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(54) **DEVICE FOR NON-INVASIVE ULTRASOUND TREATMENT OF DISC DISEASE**

GERÄT ZUR NICHTINVASIVEN ULTRASCHALLBEHANDLUNG VON BANDSCHEIBENERKRANKUNGEN

DISPOSITIF DE TRAITEMENT NON-INVASIF A ULTRASONS D'AFFECTION DISCALE

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Description

[0001] The present invention relates to a device for non--invasive ultrasound treatment of disc disease, wherein at least one therapeutic ultrasound transducer is provided for treatment of the disc, preferably nucleus pulposus, of a patient by generating by means of said therapeutic ultrasound transducer an ultrasonic field, the temperature focus of which is located in the disc, preferably nucleus pulposus, for heating thereof, and wherein the therapeutic ultrasound transducer is of a "phased--array"-type for being able to vary the distance between the transmitter element of the therapeutic ultrasound transducer and the temperature focus of its ultrasonic field.

[0002] The intervertebral disc consists of an outer fibrous tissue ring, anulus fibrosus, and an inner, more viscous part, nucleus pulposus. The disc functions as a shock absorber and if anulus fibrosus breaks, e.g. a small fissuring, disc matter may find its way out and cause a compression of nerve roots and induce an inflammatory reaction.

[0003] Prolapsed intervertebral discs have been treated surgically since the thirties by removal of the displaced disc matter and/or a part of the bulging disc. Later, the surgical treatment has developed towards less invasive operations and now, microscopes and percutaneous techniques are used for removing disc matter. An alternative method for surgical treatment is chemonucleolys, where the enzyme chymopapain is injected into nucleus pulposus, the central part of the disc. The enzyme polymerizes the long proteoglycan chains in nucleus pulposus with subsequent loss of the hygroscopicity. This reduces the volume and pressure in nucleus pulposus and the bulging part of the disc, which explains the pain relief patients with sciatica experience after chemonucleolys. The method has proven to give pain relief in 75 per cent of the cases and has a well documented cost efficiency. Unfortunately, the method has caused serious allergic reactions in about 1 per cent of the cases. Next step in the development could be a non-invasive treatment or therapy of prolapsed intervertebral discs, which preferably should be painless, avoid the risk for infections and carried through ambulatory.

[0004] A method for thermotherapy and coagulation of tissue involves use of focused ultrasound with high intensity. The ultrasound pass well through soft tissue and can be focused on remote spots within a surface of a few millimeters. The energy absorption in the tissue increases the temperature with a sharp temperature gradient such that the boundaries of the treated volume are clearly limited without causing any damages on the surrounding tissue (US 5 291 890, US 5 501 655). Ultrasound treatment or therapy of prolapsed intervertebral discs is previously known (EP 0 872 262 disclosing the preamble of claim 1).

[0005] Heat treatment or thermotherapy of discs has proven successful in a method called IDET (US 6 073 051, US 6 007 570, US 5 980 504). The method has as its aim to insert a catheter into the disc by means of a cannula. Farthest out on the catheter there is a spool which is heated by applying a radio frequency voltage thereon (US 5 785 705). The heat is increased to about 90°C in nucleus pulposus where the heating element of the catheter has been located and treatment or therapy is carried through for about 15 minutes.

[0006] Surgery with focused ultrasound has several advantages compared with other thermal techniques. In the first place, it is non-invasive, secondly, focus can be made movable and thirdly, the energy can be supplied in a few seconds. The limitation of ultrasound is its absorption in bone and its poor penetration through gas--filled passages. Clinical applications of ultrasound surgery are today mostly used in ophtalmic surgery, urology and oncology. The effect of ultrasound can be divided into thermal and non-thermal effects.

[0007] The thermal effects of ultrasound are caused by absorption of ultrasound in the tissue. This leads to a temperature increase which is dependent on the parameters of the ultrasound (frequency and intensity) and the acoustic properties of the tissue. The absorption of ultrasound in musculoskeletal tissues increases with the apatite and protein content, which means high absorption in bone, cartilage, tendons and ligaments. Water however, has a low ultrasound absorption capacity and can for this reason be used as an acoustic medium between the ultrasound transducer and the tissue. Higher absorption can be expected in anulus fibrosus (high collagen content) than in nucleus pulposus (high water content). This will lead to higher temperatures in the outer part of the intervertebral disc than in the central part. In order to avoid that the temperature in anulus fibrosus exceeds a detrimental level at the same time as the temperature in nucleus pulposus reaches a sufficient level, the ultrasound can be transmitted from several ultrasound sources. In this manner, the fields will overlap each other and increase the effect in nucleus pulposus at the same time as the intensity in the surrounding tissue including anulus fibrosus can be kept low.

[0008] The object of the present invention has been to facilitate, at the abovementioned devices, location of the temperature focus of the ultrasonic field of the ultrasound transducer on a desired point in the disc, preferably in nucleus pulposus. This is arrived at according to the invention by means of a device having the characterizing features of subsequent claim 1.

[0009] By means of the device defined in the claims, it is achieved that the temperature focus of the ultrasonic field of the therapeutic ultrasound transducer can be located and maintained on the desired point in the disc, preferably in nucleus pulposus.

[0010] The invention will be further described below with reference to the accompanying drawings, in which

fig. 1 schematically illustrates a structural embodiment of the device according to the invention; and

fig. 2 schematically illustrates a calibrating device which may form part of a device according to fig. 1.

[0011] The treatment device 1 schematically illustrated in fig. 1 is adapted to generate, by means of one or more therapeutic ultrasound transducers 2 (so called therapeutic transducers), one or more ultrasonic fields 3, the temperature focus F of which is intended to be located in the intervertebral disc 5, preferably in nucleus pulposus 6, of the patient 4 for treatment thereof. In fig. 1, only one therapeutic ultrasound transducer 2 is illustrated, but there may be several transducers as in e.g. EP 0 872 262.

[0012] The therapeutic ultrasound transducer 2 comprises a plurality of, preferably three or more position transmitters 7 for determining its position.

[0013] In more detail, the therapeutic ultrasound transducer 2 is adapted to cause a local temperature increase in nucleus pulposus 6 so that enzymes such as collagenase present in the disc 5, are activated and cause decomposition of collagen and proteoglycanes, which results in shrinking of nucleus pulposus 6 primarily because of less hygroscopicity. The therapeutic ultrasound transducer 2 can transmit its ultrasonic field 3 dorsolaterally from several different ports simultaneously. For being able to vary the focal distance of the therapeutic ultrasound transducer 2, i.e. the distance between its transmitter element G and the temperature focus F, said therapeutic ultrasound transducer 2 must be of the "phased array"--type, including several small piezoelectric elements. By excitation of these elements with different time delays, a focused ultrasonic field 3 is generated.

[0014] The treatment device 1 further comprises a diagnostic ultrasound transducer 8. This is adapted to generate an ultrasonic field 9 for determining the acoustic properties of the patient's tissue 10 between the area 11 on the patient for location of the therapeutic ultrasound transducer 2 during treatment and the disc 5, preferably nucleus pulposus 6, to be treated. This "time of flight"--measurement with the diagnostic ultrasound transducer 8 is carried through for determining the distance between said area 11 and nucleus pulposus 6 as well as the thickness of the tissue and of the different tissue layers.

[0015] The tissue 10 passed consists in said order of skin, fat, muscles and anulus fibrosus. This information is needed to correct differences in size and tissue configuration of various patients, since the attenuation of the ultrasound is different in different types of tissue.

[0016] The diagnostic ultrasound transducer 8 comprises a plurality of, preferably three or more position transmitters 12 for determining its position and it is provided to generate an image of said tissue 10 in a monitor 13.

[0017] The treatment device 1 also comprises an optical navigating device 14 to navigate the therapeutic ultrasound transducer 2 (US 5 772 594). This optical navigating device 14 comprises at least one diagnostic camera 15 which is adapted to produce at least one picture or image of the anatomic structure 17 of the treatment area 16 in the monitor 13. The diagnostic camera may be an X-ray camera 18 taking two pictures of the anatomic structure 17 of the treatment area 16 from different directions with preferably a 90° intermediate angle and showing these in the monitor 13. At the optical navigating device 14, the X-ray camera 18 is used together with an optical analogue-digital-converter for obtaining a real time image or picture in the monitor 13 of the position and direction of the therapeutic ultrasound transducer 2 (US 6 021 343, US 5 834 759, US 5 383 454).

[0018] The X-ray camera 18 comprises a calibrating device 19 - e.g. a calibrating hood - which is located in front of the objective of the X-ray camera 18 and having markers 20 the mutual distance of which is known. The markers 20 may be round and consist e.g. of tantalum.

[0019] The optical navigating device 14 further comprises a reference device 21 which is provided to be attached to the spinous process 23 of a vertebra 22 or in a corresponding position such that it gets a determined or fixed position relative to the treatment area 16. The reference device 21 has several position transmitters 24, namely preferably at least three, and these may consist of tantalum.

[0020] Furthermore, the optical navigating device 14 comprises a signal receiving and/or signal sending unit 25. This includes a suitable number of signal receivers 26, 27 for receiving reflected or other signals from the position transmitters 7, 12 and 24 of the therapeutic ultrasound transducer 2, the diagnostic ultrasound transducer 8 and the reference device 21 respectively. The signal receiving and/or signal sending unit 25 may eventually comprise one or more signal transmitters 28 for sending or transmitting signals to said position transmitters 7, 12 and 24, which are provided to receive these signals.

[0021] The signals transmitted by the position transmitters 7, 12 and 24 may e.g. be in the form of infrared light and the signal receivers 26, 27 may in such case be receivers of infrared light.

[0022] The treating device 1 further comprises a computer 29 with at least one computer program or software which is designed to calculate a suitable setting of the transmitter element G of the therapeutic ultrasound transducer 2, based on the acoustic properties determined by the diagnostic ultrasound transducer 8, such that the temperature focus F of the ultrasonic field 3 of the therapeutic ultrasound transducer 2 can be brought to appear in the disc 5, preferably in nucleus pulposus 6, to be treated.

[0023] Said program or software may alternatively, or in combination with said setting of the therapeutic ultrasound transducer 2, be provided to calculate the position of the temperature focus F of the ultrasonic field 3 of the therapeutic ultrasound transducer 2 relative to said therapeutic ultrasound transducer 2, based on said acoustic properties and the setting of the therapeutic ultrasound transducer 2 in view of its focusing properties, so that the therapeutic ultrasound transducer 2 by means of said optical navigating device 14 can be positioned such that

said temperature focus F appears in the disc 5, preferably nucleus pulposus 6, to be treated.

[0024] The computer 29 may be provided with a program (software) which is designed to calculate the effect of the ultrasonic field 3 of the therapeutic ultrasound transducer 2 in its temperature focus F based on the acoustic properties determined by the diagnostic ultrasound transducer 8, such that the temperature increase in nucleus pulposus 6 caused by the therapeutic ultrasound transducer 2, can be determined.

[0025] In the treatment device 1 there may also be included a calibrating unit 30 for calibrating (a) the position of the temperature focus F of the therapeutic ultrasound transducer 2 relative to its transmitter element G, and (b) the heating effect in said temperature focus F generated by said therapeutic ultrasound transducer 2. The calibrating unit 30 has similar acoustic properties as human tissue and contains a plurality of thermoelements 31 by means of which the position and effect on said temperature focus F can be measured for calibration. The thermoelements 31 are connected to a schematically illustrated measure instrument 32.

[0026] Prior to treatment of the disc 5, preferably nucleus pulposus 6, the reference device 21 is located on the patient's 4 vertebra 22 and the therapeutic ultrasound transducer 2 as well as the diagnostic ultrasound transducer 8 are calibrated in the calibrating unit 30. Then, a tissue analysis is made by means of the diagnostic ultrasound transducer 8, which preferably is navigated by means of the optical navigating device 14 while its position transmitter 12 cooperate through signals with the signal receivers 26, 27. A tissue image generated by the diagnostic ultrasound transducer 8 can be produced on the monitor 13, and the values of the tissue measured with said diagnostic ultrasound transducer 8 are used for setting the focal distance and effect of the therapeutic ultrasound transducer 2.

[0027] Two X-ray pictures are taken of the patient's 4 anatomic structure 17 at the disc 5 and these X-ray pictures are shown on the monitor 13. On these X-ray pictures, the position of the position transmitters 24 of the reference device 21 relative to the disc 5 may then be determined by means of the markers 20 of the calibrating device 19.

[0028] During treatment of the disc 5, preferably nucleus pulposus 6, the therapeutic ultrasound transducer 2 is navigated by means of the signal receiving or signal sending unit 25, whereby the navigation is presented in the X-ray pictures or images on the monitor 13. This is accomplished while the position transmitters 7 of the therapeutic ultrasound transducer 2 cooperate through signals with the signal transmitters 26 of the signal receiving or signal sending unit 25. By means of said navigation, the therapeutic ultrasound transducer 2 can be positioned such that the temperature focus F of its ultrasonic field 3 will lie in the disc 5, preferably nucleus pulposus 6. The temperature in the temperature focus F preferably exceeds 45°C.

[0029] The treatment can be automatically interrupted if the patient 4 moves to an incorrect position relative to the therapeutic ultrasound transducer 2 or vice versa.

[0030] The invention is not limited to the embodiment described above, but may vary within the scope of the following claims. Thus, the treated disc 5 may e.g. be any disc in the body.

[0031] The diagnostic camera 15 may be a computerized tomography (CT) scanner which is provided to produce images of said anatomic structure 17 and these images can be processed in a computer program or software for obtaining a 3D-image in the monitor 13.

[0032] The therapeutic ultrasound transducer 2 may be provided to be positioned manually or be located on a positioning device 33 for positioning thereof relative to the disc 5 to be treated.

[0033] It should also be mentioned that the signal receiving or signal sending unit 25 of the optical navigating device 14 may be an X-ray device.

Claims

1. Device for non-invasive ultrasound treatment of disc disease having at least one therapeutic ultrasound transducer (2) with a transmitter element (G) for treatment of the disc (5) of a patient (4) by generating by means of said therapeutic ultrasound transducer (2) an ultrasonic field (3) having a temperature focus (F) that is located in the disc (5) for heating thereof, and wherein said therapeutic ultrasound transducer (2) is of a phased array-type for being able to vary the distance between the transmitter element (G) of the therapeutic ultrasound transducer (2) and the temperature focus (F) of its ultrasonic field (3), **characterized by:**

- a diagnostic ultrasound transducer (8) adapted to generate an ultrasonic field (9) having a direction of propagation substantially the same as a direction of propagation of the ultrasonic field (3) of said therapeutic ultrasound transducer (2), and to determine the acoustic properties of the patient's (4) tissue (10) between an area (11) on the patient (4) for location of the therapeutic ultrasound transducer (2) during treatment and the disc (5) to be treated by determining distance between the area (11) and the disc (5) as well as the thickness of the tissue (10) and of the different layers of said tissue (10);
- an optical navigating device (14) for navigating said therapeutic ultrasound transducer (2) comprising at least one diagnostic camera (15) adapted to produce at least one picture or image of the anatomic structure (17) of the treatment area (16) within which the disc (5) to be treated is located; and
- a computer (29) with at least one program,

which is designed to calculate a suitable setting of the transmitter element (G) of said therapeutic ultrasound transducer (2) based on the acoustic properties of the tissue (10), to correct for differences in size and tissue configuration by facing the different attenuation of the ultrasonic field in different types of tissue into account, and to calculate the position of the temperature focus (F) of the ultrasonic field (3) of the therapeutic ultrasound transducer (2) in relation to said therapeutic ultrasound transducer (2) based on said acoustic properties of the tissue (10) and the setting of said transmitter element (6) of said therapeutic ultrasound transducer (2) in view of its focusing properties, so that said therapeutic ultrasound transducer (2) can be positioned by means of said optical navigating device (14) such that the temperature focus (F) appears in the disc (5) to be treated.

2. Device according to claim 1, wherein the optical navigating device (14) comprises at least one signal receiving and/or signal sending unit (25) which is adapted to send or transmit signals to and/or receive reflected or other signals from position transmitters (24, 7) on

a) a reference device (21) which has a set position relative to the disc (5), and
b) the therapeutic ultrasound transducer (2) such that the position thereof relative to said treatment area (16) can be determined.

3. Device according to claim 2, wherein the computer (29) is provided with at least one computer program which is designed to calculate the heating effect of the ultrasonic field (3) of the therapeutic ultrasound transducer (2) in its temperature focus (F) based on the acoustic properties determined by the diagnostic ultrasound transducer (8) and the position of the therapeutic ultrasound transducer (2) relative to the disc (5) to be treated.

4. Device according to any preceding claim, wherein the diagnostic ultrasound transducer (8) is provided to determine the thickness of different layers of said tissue (10) for determining the acoustic properties thereof.

5. Device according to any preceding claim, wherein that the diagnostic ultrasound transducer (8) is provided to produce a picture or image of said tissue (10).

6. Device according to claim 2, wherein the diagnostic ultrasound transducer (8) comprises position transmitters (12) which cooperate with the signal receiving and signal sending unit (25).

7. Device according to any preceding claim, wherein the diagnostic ultrasound transducer (8) and the therapeutic ultrasound transducer (2) are the same unit.

8. Device according to any preceding claim, wherein the diagnostic camera (15) is an X-ray camera (18).

9. Device according to claim 8, wherein the X-ray camera (18) comprises a calibrating device (19) with markers (20) which are adapted to determine the position of the anatomic structure (17) of the treatment area (16) displayed in a monitor (13).

10. Device according to claim 9, wherein the monitor (13) is provided to display two X-ray photographs of said anatomic structure (17) taken with the X-ray camera (18) from two different locations.

11. Device according to any of claims 1-5, wherein the diagnostic camera (15) is a computerized tomography scanner which is provided to produce images of the anatomic structure (17) at the patient's (4) disc (5), said images being processed in a computer program or software for obtaining a 3D-image in a monitor (13).

12. Device according to any preceding claim, wherein the therapeutic ultrasound transducer (2) is provided to be positioned manually based on the calculated position of the temperature focus (F).

13. Device according to any of claims 1-11, wherein the therapeutic ultrasound transducer (2) is provided on a positioning device (33) for positioning thereof relative to the disc (5) to be treated.

14. Device according to claim 2, wherein the signal receiving or signal sending unit (25) is provided to receive or send signals in the form of infrared light and that said position transmitters (7, 12, 24) are provided to send or receive signals in the form of infrared light.

15. Device according to any preceding claim, wherein the temperature in the temperature focus (F) of the therapeutic ultrasound transducer (2) can exceed 45°C.

16. Device according to any preceding claim, wherein a calibrating device (19) is provided for calibrating the effect of the field (3) emitted by the therapeutic ultrasound transducer (2) in the temperature focus (F) of said therapeutic ultrasound transducer (2) and/or the position of said temperature focus (F) relative to the transmitter element (G) of the therapeutic ultrasound transducer (2).

17. Device according to claim 2, wherein the reference device (21) is attached to a vertebra (22) in the patient's vertebral column, preferably to the spinous process (23) of said vertebra (22).

18. Device according to claim 2, wherein the reference device (21) comprises position transmitters (24) consisting of metallic balls, preferably tantalum balls.

19. Device according to claim 2, wherein the signal receiving or signal sending unit (25) of the optical navigating device (14) consists of at least one X-ray device.

Patentansprüche

1. Gerät zur nichtinvasiven Ultraschallbehandlung von Bandscheibenerkrankungen, welches mindestens einen therapeutischen Ultraschallwandler (2) mit einem Sendeelement (G) zur Behandlung der Bandscheibe (5) eines Patienten (4) durch die Erzeugung eines Ultraschallfeldes (3) mittels des therapeutischen Ultraschallwandlers (2) aufweist, welches Ultraschallfeld einen in der Bandscheibe (5) zu deren Erhitzung befindlichen Temperaturfokus (F) aufweist, und wobei der therapeutische Ultraschallwandler (2) von der phased-array Art ist, um dazu im Stande zu sein, den Abstand zwischen dem Sendeelement (G) des therapeutischen Ultraschallwandlers (2) und dem Temperaturfokus (F) seines Ultraschallfeldes (3) zu variieren, **gekennzeichnet durch:**

- einen diagnostischen Ultraschallwandler (8), welcher zur Erzeugung eines Ultraschallfeldes (9) ausgebildet ist, welches eine Ausbreitungsrichtung aufweist, die im Wesentlichen die gleiche ist wie eine Ausbreitungsrichtung des Ultraschallfeldes (3) des therapeutischen Ultraschallwandlers (2), und welcher zur Bestimmung der akustischen Eigenschaften des Gewebes (10) des Patienten (4) zwischen einem Bereich (11) am Patienten (4) zur Positionierung des therapeutischen Ultraschallwandlers (2) während der Behandlung und der zu behandelnden Bandscheibe (5) **durch** Bestimmung des Abstandes zwischen dem Bereich (11) und der Bandscheibe (5) sowie zur Bestimmung der Dikke des Gewebes (10) und der verschiedenen Schichten des Gewebes (10) ausgebildet ist,
- ein optisches Navigationsgerät (14) zur Navigation des therapeutischen Ultraschallwandlers (2) umfassend mindestens eine diagnostische Kamera (15), welche zur Erzeugung von mindestens einem Bild oder einer Abbildung der anatomischen Struktur (17) des Behandlungsbereiches (16), innerhalb von welchem die zu behandelnde Bandscheibe (5) positioniert ist, ausgebildet ist; und
- einen Computer (29) mit mindestens einem Programm, welches zur Berechnung einer passenden Einstellung des Sendeelementes (G) des therapeutischen Ultraschallwandlers (2) ausgestaltet ist, welche Berechnung auf den akustischen Eigenschaften des Gewebes (10) basiert, um unter Berücksichtigung der unterschiedlichen Abschwächung des Ultraschallfeldes in verschiedenen Gewebearten für die Unterschiede in Größe und Gewebekonfiguration zu korrigieren, und welches zur Berechnung der Position des Temperaturfokus (F) des Ultraschallfeldes (3) des therapeutischen Ultraschallwandlers (2) relativ zum therapeutischen Ultraschallwandler (2) ausgestaltet ist, welche Berechnung auf den akustischen Eigenschaften des Gewebes (10) und der Einstellung des Sendeelementes (G) des therapeutischen Ultraschallwandlers (2) angesichts seiner Fokussiereigenschaften basiert, so dass der therapeutische Ultraschallwandler (2) mittels des optischen Navigationsgeräts (14) derart positioniert werden kann, dass der Temperaturfokus (F) in der zu behandelnden Bandscheibe (5) erscheint.

2. Gerät nach Anspruch 1, wobei das optische Navigationsgerät (14) mindestens eine Signalempfangs- und/oder Signalsendeeinheit (25) umfasst, welche zur Sendung oder Übertragung von Signalen zu und/oder zum Empfang von reflektierten oder anderen Signalen von Positionstransmittern (24, 7) an

a) einer Referenzanordnung (21), welche eine relativ zur Bandscheibe (5) feste Position aufweist, und
b) dem therapeutischen Ultraschallwandler (2), so dass dessen Position relativ zum Behandlungsbereich (16) bestimmt werden kann, ausgebildet ist.

3. Gerät nach Anspruch 2, wobei der Computer (29) mit mindestens einem Computerprogramm ausgestattet ist, welches zur Berechnung des Heizeffektes des Ultraschallfeldes (3) des therapeutischen Ultraschallwandlers (2) in seinem Temperaturfokus (F) ausgestaltet ist, welche Berechnung auf den vom diagnostischen Ultraschallwandler (8) bestimmten akustischen Eigenschaften und der Position des therapeutischen Ultraschallwandlers (2) relativ zu der zu behandelnden Bandscheibe (5) basiert.

4. Gerät nach einem der vorgehenden Ansprüche, wobei der diagnostische Ultraschallwandler (8) zur Bestimmung der Dicke von verschiedenen Schichten des Gewebes (10) vorgesehen ist, um deren akusti-

sche Eigenschaften zu bestimmen.

5. Gerät nach einem der vorgehenden Ansprüche, wobei der diagnostische Ultraschallwandler (8) zur Erzeugung eines Bildes oder einer Abbildung des Gewebes (10) vorgesehen ist.

6. Gerät nach Anspruch 2, wobei der diagnostische Ultraschallwandler (8) Positionstransmitter (12) umfasst, welche mit der Signalempfangs- und Signalsendeeinheit (25) zusammenwirken.

7. Gerät nach einem der vorgehenden Ansprüche, wobei der diagnostische Ultraschallwandler (8) und der therapeutische Ultraschallwandler (2) eine und dieselbe Einheit sind.

8. Gerät nach einem der vorgehenden Ansprüche, wobei die diagnostische Kamera (15) eine Röntgenkamera ist.

9. Gerät nach Anspruch 8, wobei die Röntgenkamera (18) ein Kalibrierungsgerät (19) mit Markierern (20) umfasst, welche zur Bestimmung der Position der auf einem Bildschirm (13) angezeigten anatomischen Struktur (17) des Behandlungsbereichs (16) ausgebildet ist.

10. Gerät nach Anspruch 9, wobei der Bildschirm (13) zum Anzeigen von zwei Röntgenbildern der anatomischen Struktur (17) vorgesehen ist, welche mit der Röntgenkamera (18) aus zwei verschiedenen Positionen aufgenommen werden.

11. Gerät nach einem der Ansprüche 1 bis 5, wobei die diagnostische Kamera (15) ein Computer-Tomographie-Scanner ist, welcher zur Erzeugung von Abbildungen der anatomischen Struktur (17) an der Bandscheibe (5) des Patienten (4) vorgesehen ist, welche Abbildungen zum Erzielen einer 3D-Abbildung auf einem Bildschirm (13) in einem Computerprogramm oder einer Software verarbeitet werden.

12. Gerät nach einem der vorgehenden Ansprüche, wobei der therapeutische Ultraschallwandler (2) für eine manuelle, auf der berechneten Position des Temperaturfokus (F) basierende Positionierung vorgesehen ist.

13. Gerät nach einem der Ansprüche 1 bis 11, wobei der therapeutische Ultraschallwandler (2) an einem Positionierungsgerät (33) vorgesehen ist, um ihn relativ zu der zu behandelnden Bandscheibe (5) zu positionieren.

14. Gerät nach Anspruch 2, wobei die Signalempfangs- oder Signalsendeeinheit (25) zum Empfang oder zur Sendung von Signalen in Form von Infrarotlicht vorgesehen ist, und dass die Positionstransmitter (7, 12, 24) zur Sendung oder zum Empfang von Signalen in Form von Infrarotlicht vorgesehen sind.

15. Gerät nach einem der vorgehenden Ansprüche, wobei die Temperatur im Temperaturfokus (F) des therapeutischen Ultraschallwandlers (2) 45°C übersteigen kann.

16. Gerät nach einem der vorgehenden Ansprüche, wobei ein Kalibrierungsgerät (19) dazu vorgesehen ist, den Effekt des durch den therapeutischen Ultraschallwandler (2) im Temperaturfokus (F) des therapeutischen Ultraschallwandlers (2) ausgestrahlten Feldes (3) und/oder die Position des Temperaturfokus (F) relativ zum Transmitterelement (G) des therapeutischen Ultraschalwandlers (2) zu kalibrieren.

17. Gerät nach Anspruch 2, wobei die Referenzanordnung (21) mit einem Wirbel (22) in der Wirbelsäule des Patienten, vorzugsweise mit dem Wirbelfortsatz (23) des Wirbels (22), verbunden ist.

18. Gerät nach Anspruch 2, wobei die Referenzanordnung (21) Positionstransmitter (24) aufweist, die aus Metallkugeln, vorzugsweise Tantalkugeln bestehen.

19. Gerät nach Anspruch 2, wobei die Signalempfangs- oder Signalsendeeinheit (25) des optischen Navigationsgeräts (14) aus mindestens einer Röntgenanordnung besteht.

Revendications

1. Dispositif de traitement non invasif d'affections discales par ultrasons, présentant au moins un transducteur (2) d'ultrasons thérapeutiques doté d'un élément émetteur (G) de traitement du disque (5) d'un patient (4) en formant au moyen dudit transducteur (2) d'ultrasons thérapeutiques un champ (3) d'ultrasons dont le foyer de température (F) est situé dans le disque (5) pour chauffer ce dernier, ledit transducteur (2) d'ultrasons thérapeutiques étant du type à réseau piloté en phase qui permet de modifier la distance entre l'élément émetteur (G) du transducteur (2) d'ultrasons thérapeutiques et le foyer de température (F) de son champ (3) d'ultrasons,
caractérisé par
un transducteur (8) d'ultrasons de diagnostic adapté pour produire un champ (9) d'ultrasons dont la direction de propagation est essentiellement identique à la direction de propagation du champ (3) d'ultrasons dudit transducteur (2) d'ultrasons thérapeutiques et pour déterminer les propriétés acoustiques du tissu (10) du patient (4) entre une zone (11) du patient (4) prévue pour le placement du transducteur

(2) d'ultrasons thérapeutiques pendant le traitement et le disque (5) à traiter, en déterminant la distance entre la zone (11) et le disque (5) ainsi que l'épaisseur du tissu (10) et des différentes couches dudit tissu (10),
un dispositif optique de navigation (14) qui assure la navigation dudit transducteur (2) d'ultrasons thérapeutiques et qui comprend au moins une caméra de diagnostic (15) adaptée pour produire au moins une représentation ou une image de la structure anatomique (17) de la zone de traitement (16) dans laquelle le disque (5) à traiter est situé et
un ordinateur (29) doté d'au moins un programme conçu pour calculer le réglage approprié de l'élément émetteur (G) dudit transducteur (2) d'ultrasons thérapeutiques sur base des propriétés acoustiques du tissu (10), pour corriger des différences de taille et de configuration des tissus en prenant en compte les différences d'atténuation du champ d'ultrasons dans les différents types de tissu et pour calculer la position du foyer de température (F) du champ (3) d'ultrasons du transducteur (2) d'ultrasons thérapeutiques en relation avec ledit transducteur (2) d'ultrasons thérapeutiques sur base desdites propriétés acoustiques du tissu (10) et en réglant les propriétés de focalisation dudit élément émetteur (G) dudit transducteur (2) d'ultrasons thérapeutiques de telle sorte que ledit transducteur (2) d'ultrasons thérapeutiques puisse être positionné au moyen dudit dispositif optique de navigation (14) de telle sorte que le foyer de température (F) soit situé dans le disque (5) à traiter.

2. Dispositif selon la revendication 1, dans lequel le dispositif optique de navigation (14) comprend au moins une unité (25) de réception de signaux et/ou d'émission de signaux adaptée pour envoyer ou émettre des signaux aux émetteurs de position (24, 7) et/ou pour recevoir des signaux réfléchis par ces derniers ou d'autres signaux sur

a) un dispositif de référence (21) qui présente une position fixée par rapport au disque (5) et
b) le transducteur thérapeutique d'ultrason (2), de telle sorte que sa position par rapport à ladite zone de traitement (16) puisse être déterminée.

3. Dispositif selon la revendication 2, dans lequel l'ordinateur (29) est doté d'au moins un programme informatique conçu pour calculer l'effet de chauffage du champ (3) d'ultrasons du transducteur (2) d'ultrasons thérapeutiques à son foyer de température (F) sur base des propriétés acoustiques déterminées par le transducteur (8) d'ultrasons de diagnostic et la position du transducteur (2) d'ultrasons thérapeutiques par rapport au disque (5) à traiter.

4. Dispositif selon l'une quelconque des revendications précédentes, dans lequel le transducteur (8) d'ultrasons de diagnostic est prévu pour déterminer l'épaisseur de différentes couches du tissu (10) en vue de déterminer leurs propriétés acoustiques.

5. Dispositif selon l'une quelconque des revendications précédentes, dans lequel le transducteur (8) d'ultrasons de diagnostic est prévu pour produire une représentation ou une image dudit tissu (10).

6. Dispositif selon la revendication 2, dans lequel le transducteur (8) d'ultrasons de diagnostic comprend des émetteurs de position (12) qui coopèrent avec l'unité (25) de réception de signaux et d'émission de signaux.

7. Dispositif selon l'une quelconque des revendications précédentes, dans lequel le transducteur (8) d'ultrasons de diagnostic et le transducteur (2) d'ultrasons thérapeutiques sont la même unité.

8. Dispositif selon l'une quelconque des revendications précédentes, dans lequel la caméra de diagnostic (15) est une caméra (18) à rayons X.

9. Dispositif selon la revendication 8, dans lequel la caméra (18) à rayons X comprend un dispositif d'étalonnage (19) doté de repères (20) qui sont adaptés pour déterminer la position de la structure anatomique (17) de la zone de traitement (16) représentée sur un écran (13).

10. Dispositif selon la revendication 9, dans lequel l'écran (13) est prévu pour afficher deux radiographies de ladite structure anatomique (17) prises avec la caméra (18) à rayons X depuis deux emplacements différents.

11. Dispositif selon l'une quelconque des revendications 1 à 5, dans lequel la caméra de diagnostic (15) est un scanner de tomographie assistée par ordinateur prévu pour produire des images de la structure anatomique (17) du disque (5) du patient (4), lesdites images étant traitées dans un programme ou logiciel informatique pour obtenir une image en 3D sur un écran (13).

12. Dispositif selon l'une quelconque des revendications précédentes, dans lequel le transducteur (2) d'ultrasons thérapeutiques est prévu pour être placé manuellement sur base de la position calculée du foyer de température (F).

13. Dispositif selon l'une quelconque des revendications 1 à 11, dans lequel le transducteur (2) d'ultrasons thérapeutiques est prévu sur le dispositif de positionnement (33) qui le positionne par rapport au disque (5) à traiter.

14. Dispositif selon la revendication 2, dans lequel l'unité (25) de réception de signaux et d'émission de signaux est prévue pour recevoir ou émettre des signaux sous la forme de lumière infrarouge et en ce que lesdits émetteurs de position (7, 12, 24) sont prévus pour envoyer ou recevoir des signaux sur la forme de lumière infrarouge.

15. Dispositif selon l'une quelconque des revendications précédentes, dans lequel la température au foyer de température (F) du transducteur (2) d'ultrasons thérapeutiques peut dépasser 45°C.

16. Dispositif selon l'une quelconque des revendications précédentes, dans lequel un dispositif d'étalonnage (19) est prévu pour étalonner l'effet du son (3) émis par le transducteur (2) d'ultrasons thérapeutiques au foyer de température (F) dudit transducteur (2) d'ultrasons thérapeutiques et/ou la position dudit foyer de température (F) par rapport à l'élément émetteur (G) du transducteur (2) d'ultrasons thérapeutiques.

17. Dispositif selon la revendication 2, dans lequel le dispositif de référence (21) est fixé sur une vertèbre (22) de la colonne vertébrale du patient, de préférence sur l'apophyse épineuse (23) de ladite vertèbre (22).

18. Dispositif selon la revendication 2, dans lequel le dispositif de référence (21) comprend des émetteurs de position (24) constitués de billes métalliques et de préférence de billes de tantale.

19. Dispositif selon la revendication 2, dans lequel l'unité (25) de réception de signaux ou d'émission de signaux du dispositif optique de navigation (14) est constituée d'au moins un dispositif à rayons X.

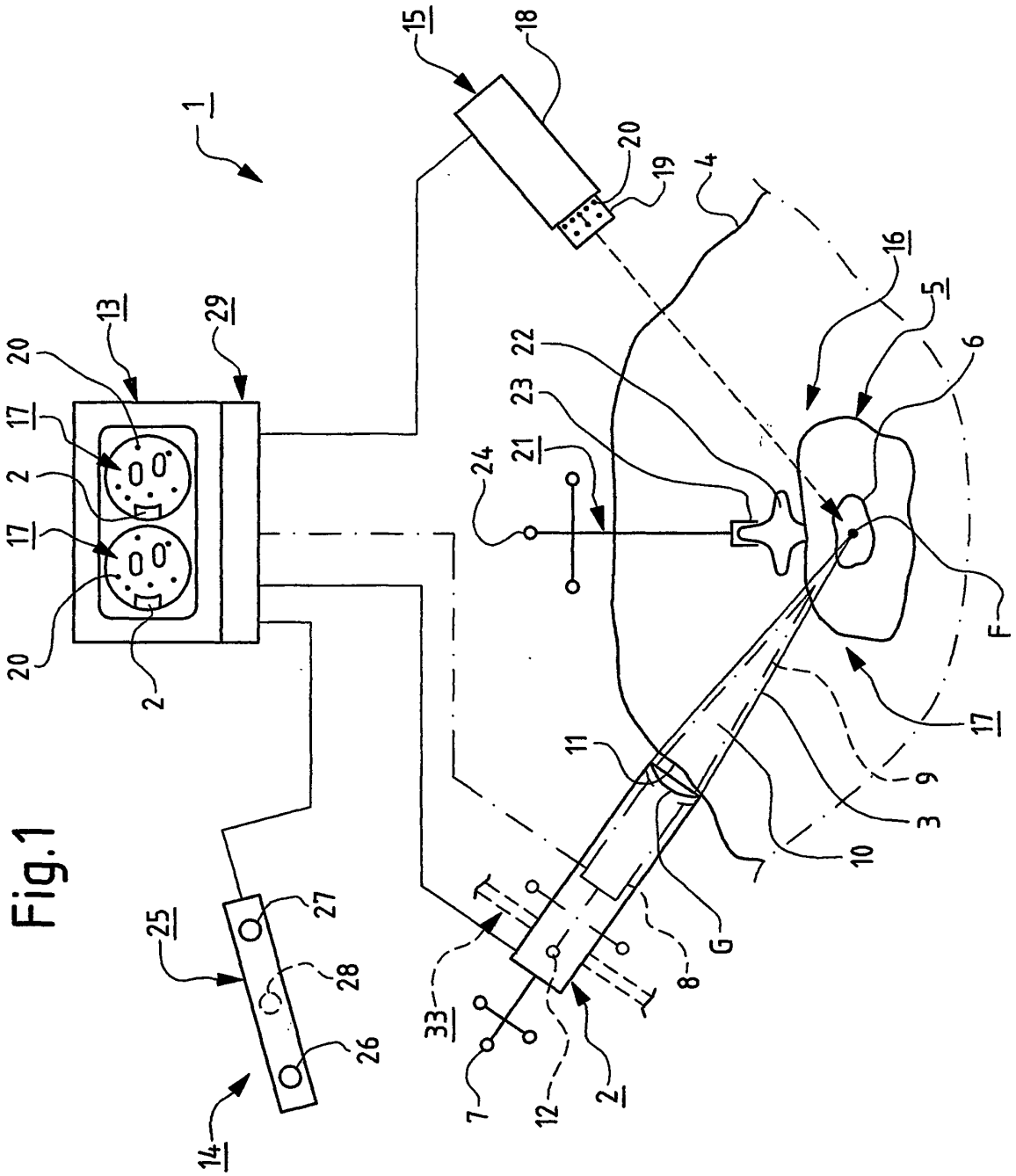
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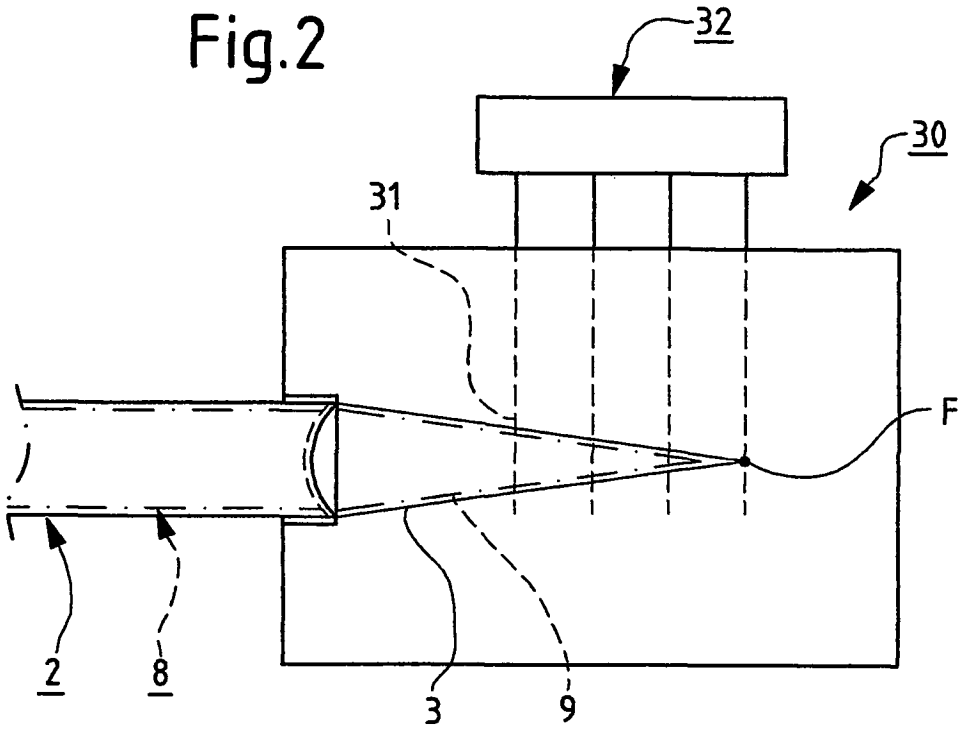
Fig.1

Fig.2



REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	用于椎间盘疾病的非侵入性超声治疗的装置		
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IPC分类号	A61N7/02 A61B8/00 A61B17/56 A61B6/00 A61B6/03 A61B6/12 A61B8/08 A61B18/00 A61B19/00 A61F7/00		
CPC分类号	A61N7/02 A61B8/0858 A61B34/20 A61B90/361 A61B2034/2055 A61B2034/2072 A61B2090/378		
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其他公开文献	EP1301243A1		
外部链接	Espacenet		

摘要(译)

本发明涉及一种用于椎间盘疾病的非侵入性超声治疗的装置。该装置包括治疗超声换能器（2），其通过借助于所述治疗超声换能器（2）产生超声场来提供用于治疗患者（4）的椎间盘（5），优选髓核（6）的治疗。（3），其温度焦点（F）位于盘（5），优选髓核（6）中，用于加热。治疗超声换能器（2）具有“相控阵”型，并且提供诊断超声换能器（8）以确定患者（4）组织（10）的声学特性。光学导航设备（14）包括至少一个诊断摄像机（15）和至少一个信号接收和/或信号发送单元（25），其适于向位置发送或发送信号和/或从位置接收反射或其他信号。发射器（24,7）在参考设备（21）上和治疗超声换能器（2）上。计算机（29）具有至少一个计算机程序，该计算机程序被设计用于结合设备的设置进行计算。

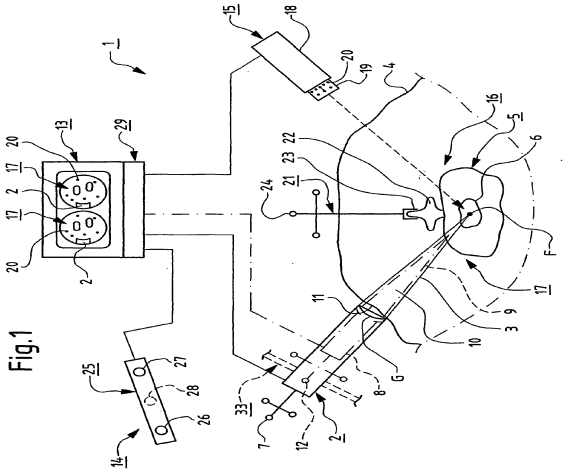
Fig.1