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(54) ARTERY IMAGING DEVICE, AND ARTERY VISUALIZATION DEVICE AND METHOD

VORRICHTUNG FÜR ARTERIENBILDGEBUNG, UND VORRICHTUNG UND VERFAHREN FÜR ARTERIENVISUALISIERUNG

DISPOSITIF D'IMAGERIE DES ARTÈRES, ET DISPOSITIF ET MÉTHODE DE VISUALISATION DES ARTÈRES

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Description

TECHNICAL FIELD

[0001] The present invention relates to an artery visualization device and an artery imaging device.

BACKGROUND ART

[0002] In examination or treatment using a catheter, for example, in cardiac catheterization examination, an artery is punctured, a guide wire is inserted, and the catheter is inserted. The to-be-punctured portion is a radial artery, a brachial artery, a femoral artery, or the like. With respect to the radial artery among these arteries, it is easy to secure rest of hemostasis after examination, and since actions of a patient do not need to be restrained, the radial artery is suitable as a to-be-punctured portion.

[0003] On the other hand, a high technique is required for the puncture of the radial artery. In general, the puncture of the radial artery is performed while estimating running of the radial artery by palpation. In the case where the puncture is difficult, the puncture may be sometimes performed by using ultrasonic diagnostic equipment. However, manipulation procedures accompanied with scanning a probe are complicated, and the ultrasonic diagnostic equipment is relatively expensive. From such a clinical background, a technique of visualizing various arteries with a simple configuration and a relatively low cost, particularly, a technique of visualizing a radial artery has been eagerly waited for.

[0004] By the way, it is known that near-infrared light has a high permeability with respect to a human tissue such as skin, fat, and muscle. A blood vessel visualization device utilizing a property in that hemoglobin in blood absorbs near-infrared light has been proposed (refer to Patent Literature 1). Patent Literature 1 discloses a technique of visualizing a blood vessel of a finger for the purpose of performing biometric authentication.

[0005] As commercialized blood vessel visualization devices using near-infrared light and a near-infrared camera, a blood vessel visualization device "VeinViewer" (registered trademark) produced by Christie Medical Holdings Inc., a non-contact vein visualization device "StatVein" (registered trademark) produced by Techno Medica Co., Ltd., and the like are known.

Citation List

Patent Literatures

[0006] Patent Literature 1: JP-2005-191748 A

[0007] US2010177182 discloses an imaging device designed with the intent of visualizing subcutaneous structures within an organism. Fluid insertions into or extractions from an organism will be facilitated as the device is adapted to be placed upon the organism in a manner giving continued full mobility for the recipient and operator of the device.

[0008] US 2011/009751 discloses a subcutaneous access device comprising a multi-layered structure capable of use in a medical imaging procedure; a light source for transillumination of a body portion of interest of a patient's body; and an attachment portion for attaching the device to the patient's body in a manner such that the body portion of interest is outwardly exposed on a side of the patient's body opposite the light source.

[0009] JP 2004 237051 discloses a blood vessel visualizing method andapparatus. A light containing wavelength components of at least 600-1, 200 nm is applied on the skin surface for obtaining am image of the blood vessel right under the skin of the person and confirming the puncture position of a blood collecting needle

[0010] US 2009/009595 discloses a scattering medium internal observation apparatus including: a light source; an illuminating apparatus that guides light from the light source to an observation object that is a scattering body; and an observation optical system for observing the observation object illuminated by the illuminating apparatus, wherein the illuminating apparatus has a light-guiding member that guides light from the light source to a surface of the observation object, and a light-shielding member that covers the surface of the observation object and which shields light reflected or scattered in the vicinity of the light-guiding member of the observation object is disposed in the vicinity of an end portion of the light-guiding member on an observation object-side.

SUMMARY OF INVENTION

Technical Problem

[0011] However, the blood vessel visualization device disclosed in Patent Literature 1 is considered to have the main object of biometric authentication, and thus, the device is not contrived for the purpose of arterial puncture. There is no description of anatomical characteristics of to-be-punctured blood vessels, and finger is mentioned only as an objective living body (refer to Figs. 2 and 11 of Patent Literature 1). However, the artery of the finger is thin, and the puncture for an examination and a treatment using catheter is not performed. In addition, in comparison with a radial artery or a brachial artery, the artery of the finger is running at the shallow sites beneath the skin (at the sites in the depth of 2 to 3 mm beneath the skin) . Since the artery of the finger is not surrounded by bones, it is easy to irradiate transmission light. In addition, although the near-infrared light emitted from a light source propagates air to be irradiated on the living body, light reflected on the surface of the skin is not considered.

[0012] The above-described commercialized blood vessel visualization device ("VeinViewer" (registered trademark), "StatVein" (registered trademark), and the like) are merely devices capable of visualizing veins located within a depth of 2 to 3 mm beneath the skin.

[0013] Like this, devices for visualizing to-be-punctured arteries located in the depth of 5 to 10 mm beneath the skin, for example, devices for visualizing radial arteries or the like surrounded by bones have not been proposed.

[0014] Therefore, an object of the present invention is to provide an artery visualization device capable of very appropriately visualizing a to-be-punctured artery and an artery imaging device used for the artery visualization device.

Means for Solving Problem

[0015] In order to achieve the above object, according to an aspect of the present invention, there is provided an artery imaging device including:

an irradiation unit which includes a light source emitting near-infrared light and irradiates the near-infrared light emitted from the light source toward a back-side skin surface at a visualization site where a to-be-punctured artery is running,
a light guiding part which encapsulates the light source and is pressed against the back-side skin surface and which is formed with a material of transmitting the near-infrared light emitted from the light source and suppressing reflection of the near-infrared light on a surface of the back-side skin surface,
an optical filter which blocks visible light and transmits the near-infrared light passing through a front-side skin surface at the visualization site,
an imaging unit which receives the near-infrared light passing through the optical filter to capture an image of the visualization site, and
a pressure sensor (43) which is arranged to detect the pressure of pressing the light guiding part (40) against the opposite skin surface (22), the pressure sensor (43) being arranged on a back side of the pressing portion (42); and
a pressure regulating unit (100) which is capable of regulating a pressure of pressing the light guiding-part (40) against the opposite skin surface (22) in a range of 20 to 40 mmHg.

[0016] In addition, in order to achieve the above object, according to another aspect of the present invention, there is provided an artery visualisation method as provided in claim 9 below.

Advantageous Effect of the Invention

[0017] In the artery imaging device according to the present invention, the near-infrared light is incident from the back-side skin surface at the visualization site where the to-be-punctured artery is running, the absorption image of the near-infrared light absorbed by the artery is formed in the imaging unit which captures an image from the side of the back-side skin surface at the visualization site. Since the near-infrared light is incident on the back-side skin surface, the reflection of the near-infrared light does not occur on the surface of the front-side skin surface. Since the light guiding part which encapsulates the light source and is pressed against the back-side skin surface is formed with a material transmitting the near-infrared light and suppressing the reflection of the near-infrared light on the surface of the back-side skin surface, it is possible to allow the near-infrared light to be efficiently incident on the back-side skin surface at the visualization site. By pressing the light guiding part against the back-side skin surface, a capillary network of the skin is collapsed, so that the absorption of the near-infrared light in the skin portion on which the near-infrared light is incident is suppressed. As a result, it is possible to very appropriately visualize the to-be-punctured artery.

[0018] According to another aspect of the present invention, there is provided an artery visualization device capable of very appropriately visualizing the to-be-punctured artery may be configured by connecting the artery imaging device to an existing display unit, so that the artery imaging device has advantages in terms of costs.

BRIEF DESCRIPTION OF DRAWINGS

[0019]

Fig. 1 is a cross-sectional diagram illustrating an artery visualization device according to a first example.
Fig. 2 is a schematic cross-sectional diagram illustrating a manner of incidence of near-infrared light into a living body.
Fig. 3(A) is a front diagram illustrating development of a light shielding member illustrated in Fig. 1, and Fig. 3(B) is a cross-sectional diagram taken along line 3B-3B of Fig. 3(A).
Fig. 4 is a cross-sectional diagram illustrating an artery visualization device according to an embodiment.
Fig. 5 is a diagram illustrating a transmission image obtained by an experiment where a radial artery is visualized by using the artery visualization device according to the embodiment.
Fig. 6 is a cross-sectional diagram illustrating an artery visualization device according to Comparative Example.
Fig. 7 is a diagram illustrating an image obtained by an experiment where a radial artery is visualized by using the artery visualization device according to Comparative Example.

DESCRIPTION OF EMBODIMENTS

[0020] Near-infrared light having a high bio-permeability and a wavelength which is absorbed by hemoglobin is preferably used as irradiation light on a visualization site where arteries are running. An absorption coefficient of the oxygenated hemoglobin flowing in the arteries has a wavelength dependency. In the near-infrared wavelength range having a high bio-permeability, the absorption coefficient has a maximum in a range of 850 nm to 930 nm (refer to http://www.frontech.fujitsu.com/services/products/palmsecure/ what/interview/).

[0021] Epidermis located in the outermost layer of the skin reflects visible light and near-infrared light. Even in the case of the near-infrared light having a high bio-permeability, 80% of the irradiation light is reflected by the epidermis, and thus, about 10% of the light reaches a site in the depth of 3 mm beneath the skin (refer to Yoshihisa Aizu, "Skin Tissue Multilayer Structure Modeling, Journal of Japan Society of Mechanical Engineers, 2011. 7, vol. 114, no. 1112, 541 pages).

[0022] In general, puncture which is performed for the purpose of catheterization examination or invasive arterial pressure measurement is performed on a radial artery or a brachial artery. Therefore, in the visualization device for artery puncture, anatomical characteristics of the applied artery need to be considered.

[0023] The radial artery or the brachial artery is surrounded by bone tissues and is running in the depth of 5 to 10 mm beneath the to-be-punctured skin surface. In order to visualize the artery having such anatomical characteristics, the near-infrared light needs to be efficiently incident on the site where the artery is running, so that the near-infrared light needs to be emitted from the to-be-punctured skin surface.

[0024] In order to depict a near-infrared absorption image of the artery running in the depth of 5 to 10 mm beneath the skin, the near-infrared light needs not be irradiated on the surface of the skin of the to-be-punctured portion. This is because the reflected near-infrared light invalidates the absorption image by the artery.

[0025] The inventors of the present application insensitively studied based on the above-described findings, and as a result, achieved the technique for visualizing the radial artery and the brachial artery for the purpose of the puncture thereof.

[0026] Hereinafter, embodiments of the present invention will be described with reference to the attached drawings. In addition, in the description of the drawings, the same components are denoted by the same reference numerals, and the redundant description is omitted. Dimensional ratios in the drawings are exaggerated for the convenience of explanation, and thus, the ratios are different from actual ratios.

(First Example)

[0027] Fig. 1 is a cross-sectional diagram illustrating an artery visualization device 10 according to a first example, and Fig. 2 is a schematic cross-sectional diagram illustrating a manner of incidence of near-infrared light into a living body. In addition, Fig. 3 (A) is front diagram illustrating development of a light shielding member 90 illustrated in Fig. 1, and Fig. 3(B) is a cross-sectional diagram taken along line 3B-3B of Fig. 3 (A) .

[0028] As described in brief with reference to Fig. 1, the artery visualization device 10 according to the first example is configured to include an irradiation unit 30 which includes a light source 32 emitting near-infrared light and irradiates the near-infrared light emitted from the light source 32 toward a back-side skin surface 22 at a visualization site 20 where a to-be-punctured artery 21 is running, a light guiding part 40 which encapsulates the light source 32 and is pressed against the back-side skin surface 22 and which is formed with a material of transmitting the near-infrared light emitted from the light source 32 and suppressing reflection of the near-infrared light on the surface of the back-side skin surface 22, an optical filter 50 which blocks visible light and transmits the near-infrared light passing through a front-side skin surface 23 at the visualization site 20, a camera 60 (corresponding to an imaging unit) which receives the near-infrared light passing through the optical filter 50 to capture an image of the visualization site 20, and a monitor 70 (corresponding to a display unit) which displays the image captured by the camera 60. In the artery visualization device 10, the front-side skin surface 23 and the imaging unit 60 are arranged so as to be separated from each other, and a work space 80 where the puncture is performed is installed between the front-side skin surface 23 and the imaging unit 60. Hereinafter, the artery visualization device 10 according to the first example will be described in detail.

[0029] The illustrated visualization site 20 is, for example, a wrist portion where a radial artery as the to-be-punctured artery 21 is running. A hand is stretched to a side of the body, and the palm is directed upwards. The radial artery 21 is located in the depth of 5 to 10 mm beneath the skin and is surrounded by a radius 24, a carpal tunnel 25, a flexor tendon 26, and the like. In the figure, reference numeral 27 denotes an ulnar artery, and reference numeral 28 denotes an ulna.

[0030] The irradiation unit 30 is configured to include a chassis 31 which is formed in a substantially hollow box shape and a light source 32 which is arranged inside the chassis 31 to emit the near-infrared light. The chassis 31 is formed with a metal material such as aluminum which does not transmit the near-infrared light. The visualization site 20 is placed from the upper surface side of the chassis 31. The near-infrared light emitted from the light source 32 is irradiated toward the back-side skin surface 22 at the visualization site 20. As the light source 32, for example, an LED or the like emitting the near-infrared light may be used. The irradiated near-infrared light is preferably in a wavelength range of 840 to 950 nm. This is because the near-infrared light in the wavelength range of less than 840 nm is hard to transmit the visualization site 20 and the near-infrared light having a long wavelength exceeding the wavelength of 950 nm is hard to transmit due to absorption by water inside the living body.

[0031] The irradiated near-infrared light is more preferably in a wavelength range of 850 to 930 nm. Since the absorption coefficient of the oxygenated hemoglobin flowing in the artery has a maximum in the wavelength range of 850 to 930 nm, transmission light of which signal intensity is decreased due to the artery 21 may be obtained. As a result, a difference in contrast between the transmission light passing through the artery 21 and the transmission light passing through peripheral tissues occurs, and thus, it is easy to visually recognize the artery.

[0032] As illustrated in Fig. 2, as the manner of incidence of the near-infrared light into the living body, a transmission manner using pseudo-parallel light is preferred. On an imaging plane, a transmission light image of the transmission light passing through the living body and absorption image of the light absorbed by the artery 21 are formed. Therefore, preferably, the transmission light is incident vertically on the imaging plane.

[0033] Even the near-infrared light having a high biopermeability is easily reflected by the epidermis located in the outermost layer of the skin. In order to capture a clear image of the visualization site 20 by using the near-infrared light, it is necessary to suppress the reflection of the near-infrared light on the surface of the back-side skin surface 22. Therefore, the light guiding part 40 which encapsulates the light source 32 and is pressed against the back-side skin surface 22 is arranged between the light source 32 and the visualization site 20. The light guiding part 40 is formed with a material which transmits the near-infrared light emitted from the light source 32 and suppresses the reflection of the near-infrared light on the surface of the back-side skin surface 22. By the light guiding part 40, the near-infrared light is guided from the light source 32 to the back-side skin surface 22, and the reflection of the near-infrared light on the surface of the skin surface 22 is suppressed. As a result, the near-infrared light may be efficiently incident on the back-side skin surface 22 at the visualization site 20. In addition, since the near-infrared light is incident on the back-side skin surface 22, the reflection of the near-infrared light does not occur on the surface of the front-side skin surface 23.

[0034] As a material for forming the light guiding part 40, a material having a high transmittance with respect to the near-infrared light is preferred, which is obvious in terms of the transmission of the near-infrared light from the light source 32 to the back-side skin surface 22. In addition, in terms of the suppression of the reflection of the near-infrared light on the surface of the skin surface 22, as a material for forming the light guiding part 40, a material having a refractive index close to the refractive index of the living body is preferred. Preferably, the refractive index of the light guiding part 40 is in a range of from the refractive index of water of 1.33, a large amount of which is contained in the living body, to the refractive index of collagen of 1.44, a large amount of which is contained in the living body.

[0035] As an example of the material for forming the light guiding part 40, a silicon rubber having a high transmittance with respect to the near-infrared light and a refractive index close to that of the living body may be exemplified, and the refractive index is in a range of 1.33 to 1.44. Due to the light guiding part 40 formed with the forming material, the near-infrared light may be efficiently incident on the back-side skin surface 22 at the visualization site 20.

[0036] Preferably, ointment or cream having a high transmittance with respect to the near-infrared light is applied on the surface of the light guiding part 40 which is pressed against the back-side skin surface 22. This is because the reflection of the near-infrared light on the surface of the back-side skin surface 22 may be further suppressed.

[0037] By pressing the light guiding part 40 against the back-side skin surface 22, the back-side skin surface 22 is pressed, so that a capillary network of the skin is collapsed. Therefore, the absorption of the near-infrared light at the skin portion on which the near-infrared light is incident maybe suppressed. As a result, it is possible to efficiently irradiate the near-infrared light on the artery 21 located at a position deeper than the capillary network, so that it is possible to more clearly visualize the artery 21.

[0038] Preferably, a pressing portion 42 which protrudes toward the back-side skin surface 22 to press the back-side skin surface 22 is formed in the light guiding part 40. This is because the capillary network of the skin is easily collapsed by locally pressing the back-side skin surface 22 by using the pressing portion 42. Accordingly, it is possible to further suppress the absorption of the near-infrared light in the skin portion on which the near-infrared light is incident, so that it is possible to more clearly visualize the artery 21. If the shape of the pressing portion 42 is a shape of capable of easily collapsing the capillary network of the skin by pressing the back-side skin surface 22, the shape of the pressing portion 42 is not particularly limited. As illustrated, for example, a hemispherical shape may be exemplified. In addition, besides a shape having one convex portion, the pressing portion 42 may have a shape having a plurality of convex portions.

[0039] The pressure of pressing the light guiding part 40 against the back-side skin surface 22 is preferably in a range of 20 to 40 mmHg. This is because, by pressing the light guiding part 40 in a pressure range of 20 to 40 mmHg, the back-side skin surface 22 is pressed to collapse the capillary network of the skin, so that the absorption of the near-infrared light in the skin portion on which the near-infrared light is incident is suppressed.

[0040] A pressure sensor 43 is arranged between the back surface side of the light source 32 and the chassis 31. A contact pressure of pressing the light guiding part 40 against the back-side skin surface 22 is detected by the pressure sensor 43. A pressure detection method of the pressure sensor 43 is not particularly limited. For example, a pressure sensor using a method of detecting the pressure by reading out, as a voltage signal, a change in electrical resistance caused by deflection of a diaphragm due to the external pressure and distortion of a piezoresistive element formed on the diaphragm may be applied. Since the deflection amount of the diaphragm is directly recognized as a change in electrical resistance of the piezoresistive element, there are a large number of the pressure sensors using the method, which have a simple element structure and are miniaturized. The contact pressure detected by the pressure sensor is displayed on the monitor 70 by using numerical values, indicator bars, or the like. By adjusting the force of pressing the visualization site 20 against the light guiding part 40 while checking the display, it is possible to regulate the contact pressure between the back-side skin surface 22 and the light guiding part 40 in a range of 20 to 40 mmHg.

[0041] The optical filter 50 may be inserted between an imaging element and a lens in the camera 60 or arranged in front of the camera 60. In order to visualize the artery 21 located at the position in the depth of 5 to 10 mm beneath the skin, it is preferable that components having a wavelength shorter than 840 nm be blocked.

[0042] As the camera 60, a CCD camera, a CMOS camera, or the like for the near-infrared light which images the near-infrared light passing through the visualization site 20 and the optical filter 50 is applied. The CCD camera is a camera configured with a charge coupled device (CCD) element, and the CMOS camera is a camera using a complementary metal oxide semiconductor (CMOS). Data acquired by the near-infrared light CCD camera or the like are subject to image processes such as a noise process, an edge process, and a contrast enhancement process and an image analysis to be converted into data for an image which is to be displayed on the monitor 70.

[0043] If the monitor 70 is able to display the image captured by the camera 60, the monitor 70 is not particularly limited. A desk-top display may be used, and a head-mounted display may also be used. The displayed image may be any one of monochrome and color images. Medical persons such as operators may accurately recognize the position and direction of the running artery 21 by viewing the image of the artery 21 displayed on the monitor 70.

[0044] Since the artery visualization device 10 according to the embodiment is contrived for the purpose of easily performing the puncture of the artery 21, the skin at the to-be-punctured portion needs to be opened so as to perform the puncture. Therefore, the front-side skin surface 23 and the camera 60 are arranged so as to be separated from each other. As a result, the work space 80 where the puncture is performed is formed between the front-side skin surface 23 and the camera 60. The distance between the front-side skin surface 23 and the camera 60 may be set to be an appropriate distance in terms of securing the sufficient work space 80. As an example, the front-side skin surface 23 and the camera 60 are preferably arranged so as to be separated from each other by 20 centimeters or more.

[0045] The artery visualization device 10 is configured to further include a light shielding member 90 which covers the front-side skin surface 23. As illustrated in Figs. 3(A) and 3(B), a light shielding portion 91 formed with a material of blocking the near-infrared light and an observation window 92 opened for imaging the visualization site 20 are installed in the light shielding member 90. The light shielding member 90 may be configured to cover the front-side skin surface 23 in the state that the observation window 92 is allowed to be located just over the radial artery 21. By covering with the light shielding member 90, the near-infrared light may be transmitted from only the to-be-punctured portion in the front-side skin surface 23, so that the visualization of the to-be-punctured artery 21 becomes reliable. As a material of blocking the near-infrared light, for example, a light-shielding rubber may be exemplified, but not limited thereto.

[0046] The light shielding member 90 is configured to include a protruding portion 93 which is arranged around the observation window 92 and protrudes from the light shielding portion 91. By allowing the protruding portion 93 to be in contact with the front-side skin surface 23, the near-infrared light passing through a site excluding the site which faces the observation window 92 in the front-side skin surface 23 is blocked from being mixed into the observation window 92. The near-infrared light may be transmitted from only the to-be-punctured portion in the front-side skin surface 23, so that the visualization of the to-be-punctured artery 21 becomes more reliable.

[0047] As fixtures 94 for fixing the visualization site 20 in the state of being pressed against the light guiding part 40, for example, surface fasteners 95a and 95b which are generally called Magic Tape (registered trademark) are installed at both ends of the light shielding member 90. The surface fastener 95a of the light shielding member 90 is detachably adhered to the surface fastener 95b of the chassis 31 side. By fixing the light shielding member 90 by using the fixture 94, the visualization site 20 is fixed in the state of being pressed against the light guiding part 40, so that it is possible to prevent the position of the light shielding member 90 from being shifted or deviated during the artery visualization. Accordingly, it is possible to more reliably perform the visualization of the to-be-punctured artery 21.

[0048] As described heretofore, the artery visualization device 10 according to the first example has the following features.

(1) The light guiding part 40 is formed with a material which transmits the near-infrared light emitted from the light source 32 and suppresses the reflection of the near-infrared light on the surface of the back-side skin surface 22, the light source 32 is encapsulated by the light guiding part 40 and the light guiding part 40 is pressed against the back-side skin surface 22, so that the reflection of the near-infrared light does not occur on the surface of the back-side skin surface 22 which is the incidence side of the near-infrared light.

(2) The near-infrared light is incident on the artery

running portion from the back-side skin surface 22, and the absorption image of the near-infrared light absorbed by the artery 21 is formed in the camera 60 which captures the image from the side of the front-side skin surface 23. Since the near-infrared light is incident on the back-side skin surface 22, the reflection of the near-infrared light does not occur on the surface of the front-side skin surface 23.

(3) By pressing the back-side skin surface 22 by using the light guiding part 40, the capillary network of the skin is collapsed, so that the absorption of the near-infrared light in the skin portion on which the near-infrared light is incident is suppressed.

[0049] Due to the above features, it is possible to very appropriately visualize the to-be-punctured artery 21.

[0050] Since the front-side skin surface 23 and the imaging unit 60 are arranged so as to be separated from each other and the work space 80 where the puncture is performed is installed between the front-side skin surface 23 and the imaging unit 60, it is possible to visualize the to-be-punctured artery 21 without interfering with puncturing manipulation procedures.

[0051] Since the pressing portion 42 which protrudes toward the back-side skin surface 22 to press the back-side skin surface 22 is formed in the light guiding part 40, the capillary network of the skin is easily collapsed by locally pressing the back-side skin surface 22 by using the pressing portion 42. Accordingly, it is possible to further suppress the absorption of the near-infrared light in the skin portion on which the near-infrared light is incident, so that it is possible to more clearly visualize the artery 21.

[0052] Since the light shielding member 90 which is configured to include the light shielding portion 91 and the observation window 92 to cover the front-side skin surface 23 is further installed, the near-infrared light may be transmitted from only the to-be-punctured portion in the front-side skin surface 23, so that the visualization of the to-be-punctured artery 21 becomes reliable.

[0053] By allowing the protruding portion 93 of the light shielding member 90 to be in contact with the front-side skin surface 23, the near-infrared light may be transmitted from only the to-be-punctured portion in the front-side skin surface 23, so that the visualization of the to-be-punctured artery 21 becomes more reliable.

[0054] Since the irradiated near-infrared light is set to be in a wavelength range of 840 to 950 nm, it is possible to very appropriately visualize the artery 21 located at the position in the depth of 5 to 10 mm beneath the skin.

[0055] Since the material for forming the light guiding part 40 is the silicon rubber having a high transmittance with respect to the near-infrared light and a refractive index close to that of the living body and the refractive index is in a range of 1.33 to 1.44, it is possible to further suppress the reflection of the near-infrared light on the surface of the back-side skin surface 22.

[0056] By setting the pressure of pressing the light guiding part 40 against the back-side skin surface 22 to be in a range of 20 to 40 mmHg, the capillary network of the skin is collapsed by pressing the back-side skin surface 22, so that it is possible to suppress the absorption of the near-infrared light in the skin portion on which the near-infrared light is incident.

[0057] In the case where the artery for visualization is the radial artery 21 or the brachial artery, in the puncture operation which is performed for the purpose of the catheterization examination and the invasive arterial pressure measurement, it is possible to reliably and easily perform the puncture by visualizing the radial artery 21 or the brachial artery.

(Embodiment)

[0058] Fig. 4 is a cross-sectional diagram illustrating an artery visualization device 11 according to an embodiment. The same members as those of the first example are denoted by the same reference numerals, and some of the description thereof is omitted.

[0059] Similarly to the first example, the artery visualization device 11 according to the embodiment is configured to include an irradiation unit 30 which irradiates near-infrared light emitted from a light source 32 toward a back-side skin surface 22 at a visualization site 20, a light guiding part 40 which encapsulates the light source 32 and is pressed against the back-side skin surface 22, an optical filter 50, a camera 60, a monitor 70, a work space 80, and a light shielding member 90. However, the embodiment is different from the first example in that a pressure regulating unit 100 which is capable of regulating a pressure of pressing the light guiding part 40 against the back-side skin surface 22 is further included. In addition, the embodiment is also different from the first example in that the light shielding member 90 has a shape which is attachable by being wound around the visualization site 20.

[0060] A light-shielding portion 91 which is formed with a material of blocking the near-infrared light and is capable of being wound around the visualization site 20 and an observation window 92 opened for imaging the visualization site 20 are installed in the light shielding member 90 according to the embodiment. The light shielding member 90 may be configured to cover a front-side skin surface 23 in the state that the observation window 92 is allowed to be located just over a radial artery 21 and to be further wound around the visualization site 20. By covering with the light shielding member 90, the near-infrared light may be transmitted from only the to-be-punctured portion in the front-side skin surface 23, so that the visualization of the to-be-punctured artery 21 becomes reliable. As a material of blocking the near-infrared light, for example, a light-shielding rubber may be exemplified, but not limited thereto.

[0061] As fixtures 94 for fixing the visualization site 20 in the state of being pressed against the light guiding part 40, for example, surface fasteners 96a and 96b are installed at both ends of the light shielding member 90. The surface fasteners include the first surface fastener 96a which is installed at the end portion of the back surface side of the light-shielding portion 91 and the second surface fastener 96b which is installed at the end portion of the front surface side to be detachably adhered to the first surface fastener 96a. By fixing the light shielding member 90 to be being wound around the visualization site 20 by using the fixtures 94, the visualization site 20 is fixed in the state of being pressed against the light guiding part 40, so that it is possible to prevent the position of the light shielding member 90 from being shifted or deviated during the artery visualization.

[0062] The pressure regulating unit 100 is configured to include a balloon 101 which is expanded by injecting a fluid and an injection unit 102 which injects the fluid into the balloon 101. Similarly to a cuff for blood pressure measurement, the balloon 101 is formed with an inflatable rubber material. The injection unit 102 is configured to include a hollow tube 103 which is connected to the balloon 101 and an air supply tool 104 which supplies air as the fluid to the balloon 101 through the hollow tube 103. A manipulator 105 which operates a valve (not-shown) for regulating an air pressure of the balloon 101 is installed in the air supply tool 104. The light source 32 is attached on the outer surface of the balloon 101 so as to face the back-side skin surface 22. In the figure, reference numeral 106 denotes a hold plate 106 which is attached to the balloon 101 to hold the balloon 101. By pressing the hold plate 106 on a table or the like through the light shielding portion 91, it is possible to stabilize a posture of the visualization site 20 during the artery visualization.

[0063] In the case of regulating the pressure of pressing the light guiding part 40 against the back-side skin surface 22, the air pressure of the balloon 101 is regulated by the pressure regulating unit 100 while checking the contact pressure detected by the pressure sensor 43 which is displayed on the monitor 70. By using the pressure regulating unit 100, it is possible to simply and reliably regulate the pressure of pressing the light guiding part 40 against the back-side skin surface 22 in a range of 20 to 40 mmHg. By pressing the light guiding part 40 in a range of 20 to 40 mmHg, the back-side skin surface 22 is pressed to collapse the capillary network of the skin, so that so that the absorption of the near-infrared light in the skin portion on which the near-infrared light is incident is suppressed.

[0064] As described heretofore, the artery visualization device 11 according to the embodiment obtains the same functions and effects as those of the artery visualization device 10 according to the first example. In addition, since the artery visualization device 11 according to the embodiment is configured to include and the pressure regulating unit 100 which is capable of regulating the pressure of pressing the light guiding part 40 against the back-side skin surface 22, it is possible to simply and reliably regulate the pressure of pressing the light guiding part 40 against the back-side skin surface 22.

[0065] In the example and embodiment, the artery visualization devices 10 and 11 where the display unit 70 is connected to the artery imaging devices 120 and 121 configured to include the irradiation unit 30, the light guiding part 40, the optical filter 50, and the imaging unit 60 are illustrated. However, the artery imaging devices 120 and 121 may be connected to an existing display unit. In this case, by preparing only the artery imaging devices 120 and 121, the artery visualization device capable of very appropriately visualizing the to-be-punctured artery 21 may be configured, so that the artery imaging devices have advantages in terms of costs.

(Experimental Example)

[0066] A result of an experiment of visualizing the radial artery 21 by using the artery visualization device 11 illustrated in Fig. 4 will be described.

[0067] As the light source 32 of the irradiation unit 30, one LED (VSMY7850X1 produced by Vishay) having an emission center wavelength of 850 nm was used. A current of 1.75 volts and 720 mA was flowed into the LED. As a material of the light guiding part 40, a liquid silicon rubber (Shin-Etsu Silicone one-component RTV rubber "KE-441" produced by Shin-Etsu Chemical Co., Ltd.) was used. The refractive index of the liquid silicon rubber used is 1.4. The optical filter 50 which blocks components having a wavelength shorter than 840 nm was inserted between the imaging element and the lens of the camera 60. By regulating the airpressure of the balloon by using the pressure regulating unit 100, the pressure of pressing the pressing portion 42 of the light guiding part 40 against the back-side skin surface 22 was regulated to be 40 mmHg. The visualization target was the left radial artery 21 of a 50-year-old man.

[0068] The near-infrared light was transmitted from the distal forearm dorsal side, and the distal radial palmar surface side where the radial artery 21 was expected to be running was observed by the near-infrared high-sensitivity camera. The discrimination of the arteries 21 and the veins was performed according to existence and non-existence of vascular pulsation.

[0069] The position of the radial artery 21 was recognized by ultrasonic diagnostic equipment. The radial artery 21 was running in the depth of 7 mm beneath the skin.

[0070] The obtained transmission image is illustrated in Fig. 5.

[0071] Visibility of a moving picture was identified. In the moving picture having 30 frames per second, since the artery pulsation is clear, the radial artery 21 is easy to identify. The running of the radial artery 21 observed by the ultrasonic diagnostic equipment and a planar image projected on the surface of the skin were completely identical to those that were visually recognized by using video data.

(Comparative Example)

[0072] Fig. 6 is a cross-sectional diagram illustrating an artery visualization device 10A according to Comparative Example,

[0073] Unlike the embodiments, in Comparative Example, the near-infrared light was irradiated toward the front-side skin surface 23 at the visualization site 20, that is, toward the skin surface of the side where the to-be-punctured portion existed. If the near-infrared light is irradiated toward the artery 21, the reflection light of which signal intensity is decreased due to the artery 21 may be obtained. Therefore, the projection image was tried to be obtained by generating the contrast due to the difference between the reflection light at the artery 21 and the reflection light at the peripheral tissues. The light source 32, the optical filter 50, and the camera 60 which were the same as those of the above-described Experimental Example were used.

[0074] The obtained image is illustrated in Fig. 7.

[0075] As clarified from Fig. 7, only by observing the reflection light on the surface of the front-side skin surface 23, it was not possible to visualize the artery 21.

[0076] By replacing the light source 32, the wavelength of the near-infrared light is changed into a range of 750 to 950 nm, and the imaging was performed. However, since the reflection of the near-infrared light occurred on the skin surface, it was not possible to visualize the artery 21.

[0077] This patent application is based on Japanese Patent Application No. 2012-121700, filed on May 29, 2012 in the Japan Patent Office.

Reference Signs List

[0078]

10, 11:	Artery visualization device
20:	Visualization site
21:	Radial artery, to-be-punctured artery
22:	Back-side skin surface
23:	Front-side skin surface
24:	Radius
27:	Ulnar artery
28:	Ulna
30:	Irradiation unit
31:	Chassis
32:	Light source
40:	Light guiding part
42:	Pressing portion
43:	Pressure sensor
50:	Optical filter
60:	Camera (imaging unit)
70:	Monitor (display unit)
80:	Work space
90:	Light shielding member
91:	Light shielding portion
92:	Observation window
93:	Protruding portion
94:	Fixture
100:	Pressure regulating unit
101:	Balloon
102:	Injection unit
120, 121:	Artery imaging device

Claims

1. An artery imaging device having:

   an irradiation unit (30) which includes a light source (32) arranged to emit near-infrared light towards an opposite skin surface (22) of a visualization site (20) where a to-be-punctured artery (21) is running;
   a light guiding part (40) which encapsulates the light source (32) and which is formed with a material capable of transmitting the near-infrared light emitted from the light source (32) and suppressing reflection of the near-infrared light on a surface of the opposite skin surface (22), the light guiding part (40) including a pressing portion (42) which is configured to protrude towards the opposite skin surface (22) to press the opposite skin surface (22);
   an optical filter (50) which is arranged to block visible light and transmit the near-infrared light passing through a front-side skin surface (23) of the visualization site; and
   an imaging unit (60) which is arranged to receive the near-infrared light passing through the optical filter (50) to capture an image of the visualization site (20);
   characterised by further comprising:

      a pressure sensor (43) which is arranged to detect the pressure of pressing the light guiding part (40) against the opposite skin surface (22), the pressure sensor (43) being arranged on the back surface side of the light source (32); and
      a pressure regulating unit (100) which is configured to
      regulate a pressure of pressing the light guiding part (40) against the opposite skin surface (22) in a range of 20 to 40 mmHg.

2. The artery imaging device according to claim 1, wherein the front-side skin surface (23) and the imaging unit (60) are arranged so as to be separated from each other, and a work space (80) where puncture is performed is installed between the front-side skin surface (23) and the imaging unit (60).

3. The artery imaging device according to any one of claims 1 to 2, further comprising a light shielding

member (90) where a light-shielding portion (91) formed with a material of blocking the near-infrared light and an observation window (92) opened for imaging the visualization site (20) are installed to cover the front-side skin surface (23).

4. The artery imaging device according to claim 3, wherein the light shielding member (90) is configured to include a protruding portion (93) which is arranged around the observation window and protrudes from the light-shielding portion (91), and by allowing the protruding portion (92) to be in contact with the front-side skin surface (23), the near-infrared light passing through a site excluding the site which faces the observation window (92) in the front-side skin surface (23) is blocked from being mixed into the observation window (92).

5. The artery imaging device according to any one of claims 1 to 4, wherein the near-infrared light has a wavelength of 840 to 950 nm.

6. The artery imaging device according to any one of claims 1 to 5, wherein a material for forming the light guiding part (40) has a high near-infrared light transmittance and is a silicon rubber of which refractive index is close to that of a living body, and the refractive index is in a range of 1.33 to 1.44.

7. The artery imaging device according to any one of claims 1 to 6, wherein the to-be-visualized artery (21) is a radial artery (21) or a brachial artery.

8. An artery visualization device comprising the artery imaging device in accordance with any of claims 1-7 and a display unit which is arranged to display the image captured by the imaging unit.

9. An artery visualization method of visualizing a to-be-punctured artery (21) using an artery visualization device in accordance with claim 8, the method comprising
pressing the opposite skin surface (22) by using the light guiding part (40), collapsing the capillary network of the skin, and then visualizing the to-be-punctured artery (21).

Patentansprüche

1. Bildgebendes Gerät für Arterien, umfassend:

eine Bestrahlungseinheit (30) mit einer Lichtquelle (32), die so angeordnet ist,
dass sie Nah-Infrarotlicht in Richtung einer Hautoberfläche (22) emittiert, die sich gegenüber einer Visualisierungsstelle (20) befindet, an der eine zu punktierende Arterie (21) verläuft;
einen lichtführenden Teil (40), der die Lichtquelle (32) einkapselt und aus einem Material besteht, welches das von der Lichtquelle (32) emittierte Nah-Infrarotlicht weiterleiten und die Reflexion des Nah-Infrarotlichts auf einer gegenüberliegenden Hautoberfläche (22) unterdrücken kann, wobei der lichtführende Teil (40) einen Pressabschnitt (42) enthält, der dafür ausgelegt ist,
in Richtung der gegenüberliegenden Hautoberfläche (22) vorzustehen, um auf die gegenüberliegende Hautoberfläche (22) zu drücken;
einen optischen Filter (50), der so angeordnet ist, dass er sichtbares Licht blockiert und das Nah-Infrarotlicht durch eine vordere Hautoberfläche (23) der Visualisierungsstelle weiterleitet; und
eine Abbildungseinheit (60), die so angeordnet ist, dass sie das durch den optischen Filter (50) hindurchtretende Nah-Infrarotlicht zur Aufnahme eines Bildes der Visualisierungsstelle (20) empfängt;
dadurch gekennzeichnet, dass es ferner umfasst:

einen Drucksensor (43), der so angeordnet ist, dass er den Druck erfasst, wenn das lichtführende Teil (40) gegen die gegenüberliegende Hautoberfläche (22) gedrückt wird, wobei der Drucksensor (43) auf der rückwärtigen Oberfläche der Lichtquelle (32) angeordnet ist; und
eine Druckregeleinheit (100), die dafür ausgelegt ist, einen Druck in einem Bereich von 20 bis 40 mmHg zu halten, wenn das lichtführende Teil (40) gegen die gegenüberliegende Hautoberfläche (22) gedrückt wird.

2. Bildgebendes Gerät für Arterien gemäß Anspruch 1, wobei die vordere Hautoberfläche (23) und die Abbildungseinheit (60) voneinander getrennt angeordnet sind und ein Arbeitsbereich (80), in dem die Punktur durchgeführt wird, zwischen der vorderen Hautoberfläche (23) und der Abbildungseinheit (60) installiert ist.

3. Bildgebendes Gerät für Arterien gemäß einem der Ansprüche 1 bis 2, ferner umfassend ein Lichtabschirmelement (90), wobei ein Lichtabschirmabschnitt (91) mit einem das Nah-Infrarotlicht blockierenden Material gebildet ist und wobei ein zur Abbildung der Visualisierungsstelle (20) geöffnetes Beobachtungsfenster (92) installiert ist, um die vordere Hautoberfläche (23) zu bedecken.

4. Bildgebendes Gerät für Arterien gemäß Anspruch 3, wobei das Lichtabschirmelement (90) einen um das Beobachtungsfenster herum angeordneten und vom Lichtabschirmabschnitt (91) hervorragenden hervorstehenden Abschnitt (93) aufweist und wenn der hervorstehende Abschnitt (92) mit der vorderen Hautoberfläche (23) in Kontakt steht, wird das Nah-Infrarotlicht, welches eine Visualisierungsstelle durchdringt, die nicht die Stelle ist, die dem Beobachtungsfenster (92) auf der vorderen Hautoberfläche (23) zugewandt ist, daran gehindert, in das Beobachtungsfenster (92) eingemischt zu werden.

5. Bildgebendes Gerät für Arterien gemäß einem der Ansprüche 1 bis 4, wobei das Nah-Infrarotlicht eine Wellenlänge von 840 bis 950 nm aufweist.

6. Bildgebendes Gerät für Arterien gemäß einem der Ansprüche 1 bis 5, wobei ein Material, aus dem der lichtführende Teil (40) gebildet ist, einen hohen Transmissionsgrad für Nah-Infrarotlicht hat und ein Silikonkautschuk ist, dessen Brechungsindex fast dem eines lebenden Körpers entspricht und wobei der Brechungsindex zwischen 1,33 und 1,44 liegt.

7. Bildgebendes Gerät für Arterien gemäß einem der Ansprüche 1 bis 6, wobei die zu visualisierende Arterie (21) eine Radialarterie (21) oder eine Oberarmarterie ist.

8. Arterien-Visualisierungsgerät, umfassend ein bildgebendes Gerät für Arterien gemäß einem der Ansprüche 1 bis 7 und eine Anzeigeeinheit, die angeordnet ist, das von der Abbildungseinheit aufgenommene Bild anzuzeigen.

9. Arterien-Visualisierungsverfahren zum Visualisieren einer zu punktierenden Arterie (21) unter Verwendung einer Arterien-Visualisierungsgerät gemäß Anspruch 8, wobei das Verfahren umfasst:

mit dem lichtführenden Teil (40) auf die gegenüberliegende Hautoberfläche (22) drücken, das Kapillarnetz der Haut kollabieren und dann die zu punktierende Arterie (21) visualisieren.

Revendications

1. Un dispositif d'imagerie des artères ayant :

une unité d'irradiation (30) qui comprend une source de lumière (32) disposée pour émettre une lumière infrarouge proche vers une surface cutanée opposée (22) d'un site de visualisation (20) où une artère à ponctionner (21) traverse ;
une partie de guidage de lumière (40) qui encapsule la source de lumière (32) et qui est formée d'un matériau capable de transmettre la lumière infrarouge proche émise à partir de la source de lumière (32) et de supprimer la réflexion de la lumière infrarouge proche sur une surface de la surface cutanée opposée (22), la partie de guidage de lumière (40) comprenant une partie de pression (42) qui est configurée pour faire saillie vers la surface cutanée opposée (22) pour presser la surface cutanée opposée (22) ;
un filtre optique (50) qui est disposé de manière à bloquer la lumière visible et à transmettre la lumière infrarouge proche passant à travers une surface cutanée côté avant (23) du site de visualisation ; et
une unité d'imagerie (60) qui est disposée pour recevoir la lumière infrarouge proche passant à travers le filtre optique (50) pour capturer une image du site de visualisation (20) ;
caractérisé par le fait qu'il comprend en outre :

un capteur de pression (43) qui est disposé pour détecter la pression consistant à presser la partie de guidage de lumière (40) contre la surface cutanée opposée (22), le capteur de pression (43) étant disposé sur le côté de la surface arrière de la source de lumière (32) ; et
une unité de régulation de pression (100) qui est configurée pour réguler une pression consistant à presser la partie de guidage de lumière (40) contre la surface cutanée opposée (22) dans une plage de 20 à 40 mmHg.

2. Le dispositif d'imagerie des artères selon la revendication 1, dans lequel la surface cutanée côté avant (23) et l'unité d'imagerie (60) sont disposées de manière à être séparées l'une de l'autre, et un espace de travail (80) où la ponction est effectuée est installé entre la surface cutanée côté avant (23) et l'unité d'imagerie (60).

3. Le dispositif d'imagerie des artères selon l'une quelconque des revendications 1 à 2, comprenant en outre un élément de protection contre la lumière (90) où une partie de protection contre la lumière (91) formée avec un matériau bloquant la lumière infrarouge proche et une fenêtre d'observation (92) ouverte pour l'imagerie du site de visualisation (20) sont installées pour couvrir la surface cutanée côté avant (23).

4. Le dispositif d'imagerie des artères selon la revendication 3, dans lequel l'élément de protection contre la lumière (90) est configuré pour comprendre une partie saillante (93) qui est disposée autour de la fenêtre d'observation et qui fait saillie à partir de la partie de protection contre la lumière (91), et en permettant à la partie saillante (92) d'être en contact avec la surface cutanée côté avant (23), la lumière infrarouge proche passant à travers un site excluant le site qui fait face à la fenêtre d'observation (92) dans la surface cutanée côté avant (23) est empêchée d'être mélangée dans la fenêtre d'observation (92).

5. Le dispositif d'imagerie des artères selon l'une quelconque des revendications 1 à 4, dans lequel la lumière infrarouge proche a une longueur d'onde de 840 à 950 nm.

6. Le dispositif d'imagerie des artères selon l'une quelconque des revendications 1 à 5, dans lequel un matériau pour former la partie de guidage de lumière (40) a une transmission de lumière infrarouge proche élevée et est un caoutchouc de silicone dont l'indice de réfraction est proche de celui d'un corps vivant, et l'indice de réfraction est dans une plage de 1,33 à 1,44.

7. Le dispositif d'imagerie des artères selon l'une quelconque des revendications 1 à 6, dans lequel l'artère à visualiser (21) est une artère radiale (21) ou une artère brachiale.

8. Un dispositif de visualisation des artères comprenant le dispositif d'imagerie des artères selon l'une quelconque des revendications 1 à 7 et une unité d'affichage qui est disposée pour afficher l'image capturée par l'unité d'imagerie.

9. Un procédé de visualisation des artères pour visualiser une artère à ponctionner (21) en utilisant un dispositif de visualisation des artères selon la revendication 8, le procédé comprenant
la pression de la surface cutanée opposée (22) en utilisant la partie de guidage de lumière (40), l'affaissement du réseau capillaire cutané, et ensuite la visualisation de l'artère à ponctionner (21).

FIG.1

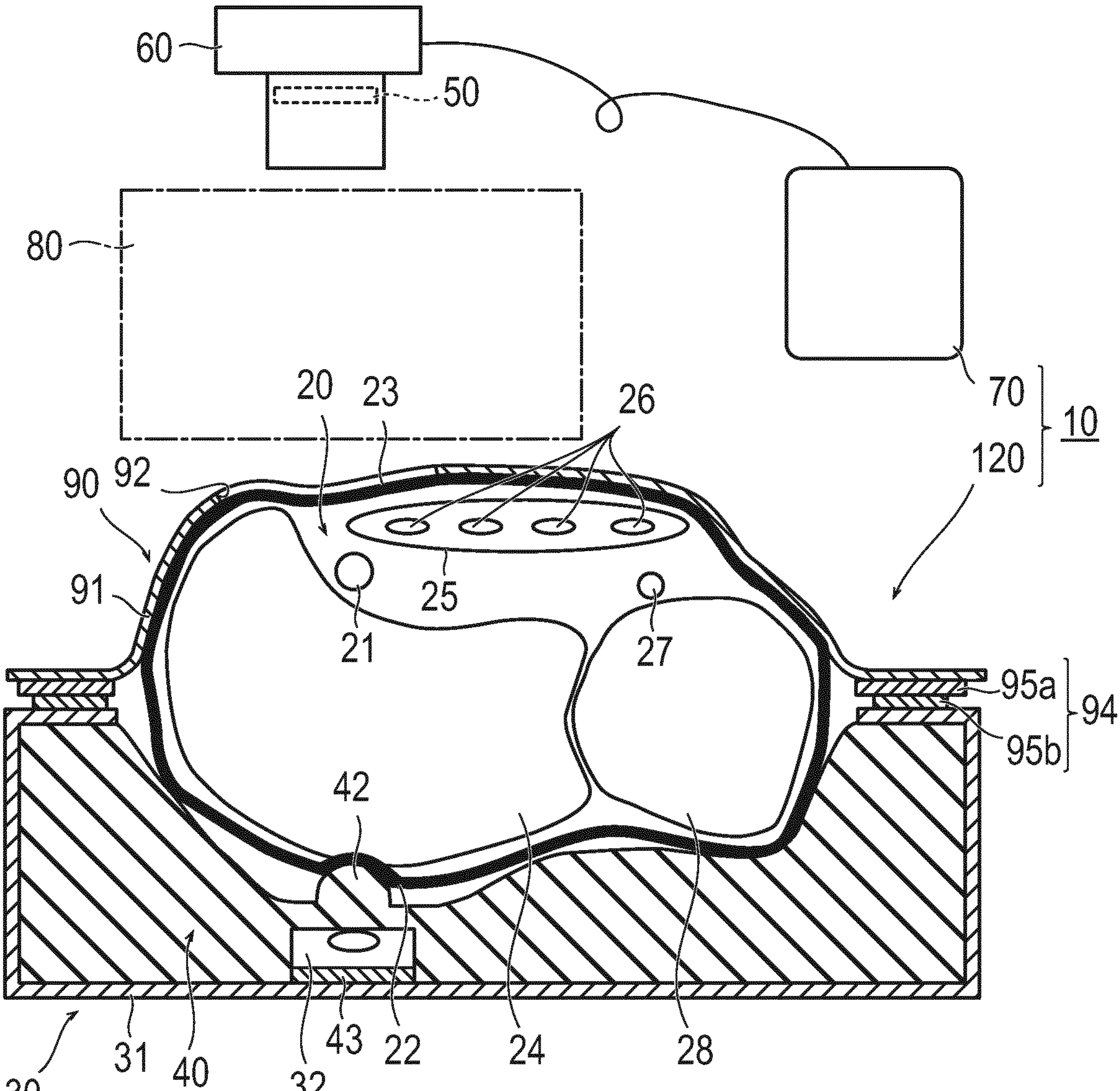

60
50
80
70
10
120
20
23
26
90
92
91
25
21
27
95a
94
95b
42
30
31
40
32
43
22
24
28

FIG.2

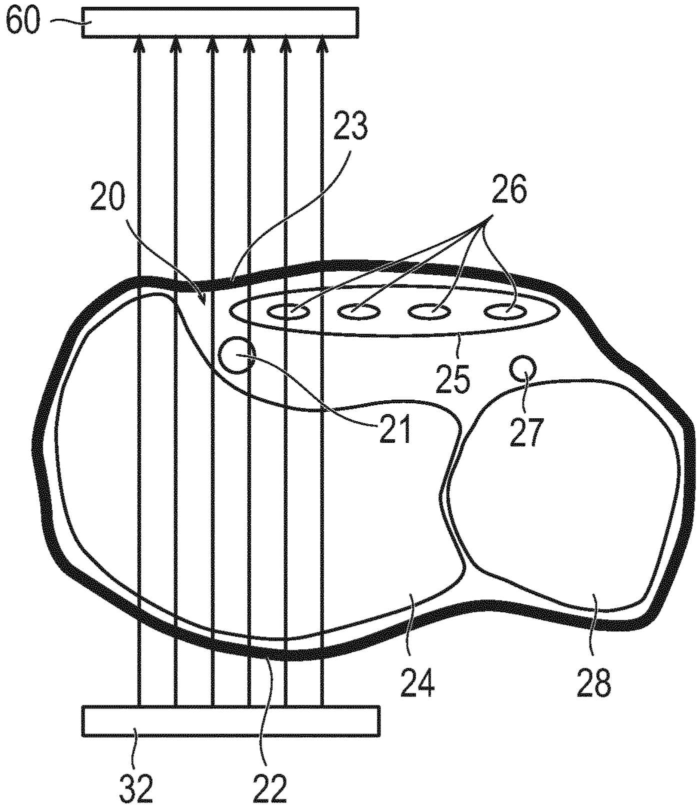


FIG.3 (A)

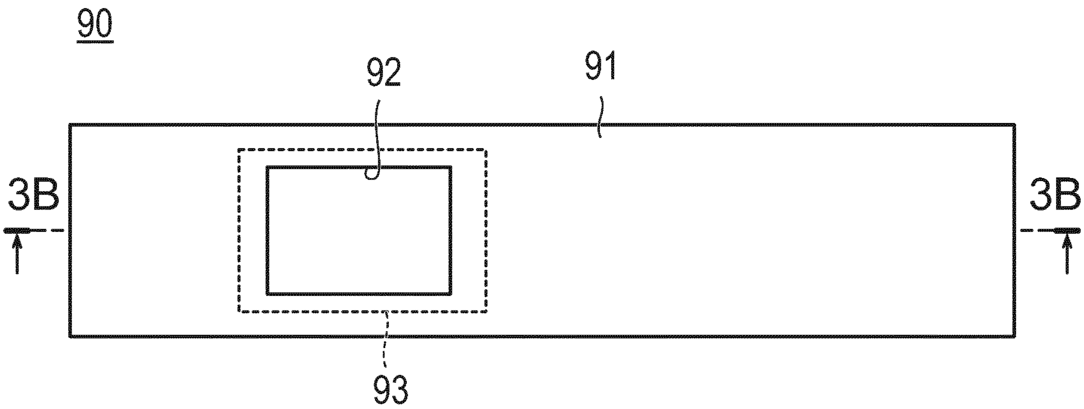


FIG.3 (B)

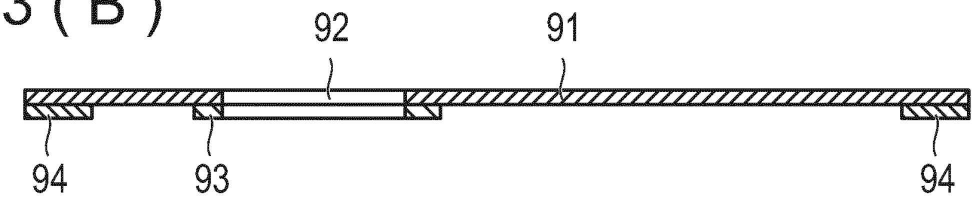


FIG.4

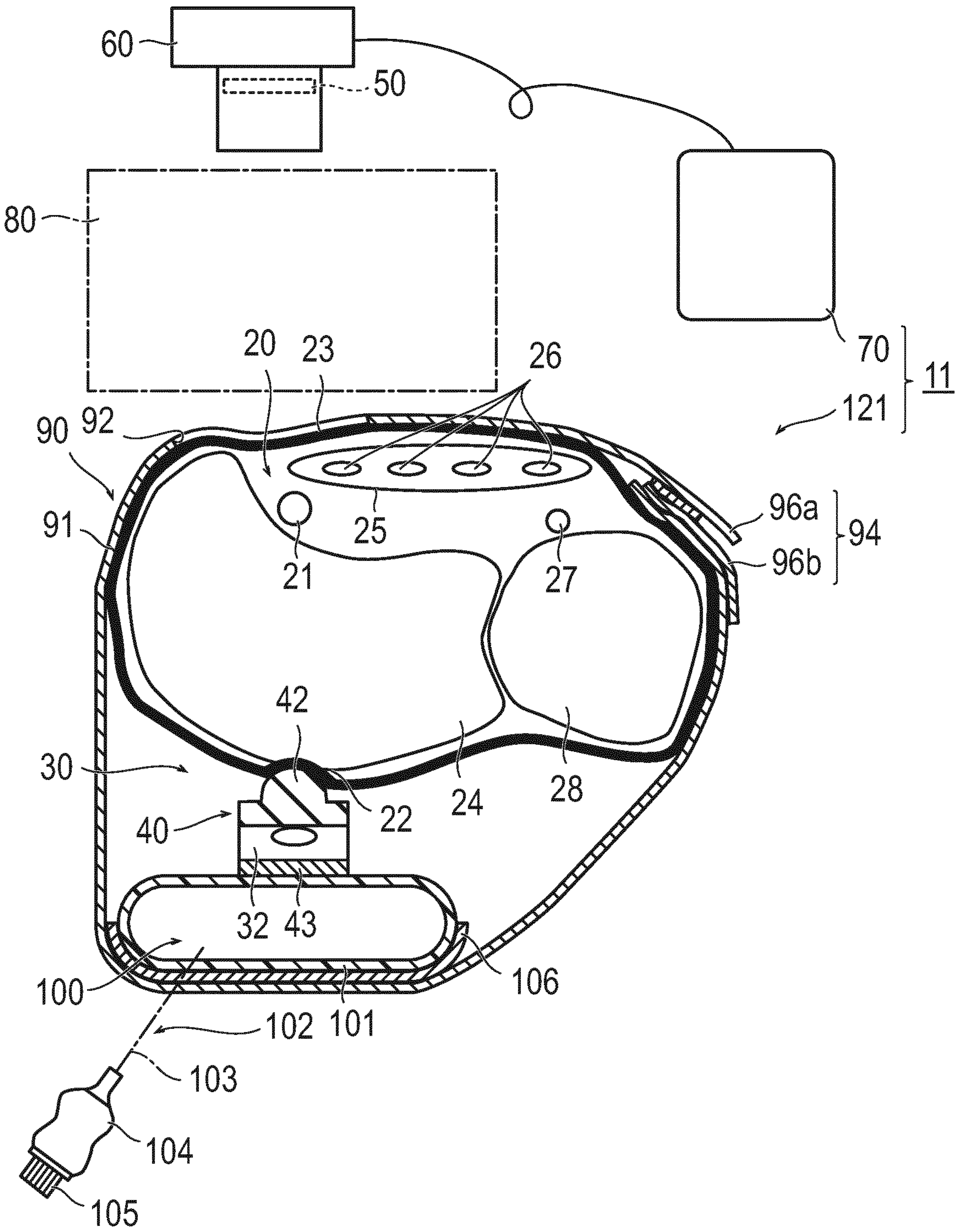

60
50
80
70
11
121
20
23
26
90
92
91
25
21
27
96a
96b
94
42
30
24
28
40
22
32
43
100
106
102
101
103
104
105

FIG.5

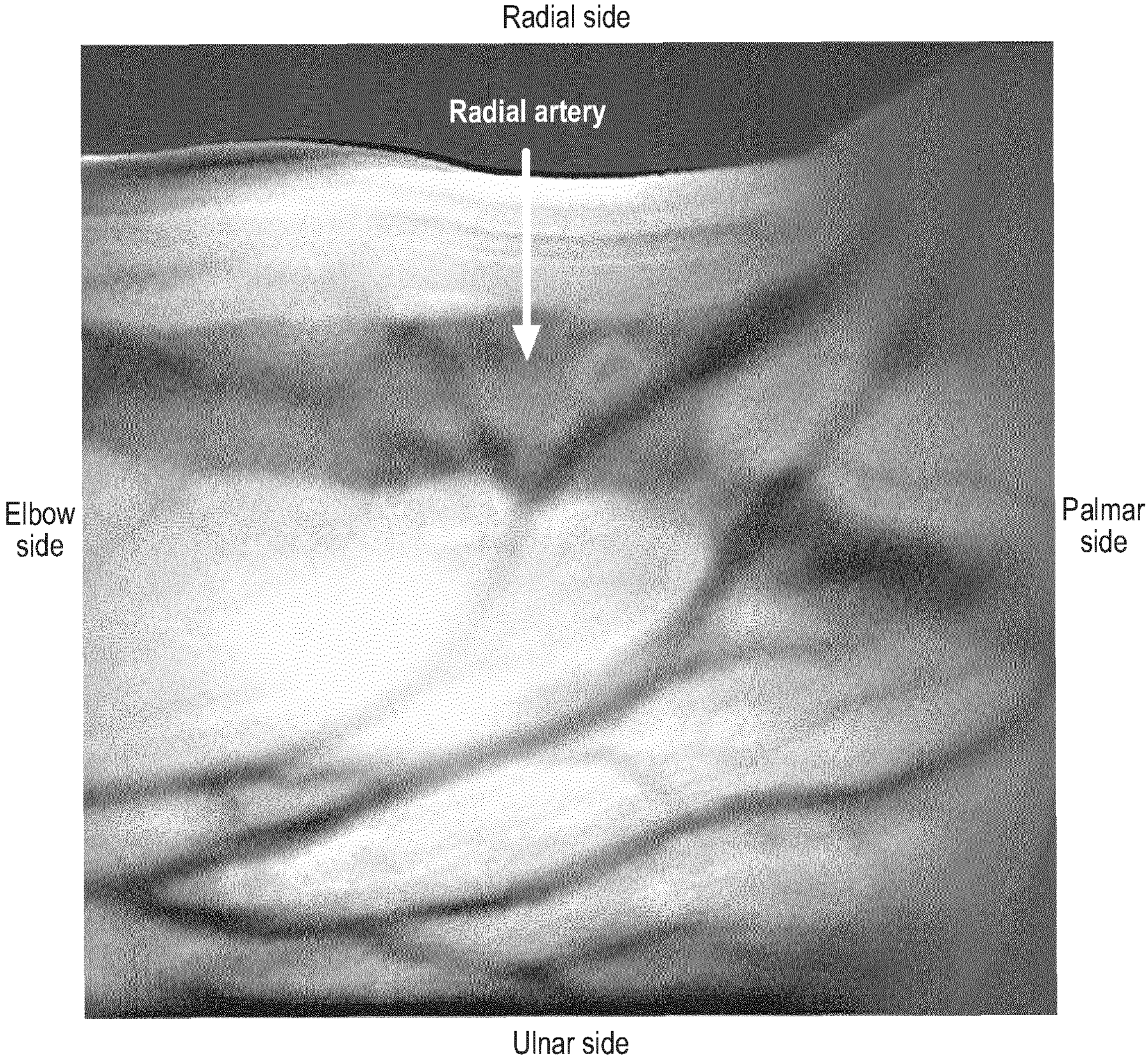

Radial side
Radial artery
Elbow side
Palmar side
Ulnar side

FIG.6

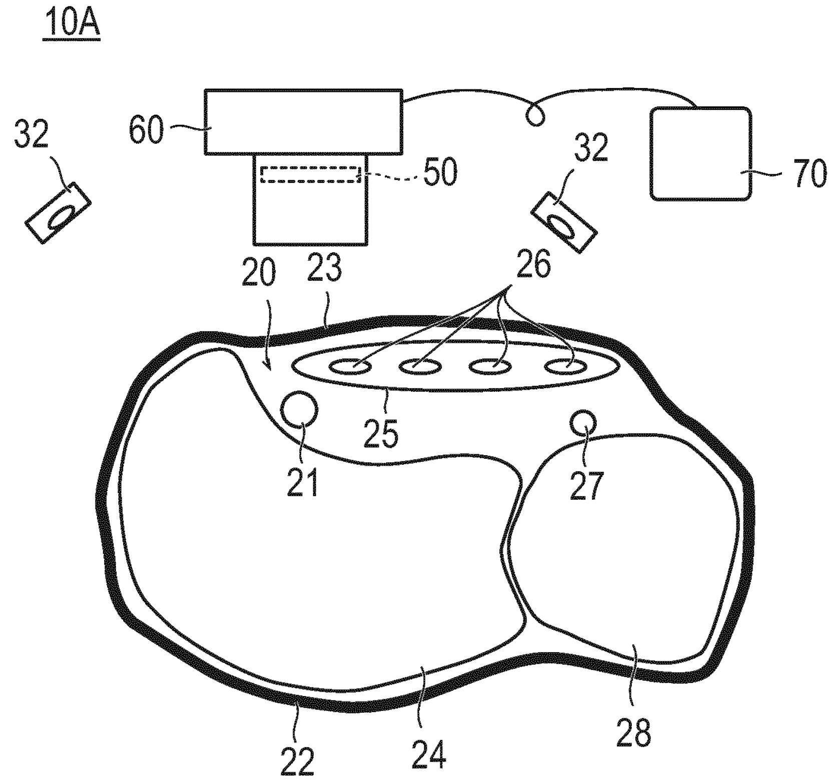
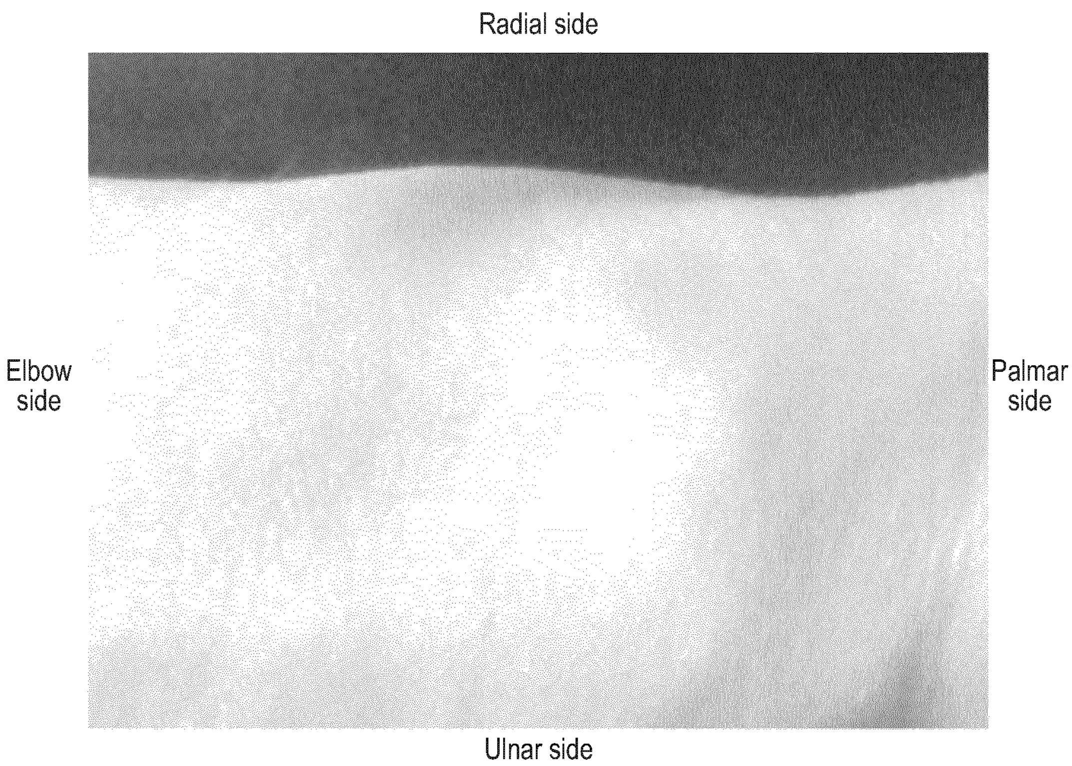

10A
32
60
50
32
70
20
23
26
25
21
27
22
24
28

FIG.7


Radial side
Elbow side
Palmar side
Ulnar side

REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	动脉成像装置以及动脉可视化装置和方法		
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[标]申请(专利权)人(译)	国立大学法人高知大学		
申请(专利权)人(译)	国立大学法人高知大学		
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外部链接	Espacenet		

摘要(译)

[问题]提供一种能够非常适当地可视化要穿刺的动脉的动脉可视化装置以及用于该动脉可视化装置的动脉成像装置。 [解决方案]动脉可视化装置（10）包括照射单元（30），该照射单元（30）将从光源（32）发出的近红外光朝着可视化部位（20）的背面皮肤表面（22）照射。 在要穿刺的动脉（21）中，导光部（40）将光源密封并压在背面皮肤表面上，并由使发射的近红外光透过的材料形成 滤光器（50）从光源发出并抑制近红外光在背面皮肤表面上的反射，该滤光器（50）阻挡可见光并使透射通过正面皮肤表面的近红外光（ 23），在可视化部位，具有接收通过光学滤波器的近红外光以捕获可视化部位（20）的图像的照相机（60）（成像单元），以及监视器（70）（显示器 单位），以显示相机拍摄的图像。

FIG.1