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Preparation for the Prophylaxis of Restenosis

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ABSTRACT

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The invention relates to a preparation for restenosis prevention. The preparations for restenosis prevention known as yet do not reach sufficient active agent concentrations in the affected sections of the vascular walls as higher doses cause undesirable side effects. The present invention is a preparation to which at least one antihyperplastic agent is added that has a distribution ratio between butanol and water ≥ 0.5 . The lipophilic active agent is absorbed by the vascular wall fast and in sufficient quantity. The preparation may be a liquid that can pass through capillaries and may contain a contrast agent so that the active agent is transferred into the vascular wall without any additional effort while the usually required contrast radiograms are taken. The preparation may also be applied to a catheter.

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**COMPLETE SPECIFICATION
FOR A STANDARD PATENT**

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The following statement is a full description of the invention, including the best method of performing it, known to me:

DESCRIPTION

A preparation for restenosis prevention

The invention relates to a preparation for restenosis prevention and its application to an angiography catheter.

Stenoses of blood vessels are a major cause of morbidity and mortality. Local stenoses or occlusions of larger vessels up to ca. 2 mm in diameter can be dilated back to their original lumen in many instances using inflatable balloon catheters. High pressures are applied when doing this, which may result in lacerations of the thickened vascular walls that are squeezed and displaced into the surrounding tissue. In some of these operations, tubular perforated metal supports (stents) are implanted to keep the vessels open. The vascular walls treated in this way frequently respond by increased growth in thickness that is similar to developing a scar within a few weeks and months. As a result and due to advancing arteriosclerosis, these vessels may relatively soon become stenosed again (restenosis). Restenosis is a severe medical problem that causes high costs.

A proven clinical method to prevent restenosis is irradiation of the affected vascular wall sections with a high dosage of X-rays (extracorporal sources or intraluminal radioisotopes) immediately after the surgery.

Major disadvantages of irradiation are the required precautions when handling preventive radiation dosages. Many other methods for preventing premature restenosis

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have been tested in labs and clinical practice but as yet without any major breakthrough [Bult H. Restenosis: A challenge for pharmacology. Tips 21 pp. 274-279, 2000]. Good results were only achieved using drug-releasing stents. For this method to be effective, stents have to be implanted so that restenosis cannot be prevented when the vessel is just dilated and no stent is implanted.

Inhibition of mitosis, reactive vascular wall thickening and restenosis has been described for a great number of drugs: Important principles of action are inhibition of platelet aggregation, enzyme inhibition, inhibition of mitosis, cytostatics, and corticoids. Favorable results were achieved in vitro and partly in animal experiments but have not been confirmed in clinical tests. A frequent explanation offered is that active agent concentrations in the affected sections of the vascular wall are insufficient. This is particularly true for oral and intravenous administration where side effects prevent higher doses. As an alternative, administration using specific catheters was attempted wherein these catheters either press the drug solution through the pores of a tight-sitting balloon directly into the vascular wall or block supply and discharge in a vessel section and expose the vessel wall to the drug solution for some time [Herdeg, C., M. Oberhoff, D.I. Siegel-Axel, A. Baumbach, A. Blattner, A. Küttner, S. Schröder, K.R. Karsch: Paclitaxel: Ein Chemotherapeutikum zur Restenoseprophylaxe? Experimentelle Untersuchungen in vitro und in vivo. Z Kardiologie 89 pp. 390 -397, 2000]. Drug exposure of previously dilated vessel sections that was effective over a longer period of time was achieved by the slow release of active agents from coated stents. However, the problem of achieving sufficient active agent

concentrations over a sufficient exposure time in the vessel sections requiring treatment remains the same with all these methods. Hydrophilic active agents are quickly washed out of tissues [Baumbach, A., C. Herdeg, M. Kluge, M. Oberhoff, M. Lerch, K.K. Haase, C. Wolter, S. Schröder, K.R. Karsch: Local drug delivery: Impact of pressure, substance characteristics, and stenting on drug transfer into the arterial wall. Cathet Cardiovasc Intervent 47 pp. 102 - 106, 1999]. Repeated administration is impossible because of the invasive access using catheters. Lipophilic active agents do not dissolve well enough in vessel-compatible aqueous media or are kept in solution as micelles or liposomes; these micelles or liposomes are only slowly absorbed by the tissue. Administration using special catheters that interrupt the blood flow for some time or press the active agent solution under high pressure into the vascular wall first of all causes additional tissue damage and intensifies reactive hyperplasia. Coated, drug-releasing stents are difficult to produce in constant quality, they contain only very low active agent quantities due to their light weight and delicate design and are not suitable for proximal and distal treatment of the vascular sections at risk of restenosis a few millimeters around the stent. If a stent was implanted at an earlier time, and there is stenosis in its lumen, this can be removed by inflating a balloon catheter. This implantation of a second stent into the lumen of the first stent to prevent vessel wall hyperplasia as a consequence of dilatation is undesirable so that there is no effective method of restenosis prevention for this case. The same applies when there is no indication for implanting a stent after angioplasty or when hyperplastic vessel processes are taking place without clear stenosis

of the lumen so that neither vessel dilatation nor stent implantation are required. Some of these vessel wall changes may cause sudden, mostly thrombotic occlusions. In this case, too, a method independent of stent
5 implantation for inhibiting pathological vessel wall changes is desirable.

Active agents that were tested with some success in laboratory settings are heparin and hirudin derivatives,
10 prostacyclins, corticoids, rapamycin, colchicine, and paclitaxel.

In most cases, the active agents were applied to stents; whenever solutions were used, these were aqueous solutions or, for the poorly water-soluble paclitaxel
15 (4,10- β -diacetoxy-13- α -((2R,3S)-3-benzamido-2-hydroxy-3-phenylpropionyloxy)-2 α -benzoyloxy-5- β ,20-epoxy-1,7- β -dihydroxy-11-taxene-9-one), aqueous solutions with an ethanol or cremophor additive. Micelles are formed when using cremophor [poly(oxyethylene)-35-castor oil] that
20 can largely be avoided when using ethanol.

Suspensions or emulsions with relatively large-sized particles in aqueous cytostatic solutions with or without an added contrast agent have been described for direct
25 injection into tumor-feeding blood vessels. These preparations are used to close tumor vessels and for simultaneous cytostatic treatment. Closing the vessels is directly opposed to the purpose of this invention.

30 It is the problem of this invention to provide agents for the local treatment of potentially hyperproliferative tissue that can be handled easily and do not harm the patient.

Based on the state of the art, this problem is solved according to the invention by a preparation containing at least one antihyperplastic agent with a distribution ratio between butanol and water of ≥ 0.5 , and by inserting said preparation in an agent for enhancing the imaging of arteries and veins or by applying it to a catheter.

The concept of the invention is based on the observation that active agents from adequately concentrated solutions, gels or other matrices are absorbed fast and in sufficient quantities by a vessel wall unless they are enclosed in outwardly hydrophilic micelles by solubility promoters. When the active agents are lipophilic (butanol to aqueous buffer solution (pH 7) distribution ratio ≥ 0.5 , preferably ≥ 1 and ≥ 5 particularly preferred, or octanol to aqueous buffer solution (pH 7) distribution ratio ≥ 1 , preferably ≥ 10 , and ≥ 50 particularly preferred), and/or reversibly ($>10\%$, preferably $> 50\%$, $>80\%$ particularly preferred) and/or irreversibly bind to cell components (such as paclitaxel, probucol (4,4'-(isopropylidenebisthio)bis(2,6-di-tert-butylphenol), porphyrin derivatives), the retention time in the blood vessel when administered during vessel dilatation and optional stent implantation is sufficient for the treatment effect. Prevention of reduction of initial reactive hyperplasia as a consequence of vascular injury prevents the vessel wall from growing too thick over many months. Surprisingly, the preparations according to the invention did not require longer exposure of the tissue to be treated or indirect infiltration and additional injury of the vessel wall.

Contrast agents were selectively injected into the affected vessels several times during angioplasty and stent implantation to determine positioning, degree and form of the stenosis, to specify the exact position of the dilatation catheter, evaluate dilatation success, and, optionally, to implant a stent of appropriate thickness and length. By adding the active agents or their preparations that are suited for the purpose to the contrast agents used for diagnostic purposes, the active agent is transferred into the vascular wall with each injection of contrast agent, without additional effort or damage to the vessels. The entire vessel section imaged for diagnostic purposes is treated including the area in front of the stenosis and the area away from its center. This has the major benefit that critical zones upstream and downstream from the dilated stenosis and optional stent implantation are not excluded from treatment.

If the injection of contrast media is not required or undesirable, solutions of lipophilic active agents in other aqueous carriers can be used without adding micelle-forming substances. One requirement is that these solutions contain a higher active agent concentration than the saturation concentration in the aqueous medium. This can be achieved by adding organic solvents that form few or no micelles such as ethanol or DMSO and/or by dissolving the active agents under conditions that are not beneficial for storage and administration (e. g. heating, mixing with concentrated active agent solutions in organic solvents) to form sufficiently stable oversaturated solutions.

In some cases, solubility of the lipophilic active agents in the contrast agent solutions or the stability of

oversaturated solutions are surprisingly improved.
Another surprising effect due to the contrast agents is
enhanced adhesion and absorption of active agents by
vessel walls and good local tolerance of some substances
of extreme systemic toxicity in sensitive vessel
sections.

When active agent and contrast medium are incompatible or
when the active agent does not dissolve properly in the
contrast medium, the active agent solution can also be
directly infused or injected through the diagnostic
catheter into the respective vessel. It is preferred to
use similar volumes as they are common for vessel imaging
using contrast media through catheters [Elke M:
Kontrastmittel in der radiologischen Diagnostik, pp. 113-
119, 3rd edition, Georg Thieme Verlag Stuttgart New York,
1992].

Contrast agents are solutions, suspensions or emulsions
well tolerated by vessels that can be used to enhance the
representation of blood vessels or the bloodstream in
radiograms, sonograms, optical imaging or magnet
resonance imaging.
These contrast agents include Visipaque 320 (iodixanol),
Ultravist 370 (iopromide), Omnipaque 350 (iohexol) or
Solutrast 370 (iopamidol) or Magnevist (gadolinium-DPTA)
or Gadovist 1M (Gd-D03A-butrol).

Active agents can be all substances suitable for
inhibiting cell growth, cell multiplication and
hyperplastic proliferation provided they meet the
criteria defined above regarding lipophilia and/or
binding to tissue components. Inasmuch as some active
agents are not sufficiently lipophilic or capable of

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binding, their pharmacologically active derivatives or precursors of pharmacologically active substances may be used that release the actual active agent when in the tissue only. Preferred are cytostatics from the taxoid group such as paclitaxel and docetaxel ((2R,3S)-N-(tert-butoxycarbonyl)-2-hydroxy-3-phenyl- β -alanine-(4-acetoxy-2- α -benzoyloxy-5- β ,20-epoxy-1,7- β ,10- β -trihydroxy-9-oxo-11-taxene-13- α -yl-ester)), or epothilones as examples of lipophilic substances. These are so lipophilic and insoluble in water that even more hydrophilic derivatives as described by Nicollau KC, Riemer C, Kerr MA, Rideout D, Wrasidlo W. Design, Synthesis and biological activity of protaxols. Nature, 1993; 364: pp. 464-466 or in USP 457,674, Novel Taxoids, are preferred as long as their molecular weight does not exceed ca. 10 kD. Other useful active agents are selected from the groups of corticoids, mitosis inhibitors such as colchicine, antibiotics such as azithromycin or roxithromycin (Gupta et al. 1998) or antioxidants such as probucol, as well as heparin and hirudin derivatives or prostacyclins. Furthermore, immunosuppressants such as rapamycin are among the active agents that can be used.

Examples of lipophilic derivatives of otherwise hydrophilic cytostatics can be found in Brunner H, Schellerer K-M, Treitinger B. Synthesis and in vitro testing of hematoporphyrin type ligands in platinum(II) complexes as potent cytostatic and phototoxic antitumor agents. Inorganica Chimica Acta, 1997; 264: pp. 67-79 in the form of conjugates of platinum complexes with porphyrins.

5 The preparations according to the invention that contain a cytostatic as an active ingredient are also suitable for treating tumor diseases. It is advantageous in this case that the treatment is local, which minimizes the strain the patient is put under.

10 Besides lipophilic substances, other active agents or substrate-bound active agents with a specific affinity to vessel walls, particularly to vessel walls showing pathological change, are suitable. Substances have a specific affinity to vessel walls when they are not washed away by the bloodstream within a few minutes. It is known that small concentrations of magnetites are deposited after intravenous administration in vessel walls that show arteriosclerotic change (Schmitz SA et al. Superparamagnetic iron oxide - enhanced MRI of atherosclerotic plaques in Watanabe hereditary hyperlipidemic rabbits. Invest Radiol, 2000; 35: 460-471). However it is surprising that these magnetites reach concentrations sufficient for treatment after a short-time flow through the vessels that are dilated using a balloon. To make these magnetites usable for treatment, they must be coated with drugs as described, for example, by Lübke AS, Bergemann C, Huhnt W, Fricke T, 25 Riess H, Brock JW, Huhn D. Preclinical experiences with magnetic drug targeting: Tolerance and efficacy. Cancer Research, 1996; 56: 4694 - 4701).

30 The active agents are dissolved as much as possible in the undiluted contrast agents. They can also be prepared as a separate solution that is diluted with contrast agents prior to use. The mixing ratio of active agent solution and contrast agent solution should not be greater than 2:1, preferably <1:1, <0.2:1 being

particularly preferred. The active agent should be dissolved in a well-tolerable aqueous medium or a medium that can be mixed with water. Also admissible are organic solvents that are well tolerated (at least after being diluted with the contrast agent solution or another aqueous medium) such as ethanol, DMSO, DMF, etc. The prepared injection solution will mostly contain as great a portion of water as possible(>90 volume percent, preferred >95 volume percent, ≥99 volume percent particularly preferred).

The concentration range of each active agent is dependent on their solubility in physiologically tolerable solvents without having to resort to micelle-forming agents such as cremophor and on the efficacy and tolerability of the active agents. The upper limit of the concentration is always determined by the volume to be administered (e. g. 100 to 200 ml for repeated injection into the coronary arteries) and the maximum systemically tolerable dose (e. g. ca. 100 mg per sqm body surface for paclitaxel). Preferred and sufficiently effective due to local administration and action are dosages of 1/10th or less of the maximum systemically tolerable dose.

Other effective substances such as coagulation inhibitors, platelet aggregation inhibitors, enzyme inhibitors, complex-forming agents for calcium ions, etc. may be added to the preparations. These do not have to meet the criteria for lipophilia, binding to tissue components or molecular weight as the effect can also be acute and intravascular; what has been said in the paragraph regarding concentration and dosage above applies here because the focus is on the local effect in the vessel section through which the preparation flows.

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Another way of administering antiproliferative agents is provided by a catheter used for vessel dilatation that has an inflatable balloon which itself causes the vascular dilatation. The balloon can be coated with the active agent. When the vessel is dilated, the balloon is pressed against the vessel wall. This provides an opportunity for the active agent to transfer into the vessel wall. If the balloon is used to dilate a stent, even the active agent between the balloon and the stent can be released because the metal struts of the stent are displaced relative to the balloon surface.

These variations of active agent administration do not constitute an additional step for the physician as compared to the original process of vessel dilatation or stent implantation.

The following methods can be used if the active agents are to be applied to the part of the catheter that is used for vessel dilatation: Dissolution of the active agent(s) in a solvent that does not corrode the catheter, immersion of the respective catheter part in the solution, removal of the catheter from the solution, and drying. Optionally, matrix or gel-forming adjuvants can be added to the active agent solution in the vessel, e. g. lipides or polymers used in pharmacology. Coating can be performed in several steps, while agent-containing and agent-free layers may alternate. The solvents for the respective layers should be selected in such a way that the subsequent coating does not strip off the previous one.

According to a first embodiment of the invention, there is provided a method for manufacturing a balloon

catheter coated with an antihyperplastic active ingredient dried on the balloon surface, which contains a catheter with an expandable balloon, comprising the steps of:

- (a) dissolving the active ingredient in a solvent, which does not attack the catheter,
- (b) immersing the balloon in the solution, and
- (c) removing the balloon from the solution and drying; characterised in that the catheter is coated with a preparation containing at least one antihyperplastic active ingredient with a distribution coefficient between butanol and water of ≥ 0.5 .

According to a second embodiment of the invention, there is provided balloon catheter comprising a catheter with an expandable balloon, characterised in that the balloon is coated with at least an antihyperplastic active ingredient dried on the balloon surface, which is not enclosed by solubilisers in outwardly hydrophilic micelles.

The examples below shall explain that invention:

[Text continues on page 12]

Examples

Example 1a: Solution for direct administration into the arteries

80 mg of 7-(2'',3''-dihydroxypropyl oxycarbonyl)-paclitaxel are dissolved in 5 ml of dimethyl sulfoxide and diluted with 5 ml of a 5% glucose solution. The solution or a part thereof is slowly infused into the previously dilated arteries.

Example 1b: X-ray contrast medium with an additive for inhibiting intimal hyperplasia

99 parts of a portion of the solution described in 1a are added to the Visipaque 320, a commercial X-ray contrast medium, and immediately mixed well. The solution can be used as is common for angiography prior to or after vessel dilatation.

Example 2a: Solution as an additive to contrast agents

200 mg of 7-(2'',3''-dihydroxypropyl oxycarbonyl)-paclitaxel are dissolved in 10 ml of absolute ethanol (= solution A); 0.35 ml of this solution can be added to 100 ml of contrast agent.

Example 2b: X-ray contrast medium for restenosis prevention

100 ml of Ultravist 370 (Schering AG, Berlin; active ingredient iopromide equivalent to 370 mg of iodine/ml) containing 0.35 volume percent of ethanol and 7 mg of 7-(2'',3''-dihydroxypropyl oxycarbonyl)-paclitaxel. The

solution is produced by dissolving the 7-(2'',3''-dihydroxypropyl oxycarbonyl)-paclitaxel in ethanol and adding it under constant stirring to the contrast agent.

5 Example 2c: X-ray contrast medium for restenosis prevention

The preparation according to Example 2b with an addition of 10 I.U. of low-molecular heparin

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Example 2d: Restenosis-inhibiting perfusion solution

3.5 ml of the solution A described in Example 2a are mixed with 46.5 ml of ethanol and added under fast shaking to 1000 ml of warm (-50 °C) 5% glucose solution or isotonic electrolyte solution. This solution is infused via a catheter into the vessels to be treated just like a contrast medium; however, the infusion rate can be reduced as compared to that of contrast agents.

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Example 3a: X-ray contrast medium for inhibiting intimal hyperplasia

100 ml of Ultravist 370 (see Example 2b) mixed with 0.4 volume percent of ethanol and 14.4 mg of 7-(2'',3''-dihydroxypropyl oxycarbonyl)-paclitaxel. The preparation is produced as described in Example 2b.

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Example 4a: X-ray contrast medium for inhibiting cell growth

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100 ml of Solustrast 370 (Byk-Gulden, Konstanz; active ingredient iopamidol equivalent to 370 mg of iodine/ml) containing 1.0 volume percent of ethanol and 8.2 mg of

paclitaxel/ml. The preparation is produced by first dissolving the paclitaxel in absolute ethanol while heating it slightly, then adding the contrast agent quickly and under strong stirring.

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Example 4b: X-ray contrast medium for inhibiting intimal hyperplasia

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Preparation according to Example 4a plus adding 5 I.U. of heparin and 5 mmol/l of citrate buffer (pH 7.0).

Example 5a: Solution as an additive to contrast agents or infusion solutions

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20 mg of (±)-trans-1,2-diaminocyclohexane(7,12-bis[1-(1,4,7,10,13,16-hexaoxaheptadecyl)-ethyl]-3,8,13,17-tetramethylporphyrin-2,18-dipropionato)platinum(II) are dissolved in 10 ml of dimethyl sulfoxide (=solution B)

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Example 5b: X-ray contrast medium with an additive for inhibiting cell growth

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1 ml of solution B is added under fast stirring to 100 ml of Ultravist 370 (see Example 2b). The solution is suitable for infusion into arteries or injection into living or dead tissues or body cavities. It allows excellent control of its initial distribution and causes a long-lasting cytostatic effect.

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Example 5c: Contrast medium for magnetic resonance tomography with an additive for inhibiting cell growth

1 ml of solution B is added to 10 ml of 50 mmolar gadolinium DTPA (= gadopentetate) solution. A 50 mmolar

gadolinium-DTPA solution is prepared from Magnevist, a commercial preparation (Schering AG, Berlin), by diluting the product ten times. The solution can be infiltrated, for example, in vital tumors or in tumors after they were destroyed by ethanol, heat or cold treatment. The distribution of the solution is well visible in magnetic resonance tomograms. The solution itself supports the total destruction of the tumor in the immediately infiltrated area and its vicinity.

Example 6: In-vivo efficacy of the preparation as described in Example 2b

2 coronary arteries each in a total of 8 pigs were dilated under anesthesia, and stents (fine, heavily perforated metal tubes) were implanted. The arteries respond by wall thickening, which results in narrowing the original lumen of the arteries. 4 pigs were administered a regular X-ray contrast agent (Ultravist 370) for imaging the arteries and checking the stent implantation, 4 pigs were administered the preparation according to Example 2b. The vessels of both test groups practically had the same widths (inside diameters 3.4 ± 0.2 mm and 3.5 ± 0.2 mm) immediately after treatment. 4 weeks after treatment, the inside arterial diameter in animals that only received the regular contrast agent had stenosed by 1.9 ± 0.8 mm, whereas the arterial diameter in the animals that were treated with the solution according to Example 2b was only reduced by 0.9 ± 0.6 mm. This difference is statistically significant ($p = 0.01$). The undiluted solution according to Example 2b was tolerated without side effects despite the addition of a high concentration of a relatively toxic cytostatic after

injection in the coronary arteries and simultaneous ECG and blood pressure measurements.

Example 7a: Coating a catheter

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The distal area carrying the balloon of a balloon catheter designed for vessel dilatation is immersed under sterile conditions in the ethanolic solutions from Example 2a (=solution A), kept in the solution for ca. 5 minutes, then removed and dried for 2 hours at room temperature. The balloon catheter can then be used in the common way for dilating vessels.

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Alternatively, a stent is placed on the balloon after drying.

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Example 7b:

The procedure is like in Example 7a, but 100 mg of pharmaceutical castor oil are now added to solution A.

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Example 8a:

Solubility in the contrast agent or physiological NaCl solution

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7.6 mg of paclitaxel are dissolved in 0.5 mg of ethanol and added at room temperature to 50 ml Ultravist-370 (contains 768 mg of iopromide/ml, specific weight ca. 1.4 g/ml). A clear solution without any turbidity is obtained after mixing that remains stable for several days. No particles can be identified in the solution under a microscope.

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4.2 mg of paclitaxel are dissolved in 0.5 ml of ethanol and added at room temperature to 50 ml of a 0.9% NaCl solution. The preparation becomes turbid immediately after mixing; most particles are found on the surface of the solution after 2 hours. Large aggregations of fine particles are found using a microscope.

Evaluation: The solubility of paclitaxel in the contrast agent is highly surprising. The contrast agent solution contains 0.7 ml of water/ml of solution mixture, i. e. Less solvent is available to paclitaxel in the contrast agent solution than in the NaCl solution. In spite of that, paclitaxel dissolves better in the contrast agent solution than in the NaCl solution.

Example 8b:

Magnetite as the carrier of the antihyperplastic agent

75 mg of paclitaxel are dissolved in 5 ml of ethanol. The paclitaxel solution is added to 50 ml of an aqueous preparation of a colloidal magnetite coated with degraded dextrane (concentration refers to $\text{Fe}^{2+/3+}$ 0.5 molar, e.g. SH U 555C, test preparation by Schering AG, Berlin) and quickly intermixed. The magnetite particles adsorb paclitaxel and carry it after intravenous or intra-arterial injection, inter alia, into arterial walls showing arteriosclerotic change and brain tumors. Dosage depends on the use of the magnetite and is ca. 50 μmol referred to Fe/kg of body weight.

The foregoing embodiments are illustrative only of the principles of the invention, and various modifications and changes will readily occur to those skilled in the art. The invention is capable of being practiced and carried out in various ways and in other embodiments. It is also to be understood that the terminology employed herein is for the purpose of description and should not be regarded as limiting.

The term "comprise" and variants of the term such as "comprises" or "comprising" are used herein to denote the inclusion of a stated integer or stated integers but not to exclude any other integer or any other integers, unless in the context or usage an exclusive interpretation of the term is required.

Any reference to publications cited in this specification is not an admission that the disclosures constitute common general knowledge in Australia.

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The claims defining the invention are as follows:

1. A method for manufacturing a balloon catheter coated with an antihyperplastic active ingredient dried on the balloon surface, which contains a catheter with an expandable balloon, comprising the steps of:
 - (a) dissolving the active ingredient in a solvent, which does not attack the catheter,
 - (b) immersing the balloon in the solution, and
 - (c) removing the balloon from the solution and drying;characterised in that the catheter is coated with a preparation containing at least one antihyperplastic active ingredient with a distribution coefficient between butanol and water of ≥ 0.5 .
2. The method as claimed in Claim 1, characterised in that the catheter is coated with a preparation containing at least one antihyperplastic active ingredient with a distribution coefficient between butanol and water of ≥ 0.5 in capillary-accessible liquid form together with an agent for improving venous and arterial imaging.
3. The method as claimed in Claim 1 or claim 2, characterised in that the antihyperplastic active ingredient is a cytostatic, a corticoid, a prostacyclin, an antioxidant, an antibiotic, an agent for inhibiting cell proliferation or an immune suppressor.
4. The method as claimed in any one of Claims 1 to 3, characterised in that the antihyperplastic active ingredient is a taxoid.
5. The method as claimed in any one of Claims 1 to 4,

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characterised in that the antihyperplastic active ingredient is paclitaxel, docetaxel, probucol, a porphyrin derivative, colchicine or epothilon.

5 6. The method as claimed in any one of Claims 2 to 5, characterised in that the agent for improving venous and arterial imaging comprises vessel-compatible solutions, suspensions or emulsions, used in X-ray imaging, in ultrasound examination, in optical imaging or in magnetic resonance imaging for improved
10 imaging of blood vessels or blood flow.

7. The method as claimed in any one of Claims 2 to 6, characterised in that the agent for improving venous and arterial imaging is an X-ray contrast agent.

15 8. The method as claimed in any one of Claims 2 to 7, characterised in that the agent for improving venous and arterial imaging is iodixanol (Visipaque), gadolinium-DTPA (Magnevist), Gd-DO3A-butrol (Gadovist), iopromid (Ultravist), iohexol (Omnipaque)
20 or iopamidol (Solutrast).

9. The method as claimed in any one of Claims 1 to 8, characterised in that the preparation additionally contains coagulation inhibitors, and/or platelet aggregation inhibitors
25 and/or enzyme inhibitors and/or calcium chelators.

10. The method as claimed in any one of Claims 1 to 9, wherein the active ingredient binds irreversibly or reversibly to at least
30 10 % of tissue.

11. The method as claimed in any one of Claims 1 to 10, wherein the preparation has a specific affinity to vessel walls.

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12. The method as claimed in any one of Claims 1 to 11, characterised in that the solution contains a non-micelle-forming solubiliser.

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13. The method as claimed in any one of Claims 1 to 12, characterised in that the solution contains no matrix- or gel-forming additives.

10

14. A balloon catheter comprising a catheter with an expandable balloon, characterised in that the balloon is coated with at least an antihyperplastic active ingredient dried on the balloon surface, which is not enclosed by solubilisers in outwardly hydrophilic micelles.

15

15. The balloon catheter as claimed in Claim 14, characterised in that the antihyperplastic active ingredient has a distribution coefficient between butanol and water of ≥ 0.5 .

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16. The balloon catheter as claimed in Claim 14 or 15, characterised in that the coating further contains an agent for improving venous and arterial imaging.

25

17. A method for manufacturing a balloon catheter as defined in claim 1 and substantially as hereinbefore described with reference to examples 7a and 7b.

30

18. A balloon catheter as defined in claim 14 and substantially as hereinbefore described with reference to examples 7a and 7b.

DATED: 26 February 2008