microcatheter, Cordis Endovascular Systems, Miami Lakes, Florida), an example of which is shown in Figure 3a and generally comprises a proximal portion PP having a lumen L and a distal segment 270 having a lumen 271 which is continuous with the lumen L of the proximal portion PP.

With specific reference to Figures 3b and 3b’, this second example of the over the wire embolectomy catheter device 10’ comprises an elongate, pliable catheter 11’ having a helical basket type obstructive matter capturing receptacle (not shown) similar to that of the first example, but wherein the receptacle (not shown) is formed of only two (2) wire members. As in the above described first example, the obstructive matter capturing receptacle (not shown) of this second example 10’ is initially retractable to a first (i.e., stowed) configuration and is subsequently advanceable to a second (i.e., operative) configuration which is essentially the same as that described above with respect to the first example 10.

In this second example, the flexible catheter 11’ comprises a proximal portion 12’ having a first diameter and first flexibility, and a distal portion 270 which has a second (i.e., smaller) diameter and a second (i.e., greater) flexibility. An insert member 28’ having four (4) guide bores 26’ extending longitudinally therethrough, is positioned within the lumen 271’ of, and is coextensive with, the locations (i.e., the 3, 6, 9 and 12 o’clock positions). The distal tip member 28 may be formed of material which is more rigid than the catheter body 12 and may have a proximal portion 40 of reduced diameter which is inserted into the distal end DE of the catheter body lumen 22, as shown in Figures 2a, 2b and 2d. Each of the four (4)
preformed segments 20 which form the obstructive matter capturing receptacle 14, when advanced out of the catheter 11 must pass through a respective one of the wire passage bores 26 formed in the catheter tip member 28. Figure 2d’ shows an alternative construction of the distal tip member wherein four (4) cut-out notches 26A, T are formed at the 3, 6, 9 and 12 o’clock positions to serve as discrete guide wire passageways for the individual wire segments 20, in lieu of the wire passage bores 26.

[0036] A proximal actuator shaft 24’ extends to a housing 13 formed on the proximal end of the catheter, and such proximal actuator shaft 24’ may be manually advanced and retracted to control deployment and retraction of the obstructive matter capturing receptacle 14. A contrast medium injection port 15 is also formed on the proximal housing 13, for injection of radiographic contrast medium through the lumen 22 and out of the distal end DE of the catheter 11. In this regard, it is preferable that the outer diameter of the guidewire GW be at least slightly less than the inner diameter of the lumen 22 to permit some radiographic contrast medium to pass through the lumen 22 and out of the distal end of the catheter even when the guidewire is positioned within the lumen. Also, radiographic contrast solutions (i.e., dyes) of minimal viscosity may be selected to enhance the ability of the contrast medium to pass through the lumen 22 while the guidewire GW is positioned therewithin.

[0037] When the actuator 24 is withdrawn in the proximal direction, it will pull the wire segments 20 in the proximal direction, through the wire passage bores 26 and into the lumen 22 of the catheter. When the actuator 24 is fully retracted, as shown in Figure 2a, the segments 20 will be drawn fully through the wire passage bores 26 and will assume substantially straight configurations, and the nose cone 30 mounted on the distal end of the obstructive matter capturing receptacle will be in distal portion 270 of the catheter 11’. This insert member 28’ is a generally cylindrical member having four (4) longitudinal bores 20’ extending therethrough, as shown in Figure 3b’. However, since the obstructive matter capturing receptacle (not shown) of this example is formed of only two (2) elongate members 20’, the remaining two guide bores 26’ remain unoccupied and may serve as passageways through which radiographic contrast medium (e.g., dye), medicaments, perfusion solution or other fluid may flow.

B. Rapid Exchange Embodiments of the Embolectomy Catheter Device:

[0038] Figures 3e, 3e’, 3f and 3f’ are illustrative of rapid exchange examples of the embolectomy catheter device 10”, 10” and 10”. Fig 3d, 3d’, and 4 are illustrative embodiments of the embolectomy catheter device. These rapid exchange embolectomy catheter devices 10”, 10” and 10” incorporate guidewire lumens which extend through only a distal portion of the catheter 11”, 11”’, 11”’ so as to permit the catheter 11”, 11”’, 11”’ to be exchanged without the need for use of an exchange-length guidewire (i.e., a guidewire which is long enough to allow the exteriorized portion of the guidewire to be longer than the catheter so that the catheter may be withdrawn, removed and exchanged while holding the guidewire in substantially fixed position. The rapid-exchange embodiments are particularly suited for the treatment of stroke by removing thromboemboli from small blood vessels of the brain (i.e., blood vessels located on, in or around the brain), as the use of exchange-length guidewires may be undesirable in such delicate neuroradiological procedures. see, Morris, P., Practical Neuroradiology, Chapter 2, page 41 (Williams & Wilkins 1997)

First Embodiment

[0039] Figures 3d and 3d’ show a first embodiment (i.e., a rapid exchange type embodiment) of the embolectomy catheter device 10” which is similar in construction to the above described second example 10’, but which incorporates a guidewire passage port 267’ formed in the sidewall of the catheter 11” at a spaced distance (e.g., 0.5-35 cm) from its distal end, and a guidewire deflector tube 260’ which extends from the guidewire passage port 267’ to the lumen 22’. The guidewire deflector tube 260’ has a distal end which is held in a centered position within the lumen by a plurality of radial support members 264’. Longitudinal passages 266, 266(alt) are formed between the radial support members 264’ to allow radiographic contrast medium or other fluid to flow through the lumen 22’, past the distal end of the guidewire deflector tube 260’. Selected ones of the longitudinal passages 266(alt) are larger than the others 266 to permit the elongate members 20’ which form the obstructive matter capturing receptacle to pass therethrough, as shown. The proximal end of a guidewire PEG may be inserted into the distal end opening DEO of the catheter 11” and, thereafter, the catheter 11” may be advanced in the distal direction such that the proximal end of the guidewire PEG will enter into the distal end of the guidewire deflector tube 260’, and will be thereby deflected out of the side guidewire passage port 267’, as shown.

Third Example

[0040] In the third example (i.e., another rapid exchange example) shown in Figures 3e and 3e’, the catheter 11” comprises a main tube 300 which has a proximal portion 302 of a first diameter D1 and a distal portion 304 of a second diameter D2. A side tube 308 is affixed to one side of the distal portion 304 of the main tube 300, and a guidewire passage aperture 310 is formed into the lumen 309 of the side tube 308, such that the lumen 309 of the side tube may be used as the guidewire lumen, and the distal portion of the guidewire GW which emerges from the side tube lumen 309 may then be passed through the separate guidewire lumen of the obstructive
matter capturing receptacle 22 (not shown in figure 3e) and/or any nose cone lumen 22NC (not shown in figure 3e), as described fully hereabove.

**Fourth Example**

[0041] The fourth example (i.e., another rapid exchange example) of the embolectomy catheter device 10''' is similar in construction and operates in the same manner as the third example 10'' described above, except that the main tube 300' of this fourth example 10''' is formed of a continuous wire 316 which is wound in a tight helical coil, as shown. This construction of the main tube 300' may provide enhanced flexibility over other forms of construction.

**C. Alternative Components and Optional Elements Which May be Incorporated Into any Embodiment of the Embolectomy Catheter Devices:**

**I. Alternative Types of Obstructive matter Capturing Receptacles:**

[0042] The embolectomy catheter devices 10, 10', described herein and 10", 1010", 10''' of the present invention may incorporate various types of obstructive matter capturing receptacles as alternatives to the helical wire basket type receptacles 14, 14' shown in Figures 1a, 2b and 4. In particular, several alternative obstructive matter capturing receptacles are shown in Figures 5-7.

[0043] Figures 5-5a show one alternative obstructive matter-capturing receptacle 400 which comprises a plurality of elastic or superelastic wire spokes 402 which are preformed to a radially splayed configuration as shown, and which have a membranous or fabric cover 404 disposed thereon to form an umbrella like structure. The membranous or fabric cover 404 may be of non-porous or porous configuration, and is preferably formed of material such as polyethylene, polytetrafluoroethylene, polyurethane, ethylene vinyl acetate or silicone. A central hub is formed at the center of the spokes 402, and a guidewire lumen extends through such central hub such that the guidewire may pass the center of the receptacle 400, in the manner depicted in Figures 5 and 5a. The ends of the spokes 402 may have bulbs 408 formed thereon to minimize trauma to the surrounding blood vessel walls, as shown in Figure 5. Or, as an alternative to such bulbs 408, atrumatic loops 410 may be formed on the distal ends of the spokes 402 to prevent vascular trauma. The spokes 402 are of sufficiently small diameter to be retracted through a thromboembolism without causing substantial disruption or segmentation of the thromboembolism. Also, in the embodiment shown in Figure 6, it will be appreciated that the spokes 402 may have a greater curvature than that shown, such that the free ends of the spokes 402 will not be in direct contact with the blood vessel wall.

[0044] Figures 5b-5b" show another obstructive matter capturing receptacle 420 which comprises a plurality of elastic or superelastic wire spokes 402' which are preformed to a radially splayed configuration as shown, and a porous fabric (e.g., woven, knitted, mesh or net fabric) sac 422 attached to the spokes 402' to form an umbrella-like structure, as shown. The material used to form this sac 422 may be the same microporous material as specified hereabove with respect to the membranous or fabric cover 404 of the embodiment shown in Figure 5. A central aperture 426 is formed in the sac 422 such that a guidewire GW may be passed through a region among the spokes 402', and through such aperture 426, as shown in Figures 5b and 5b'. Draw lines 424 are attached to the free ends of the spokes 402' and extend through the lumen of the catheter. These draw lines 424 and the spokes 402' are of sufficiently small diameter to be retracted through a thromboembolism without causing substantial disruption or segmentation of the thromboembolism. After the receptacle 420 has been advanced through the thromboembolism, it is deployed (e.g., radially expanded) and retracted such that the draw lines 424 and spokes 402' will retract through and will become located proximal to, the thromboembolism. Thereafter, the draw lines 424 are retractable into the catheter to pull distal ends of the spokes 402' inwardly such that the proximal mouth PM of the sac will be drawn partially around the captured obstructive matter in the manner shown in Figures 5b' and 5b".

[0045] Figure 5c shows another alternative obstructive matter capturing receptacle which employs a resilient, generally football shaped cage to effect radial expansion/contraction of a membranous or fabric cover 444. As shown, the cage comprises approximately six (6) elongate members 442 of preformed elastic, super elastic or shape memory metal wire disposed longitudinally about a longitudinal axis LA, and having the membranous or fabric covering 444 disposed on the distal portions DP thereof. The distal ends DE of the elongate members 442 are attached to a nose cone 446 which has a guidewire passage lumen extending longitudinally therethrough. When retracted into the lumen of the catheter, the members 442 will radially compress to a diameter which is received within the catheter lumen. However, when advanced out of the catheter the members 442 will resiliently expand to the configuration shown. The proximal portions of the members are sufficiently small in diameter to slice, cut or otherwise pass in the proximal direction through a thromboembolism or clot without disrupting or causing fragmentation of the thromboembolism or clot.

[0046] Figures 7 and 7a show an alternative helical basket type of obstructive matter capturing receptacle 14" which is of the same general configuration, and operates in the same manner, as the helical basket type receptacles 14, 14' shown in Figures 1a and 4, but wherein the receptacle 14" is formed of a plurality of flat ribbons 500 formed of metal such as cobalt-chromium-nickel alloy (Elgiloy™, Elgiloy, Inc., Elgin, Illinois), a shape memory and/or super-elastic material such as nickel-titanium.
navigate the tiny blood vessels of the brain, the presence of the retracted obstructive matter capturing receptacle 14, 14', 400, 420 or 440 within that catheter 11 may severely limit the amount of radiographic contrast medium which could be infused though that catheter 11. Thus, in many instances, it may be desirable to initially insert a small angiography catheter (e.g., a microcatheter such as the Prowler™ microcatheter, Cordis Endovascular Systems, Miami Lakes, Florida), an example of which is shown in Figure 3a, into the obstructed blood vessel to perform the initial angiography and to accomplish precise positioning of the guidewire through the thromboembolism. After the initial angiography has been performed and the guidewire has been precisely positioned, the angiography catheter is withdrawn and removed, leaving the guidewire in place. Thereafter, an embolectomy catheter 10, 10', described herein and 10", of the present invention is advanced over the pre-positioned guidewire to the location of the thromboembolism.

However, the microcatheters of the prior art have not been suitably designed for this novel procedure. Such microcatheters have heretofore of an "over-the-wire" type used primarily in procedures where the catheter is retracted and removed concurrently with the guidewire over which it was inserted. Thus, as those skilled in the art will appreciate, the prior art "over-the-wire" type microcatheters can only be exchanged over a stationary guidewire if the guidewire is an "exchange-length" wire or if an extension has been attached to the proximal end of the guidewire to permit the exchange. However, the use of such "exchange-length" guidewire or a guidewire extension may be contraindicated in procedures where the catheters are being inserted into and withdrawn from tiny delicate vessels of the brain. see, Morris, P., Practical Neuroradiology, Chapter 2, page 41 (Williams & Wilkins 1997)

D. Rapid Exchange Microcatheter Useable in Conjunction with the Embolectomy Catheters:

In many procedures wherein the embolectomy catheters of this invention are used to remove thromboemboli from small blood vessels of the brain, it will be desirable to initially perform an angiogram of the blood vessel wherein the thromboembolism is believed to be located to a) verify the exact location of the thromboembolism and b) radiographically map the vascular anatomy in the immediate area of the thromboembolism and c) guide and verify the passage of a small guidewire through the offending thromboembolism. Because the embolectomy catheters 10, 10', described herein and 10", of the present invention may necessarily be of very small diameter (e.g. 2.54-5.08mm (0.10-0.20 inches)) in order to navigate the tiny blood vessels of the brain, the presence of the flat ribbons 500 are, preformed to helical configurations to form the helical basket 502. The proximal portions of the ribbons 500 serve as connector members 504 between the helical basket 502 and the catheter 11. Each ribbon 500 has first and second flat surfaces 512 and first and second edges 514. Each of the ribbons 500 is twisted 90 degrees at a point of transition 510 between the connector members 504 and the helical basket 502. This twisting of the ribs causes a) the distal portions to be situated with their edges 514 in juxtaposition such that a thromboembolus contained within the helical basket 502 will rest upon the flat surfaces of the ribbons 500, and b) the proximal portions to be situated with their edges 512 aimed in the proximal direction to facilitate retraction of the distal connector members 504 through the thromboembolus without causing the thromboembolus to be substantially fragmented or disrupted.

Optional Guide Catheter/Proximal Obstructive Matter Retaining Member:

As illustrated in figure 6, it may be desirable to use the embolectomy catheter devices 10, 10', 10", 10"" in conjunction with a guide catheter 50 through which the embolectomy catheter 11 may be advanced. When such guide catheter 50 is used, a proximal obstructive matter retaining member 52, such as a tubular sheath having a radially flared and splayable distal end as shown in Figure 5a, may be advanced out of the distal end DE of the guide catheter 50 such that the clot C or other obstructive matter may be captured between the distal obstructive matter receiving portion 16 of the receptacle 14, 14', 400, 420 or 440 within that catheter 11 may severely limit the amount of radiographic contrast medium which could be infused though that catheter 11. Thus, in many instances, it may be desirable to initially insert a small angiography catheter (e.g., a microcatheter such as the Prowler™ microcatheter, Cordis Endovascular Systems, Miami Lakes, Florida), an example of which is shown in Figure 3a, into the obstructed blood vessel to perform the initial angiography and to accomplish precise positioning of the guidewire through the thromboembolism. After the initial angiography has been performed and the guidewire has been precisely positioned, the angiography catheter is withdrawn and removed, leaving the guidewire in place. Thereafter, an embolectomy catheter 10, 10', described herein and 10", of the present invention is advanced over the pre-positioned guidewire to the location of the thromboembolism.

However, the microcatheters of the prior art have not been suitably designed for this novel procedure. Such microcatheters have heretofore of an "over-the-wire" type used primarily in procedures where the catheter is retracted and removed concurrently with the guidewire over which it was inserted. Thus, as those skilled in the art will appreciate, the prior art "over-the-wire" type microcatheters can only be exchanged over a stationary guidewire if the guidewire is an "exchange-length" wire or if an extension has been attached to the proximal end of the guidewire to permit the exchange. However, the use of such "exchange-length" guidewire or a guidewire extension may be contraindicated in procedures where the catheters are being inserted into and withdrawn from tiny delicate vessels of the brain. see, Morris, P., Practical Neuroradiology, Chapter 2, page 41 (Williams & Wilkins 1997)

In view of this shortcoming of the prior art microcatheters, applicant has devised the rapid-exchange microcatheter 265 shown in Figures 3c and 3c'. This rapid exchange microcatheter 265 comprises an elongate, flexible catheter having a proximal portion 12" of a first diameter and first flexibility, and a distal portion 270" which has a second (i.e., smaller) diameter and a second (i.e., greater) flexibility. A guidewire passage port 267 formed in the sidewall of the catheter near the distal end of its proximal portion 12", and a guidewire deflector tube 260 which extends from the guidewire passage port 267 to the lumen 271. The guidewire deflector tube 260 has a flared distal end which is held in a centered position within the lumen by a plurality of radial support members 264. Longitudinal passages 266 are formed between the radial support members 264 to allow radiographic contrast medium or other fluid to flow through the lumen 271, past the flared distal end of the guidewire deflector tube 260. The proximal end of a guidewire PEG will enter the flared distal end of the guidewire de-
E, Methods to Remove Clots or Other Obstructive Matter from Blood Vessels:

[0051] Figures 8a-8f illustrate a preferred method of using an the over-the-wire type embolectomy catheter 10 to remove a obstructive matter such as a thromboembolism or blood clot, while Figures 9a-9c illustrate a preferred method of using a rapid exchange type embolectomy catheter 10" of the invention to remove such obstructive matter. These exemplary procedures are described in detail in the paragraphs below.

Preferred Use of the Over-the-Wire Embolectomy Catheter

[0052] Figures 8a-8f show a presently preferred method for using the over-the-wire type embolectomy catheter 10 shown in Figures 1-2d to remove a thromboembolus or clot C which has become lodged immediately downstream of an arterial bifurcation BE so as to create an ischemic zoneIZ of tissue (e.g., brain tissue which is deprived of oxygen and other nutrients) located downstream of the clot C. The preferred procedures depicted in these drawings are described in the paragraphs hereinafter.

[0053] Initially, a microcatheter such as the rapid exchange microcatheter 265 of Figure 3c (not shown in Figures 8a-8f) is advanced to a position near the obstructive matter or clot C and radiographic contrast medium is injected through the microcatheter to angiographically verify the precise location of the clot C and to visualize or map the anatomy of the blood vessels in the area of the clot. Thereafter, a guidewire having a diameter of 0.01-0.014 inches and a length which is not more than 1.5 times the length of the microcatheter 265 (i.e., not an "exchange-length" guidewire) is advanced from the lumen 271 of the microcatheter 265 until its distal tip DT has passed through the clot C as shown in Figure 8a.

[0054] Thereafter, the operator will hold the proximal end of the guidewire GW to prevent longitudinal retraction of the guidewire GW while retracting and removing the rapid exchange microcatheter 265. This allows the guidewire GW to remain in its operative position as shown in Figure 8a.

[0055] Thereafter, as shown in Figure 8b, the embolectomy catheter 11 having its obstructive matter capturing receptacle retracted to its first configuration (Fig.2a) is advanced over the guidewire GW and through the clot C, such that the distal end opening DEO of the catheter 11 is located downstream of the clot C but still proximal to (i.e., upstream of) the distal tip DT of the guidewire GW.

[0056] Thereafter, as shown in figures 8c and 8d, the actuator 28 is advanced in the distal direction to cause the four wire segments 20 which form the obstructive matter capturing receptacle 14 to advance out of the distal end of the catheter such that the nose cone 30 remains upon the guidewire GW. In this manner, the obstructive matter capturing receptacle 14 is fully deployed to its second or operative configuration at a location distal to (i.e., downstream of) the clot C (Figure 3d).

[0057] Thereafter, as shown in Figure 8e, the embolectomy catheter 11 is retracted in the proximal direction to cause the proximal connector members 18 of the obstructive matter capturing receptacle 14 to pass through the clot, and to further cause the clot to be received within the concave or cavernous interior of the distal obstructive matter receiving portion 16 of the receptacle 14, as shown.

[0058] Thereafter, as shown in Figure 8f, the entire embolectomy catheter device 10, with the clot C in low, may be retracted out of the body-or to a location within a larger blood vessel (e.g., carotid artery) where the clot C and the fully deployed obstructive matter capturing receptacle 14 may be received within the lumen of a larger catheter to further secure the clot for ultimate extraction and removal form the body.

Preferred Use of the Rapid Exchange Embolectomy Catheter

[0059] The preferred method of using a rapid exchange type embolectomy catheter of this invention 10" is shown in Figures 9a-9d.

[0060] Initially, a microcatheter such as the rapid exchange microcatheter 265 of Figure 3c (not shown in Figures 9a-9d) is advanced to a position near the clot C and radiographic contrast medium is injected through the microcatheter to angiographically verify the precise location of the clot C and to visualize or map the anatomy of the blood vessels in the area of the clot. Thereafter, a guidewire having a diameter of 0.15-0.46mm (0.006-0.018 inches) and a length which is not more than 1.5 times the length of the microcatheter 265 (i.e., not an "exchange-length" guidewire) is advanced from the lumen 271 of the microcatheter 265 until its distal tip OT has passed through the clot C as shown in Figure 9a.

[0061] Thereafter, the operator will hold the proximal end of the guidewire GW to prevent longitudinal retraction of the guidewire GW while retracting and removing the rapid exchange microcatheter 265. This allows the guidewire GW to remain in its operative position as shown in Figure 9a.

[0062] Thereafter, as shown in Figure 9b, the exteriorized proximal end of the guidewire is inserted into the distal end opening DEO of the the rapid exchange embolectomy catheter 11" while its obstructive matter capturing receptacle is retracted to its first configuration (Fig. 2a) within the distal portion of the catheter 11". As the catheter is advanced in the distal direction over the guidewire GW, the guidewire will be deflected by the guidewire deflection tube 260 (see Figure 3d) and the proximal end of the guidewire will emerge out of the side guidewire passage aperture 267 of the catheter 11".
catheter 11" is advanced through the clot C, such that the distal end opening DEO of the catheter 11" is located downstream of the clot C but still proximal to (i.e., upstream of) the distal tip DT of the guidewire GW, as shown in Figure 9c. The guidewire GW extends along side of the proximal portion of the rapid exchange catheter 11" (i.e., the portion of the catheter proximal to the guidewire passage aperture 267"), as shown.

[0063] Thereafter, as shown in figure 9d, the actuator passage aperture 267', as shown. the proximal portion of the rapid exchange catheter 11" in Figure 9c. The guidewire GW extends along side of stream of) the distal tip DT of the guidewire GW, as shown downstream of the clot C but still proximal to (i.e., up-

downstream of) the clot C (Figure 9d).

[0064] Thereafter, the rapid exchange embolectomy catheter 11" is retracted in the proximal direction to cause the proximal connector members 18' of the obstructive matter capturing receptacle 14' to pass through the clot, and to further cause the clot to be received within the concave or cavernous interior of the helical basket 16' of the receptacle 14'. The clot C is then removed by retraction of the catheter 11', In the same manner shown and described above and shown in Figures 8e and 8f..

[0065] It is to be appreciated that the invention has been described herein with reference to certain exemplary embodiments only, and no effort has been made to exhaustively describe each an every possible embodi-

ment of the invention. Indeed, as those skilled in the art will appreciate, various additions, deletions, modifications and/or alterations may be made to he above described embodiments without departing from the scope of the invention as defined by the appended claims.

Claims

1. A rapid exchange embolectomy catheter device 10", 10", 10" for removing a blood clot or other obstruc-
tive matter from a blood vessel, said device comprising:

an elongate flexible catheter body 12', 12" having a proximal end, a distal end, and a lumen 22', 271 which extends longitudinally through at least a portion thereof;

an obstructive matter capturing receptacle 14, 14', 420, 420', 440 which is initially disposed in a first stowed configuration which is passable through the obstructive matter, and is subse-
quently deployable to a second radially expanded configuration; said obstructive matter capturing receptacle having a guidewire lumen which extends longitudinally therethrough in alignment with the lumen 22', 271 of said catheter body 12', 12", such that the obstructive matter cap-
turing receptacle 14, 14', 420, 420', 440 and the catheter body 12', 12" may be advanced over a previously positioned guidewire;

a guidewire passage aperture 267', 267 formed in the catheter a spaced distance proximal to the catheter’s distal end;
a curved guidewire deflector tube 260', 260 having a proximal end positioned at the guidewire passage aperture 267', 267 and a distal end positioned within the lumen 22' of the catheter such that the proximal end of the guidewire (GW) will be received within the distal end of the curved guidewire de-
flector tube 260', 260 and will thereafter pass through the curved guidewire deflector tube 260', 260 and out of the guidewire pas-
sage aperture 267', 267 as the catheter is advanced in the distal direction over the guidewire (GW), characterised in that the catheter further comprises: radial support members 264', 264 attached to the distal end of the curved guidewire deflector tube 260', 260 to hold the distal end of the curved guidewire deflec-
tor tube 260', 260 in a substantially centered position within the lumen 22', 271 of the catheter, said radial support members forming fluid passages 226 therebetween;

wherein the lumen 22', 271 extends within the catheter at least from the guidewire passage ap-

2. The rapid exchange embolectomy catheter device of Claim, 1 wherein the distal end of the curved guidewire deflector tube 260', 260 is larger in diam-
eter than the rest of the curved guidewire deflector tube 260', 260 to facilitate entry of the proximal end of the guidewire (GW) into the distal end of the curved guidewire deflector tube 260', 260.

3. The rapid exchange embolectomy catheter device according to claim 2 wherein the lumen 22', 271 ad-
ditionally extends through the portion of the catheter proximal to the guidewire passage aperture 267', 267 and is used for injection of radiographic contrast medium, and wherein at least one flow passageway is formed adjacent the distal end of the curved guidewire deflector tube 260', 260 to allow radi-
ographic contrast medium to flow past the curved guidewire deflector tube 260', 260 and out of the dis-
tal end of the catheter through said fluid passages.

Patentansprüche

1. Schnellwechsel-Embolektomie-Katheter-Vorrich-
tung (10", 10"", 10"") zur Entfernung eines Blutge-rinnels oder anderen obstruktiven Materials aus ei- nem Blutgefäß, wobei die Vorrichtung Folgendes umfasst:

 einen langgestreckten flexiblen Katheter-Kör- per (12', 12") mit einem proximalen Ende, einem distalen Ende und einem Lumen (22', 271), das sich in Längsrichtung durch zumindest einen Teil hiervon erstreckt;


Revendications

1. Cathéter d’embolectomie à échange rapide (10", 10"", 10"") pour retirer un caillot sanguin ou une autre matière obstruante d’un vaisseau sanguin, ledit dis- positif comprenant:

 un corps de cathéter souples allongé (12', 12") ayant une extrémité proximale, une extrémité distale et une lumière (22', 271) qui s’étend lon- gitudinalement à travers au moins une partie de ce dernier;

 un réceptacle de capture de matière obstruante (14, 14', 14", 420, 420', 440) qui est initialement disposé dans une première configuration arri- mée qui peut passer à travers la matériau ob- struante, et qui est déployable par la suite dans une seconde configuration radiallement expan- sée; ledit réceptacle de matière obstruante ayant une lumière de fil-guide qui s’étend longi- tudinalement à travers ce dernier, en alignement avec la lumière (22', 271) dudit corps de cathéter (12', 12"), de sorte que le réceptacle de capture de matière obstruante (14, 14', 14", 420, 420', 440) et le corps de cathéter (12', 12") peuvent être avancés sur un fil-guide préalablement po- sitionné;

 une ouverture de passage de fil-guide (267', 267) formée dans le cathéter à une distance proximale de l’extrémité distale du cathéter;
un tube déflecteur de fil-guide incurvé (260', 260) ayant une extrémité proximale positionnée au niveau de l'ouverture de passage du fil-guide (267', 267) et une extrémité distale positionnée à l'intérieur de la lumière (22') du cathéter de sorte que l'extrémité proximale du fil-guide (GW) est reçue à l'intérieur de l'extrémité distale du tube déflecteur de fil-guide incurvé (260', 260) et passe ensuite à travers le tube déflecteur de fil-guide incurvé (260', 260) et sort par l'ouverture de passage du fil-guide (267', 267) lorsque le cathéter est avancé dans la direction distale sur le fil-guide (GW), caractérisé en ce que le cathéter comprend en outre:

des éléments de support radiaux (264', 264) attachés à l'extrémité distale du tube déflecteur de fil-guide incurvé (260', 260) afin de maintenir l'extrémité distale du tube déflecteur de fil-guide incurvé (260', 260) dans une position sensiblement centrée à l'intérieur de la lumière (22', 271) du cathéter, lesdits éléments de support radiaux formant des passages de fluide (226) entre eux;
dans lequel la lumière (22', 271) s'étend à l'intérieur du cathéter au moins à partir de l'ouverture de passage du fil-guide (267', 267) jusqu'à l'extrémité distale du cathéter.


3. Cathéter d'emolectomie à échange rapide selon la revendication 2, dans lequel la lumière (22', 271) s'étend de plus à travers la partie du cathéter proximale à l'ouverture de passage du fil-guide (267', 267) et est utilisée pour l'injection de milieu de contraste radiographique, et dans lequel au moins une voie de passage d'écoulement est formée de manière adjacente à l'extrémité distale du tube déflecteur de fil-guide incurvé (260', 260) pour permettre au milieu de contraste radiographique de s'écouler au-delà du tube déflecteur de fil-guide incurvé (260', 260) et de sortir de l'extrémité distale du cathéter par lesdits passages de fluide.
REFERENCES CITED IN THE DESCRIPTION

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