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(54) **AN IMPLANTABLE CARDIAC DEVICE FOR MONITORING THE STATUS OF A CARDIOVASCULAR DISEASE**

IMPLANTIERBARE HERZVORRICHTUNG ZUR ÜBERWACHUNG DES STATUS EINER KARDIOVASKULÄREN ERKRANKUNG

DISPOSITIF CARDIAQUE IMPLANTABLE POUR SURVEILLER L'ÉTAT D'UNE MALADIE CARDIOVASCULAIRE

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Description

Technical Field

[0001] The present invention relates to an implantable cardiac device comprising a heart stimulator for electrically stimulating the heart of a patient, detecting means for measuring a physiologic parameter which is affected by the status of a cardiovascular disease associated with sympathetic activation, signal processing means for determining at least one of a low frequency, LF, and a very low frequency, VLF, Mayer wave component in the measured parameter, and an analysor for analyzing the determined Mayer wave component in relation to a predetermined reference value to determine the status of the cardiovascular disease, and to a corresponding method for monitoring the status of a cardiovascular disease associated with sympathetic activation of a patient having an implantable electric heart stimulator.

Background

[0002] Heart Rate Variability, HRV, has been suggested as a parameter reflecting the activity in the Autonomic Nervous System, ANS. This activity is altered with the health of a patient. The pathophysiologic activation of ANS at heart failure and other diseases reveal the level of stress and unbalance in the body. HRV diminishes during heart disease and can for instance be used to detect and show deterioration of a Heart Failure, HF, and predict sudden cardiac death. Unfortunately HRV can only be measured during sinus rhythm. For patients having their heart rate modulated to a large extent by an Implantable Cardiac Device, such as a pulse generator or ICD, calculation of HRV is not feasible.

[0003] Mayer waves are low frequency oscillations in ANS causing a. o. blood pressure variations and HRV. The phenomenon is not well understood but its existence and response to heart disease, and also other circumstances, have been confirmed, see e.g. Cardivascular Research, 70, 2006, pp. 12-21, Circulation 95, 1997, pp. 1449-54, and J. Hypertens., 17(12 Pt 2), Dec. 1999, pp. 1905-10.

[0004] EP 1 151 719 discloses an implantable apparatus for monitoring the condition of a heart failure patient using respiration patterns. The patient's respiratory patterns are monitored to identify periodic breathing or Cheyne-Stokes respiration. Different parameters are suggested for assessing Cheyne-Stokes respiration, like mechanical changes of thorax due to breathing, changes in blood and tissue pH, CO2 concentration and the R-R interval, extracted from ECGs. From R-R interval information measures of HRV are derived and the presence of respiratory fluctuations as well as Mayer waves are tested by examining the variability over specific frequency ranges. The absence of fluctuations in the respiratory fluctuation frequency band as well as in the Mayer waves frequency bands is interpreted as a worsening of the disease status.

[0005] In US 5 645 570 an implantable device for detecting the sympatho-vagal balance of a patient is described. From ECGs the variability of the heart rate is evaluated as the number of consecutive R-R intervals, which differ from one another by at least a minimum threshold. If this number satisfies a predetermined intervention criterium a therapeutic device for the patient is triggered.

[0006] In Lee A. Fleisher, "Heart Rate Variability as an Assessment of Cardiovascular Status", Journal of Cardiothoracic and Vascular Anesthesia, Vol. 10, No. 5 (August), 1996, pp. 659-671 the usage is described of time intervals between consecutive heart beats, preferably the R-R intervals, for evaluating HRV. The R-R intervals are derived from ECGs. The evaluation can be made in the time domain or in the frequency domain. In the latter case the power spectrum in the Mayer wave frequency range can be used to predict mortality of Congestive Heart Failure, CHF, patients.

[0007] US 2006/0094967 discloses a system for determining an index of ANS or Sympathetic Nervous System, SNS, activity for use in patient monitoring or therapy delivery control. The ANS or SNS index is calculated as a function of multiple monitored physiological variables that strongly correlate to changes in autonomic or sympathetic tone.

[0008] US 2006/0161208 discloses a cardiac rhythm management system that modulates the delivery of pacing pulses based on HRV.

[0009] Saul et al., "Assessment of Autonomic Regulation in Chronic Congestive Heart Failure by Heart Rate Spectral Analysis", American Journal of Cardiology, Vol. 61, 1998, pp. 1292-1299 discloses analysis of HRV as a non-invasive means of investigating the autonomic control of the heart. In CHF patients the heart rate spectral power was markedly reduced at all examined frequencies.

[0010] Stein et al., "Heart rate variability: A measure of cardiac autonomic tone", American Heart Journal. Vol. 127, 1994, pp. 1376-1381 analyses HRV based on routine 24-hour Holter recordings. IT was concluded that time domain measures can be used as surrogates for frequency domain measures. Decreased indices of HRV was associated with CHF.

[0011] US 7,177,686 measures the autonomic tone of a patient based on a photo-plethysmography signal representative of arterial pulse pressure. The hemodynamic status of the patient and pacing interval optimization can be performed based on the measured autonomic tone.

[0012] The above discussed prior art for HRV analysis, e.g. the use of the R-R interval measurements for assessment of HRV, is applicable only to patients in sinus rhythm, cf. e.g. the above mentioned article Lee A. Fleisher, "Heart Rate Variability as an Assessment of Cardiovascular Status", Journal of Cardiothoracic and Vascular Anesthesia, Vol. 10, No. 5 (August), 1996, p. 662, left column, third paragraph. For patients having their heart

rate modulated or controlled by a heart stimulator it is, however, not possible to use the traditional HRV analysis.

[0013] It has, however, appeared that e.g. variability of blood pressure and blood flow are possible markers for studying pathophysiologic activation of ANS at heart failure and other diseases. The strength of the arterial blood pressure oscillations, for instance, is highly affected at some cardiovascular diseases associated with sympathetic activation, e.g. congestive heart failure, CHF. There are also other physiologic parameters than the blood pressure which are affected during sympathetic activation. Thus the left ventricular tension and the left ventricular contraction pattern are also indicators of sympathetic activation as well as the mechanical AR-interval and pre-ejection time.

[0014] The purpose of the present invention is to provide a device for monitoring the status of a cardiovascular disease associated with sympathetic activation which can be used also for patients having their heart rate modulated by a heart stimulator.

Disclosure of the Invention

[0015] This purpose is obtained by a device as defined in claim 1.

[0016] Thus, according to the invention a mechanical change in at least one of the four chambers of the heart is measured. The corresponding signal is processed for determining at least one of the low frequency, LF, and the very low frequency, VLF, Mayer wave components in the measured parameter. This Mayer wave component is then analysed for determining the status of the cardiovascular disease of the patient. In this way it is possible to monitor the status of a cardiovascular disease of a patient having a heart stimulator, and not only monitor the present status of a disease but also to predict incipient heart events. An early detection of a change in the patient's status is thus possible, and a flag can then be set indicating that the patient should visit his doctor for a health control and possible change in drug administration. Normally it is wanted to foresee Acute Decompensated Heart Failure, ADHF, in an early state. 80% of these cases involve patients having previously diagnosted or chronic heart failure. Each episode of ADHF carries a higher mortality. Being able to prevent episodes of ADHF before they occur by studying Mayer waves would therefore benefit the prognosis and save lives.

[0017] According to the device according to the invention the measuring means are adapted to measure the electric transcardiac bio-impedance. The measuring means are adapted to measure the electric bio-impedance quadropolarly between right atrium and right ventricle, or bipolarly in the right ventricle. Signals measured in this way are more stable and predictable and seems to mirror the left ventricular contractions as well. The electric bio-impedance can, however, also be measured over the left ventricle, LV. The measuring means then can comprise two electrodes, one adapted for positioning in the right ventricle and the other adapted for positioning in a coronary vein on the left ventricle. The impedance measured between these electrodes mirrors the left ventricular volume. Other positionings of the electrodes are also possible. The electrodes can e.g. be adapted for epicardial location. As mentioned above the pathophysiologic activation of ANS at heart failure reveals the level of stress and unbalance in the body, and the variety of blood pressure and blood flow are possible markers that can be studied for this purpose. The left ventricular contraction pattern can be monitored by the above mentioned measurements of the electric bio-impedance over LV. Oscillations in LV pressure are indicated by stroke volume variations measured by the electric bio-impedance over LV.

[0018] Respiration modulation of the ANS signal can be a problem. The respiration frequency is, however, normally higher than the physiologic oscillations generated by ANS, viz. Mayer waves. Since the Mayer waves are low, 3-140 mHz, compared to the respiration component, ~200mHz, the respiration component can be eliminated by appropriate filtering of the peak to peak amplitude, the time integrated area of the measured impedance signal, or the contraction strength obtained from the measured dynamic impedance signal. Both respiration and heart rhythm can be measured separately, e.g. by bio-impedance measurements or electric signal detection, which also facilitates discrimination of respiration components from Mayer waves components.

[0019] The myocardial contractility is also affected during sympathetic activation. The left ventricular contraction pattern can be monitored by measurements of the bio-impedance over LV, as discussed above. The left ventricular muscular tension is an indicator of sympathetic activation which can be monitored by a sensor too. According to still other advantageous embodiments of the invention the left ventricular contractility is therefore measured. The slope of a predetermined portion of the signal, corresponding to the measured bio-impedance, is determined as a measure of the left ventricular contractility according to an advantageous embodiment of the invention.

[0020] According to yet another advantageous embodiment of the device according to the invention the measuring means are arranged to measure mechanical changes in at least one of the quantities the mechanical atrioventricular conduction time, i. e. the mechanical AR-interval, and pre-ejection period as the physiologic parameter affected by the status of a cardiovascular disease associated with sympathetic activation and thus useful for studying sympathetic activation.

[0021] According to other advantageous embodiments of the device according to the invention the detecting means is arranged to measure the physiologic parameter for a period of at least several minutes, and the signal processing means are arranged to calculate at least one corresponding data sample per heartbeat. A memory is provided for storing the data samples and a filter is pro-

vided for filtering the stored data and determining the amplitudes of LF and/or VLF Mayer wave components. Fourier transforming means can alternatively be provided for determining LF and/or VLF Mayer wave components of the measured physiologic parameter as well as the amplitudes of these components. Data are preferably measured continuously, with a frequency of e.g. 128 Hz, and at least one parameter data sample is calculated for every heartbeat as mentioned above. To be able to find the very low frequency Mayer oscillations, typically of 40 mHz, the recording of data must be performed during at least several minutes, such that a data string of at least a few hundred data are obtained for storage and further analysis.

[0022] According to another advantageous embodiment of the device according to the invention the signal processing means are adapted to determine the spectrogram of at least one of the Mayer wave components, and the analysor is adapted to analyze the determined spectrogram in relation to a predetermined template spectrogram to determine the status of the cardiovascular disease. Continuous recording of such a Mayer wave spectrogram can be used for early detection of a changed cardiac status of the patient.

[0023] According to still another advantageous embodiment of the device according to the invention an alerting means is provided to alert the patient to contact a medical doctor, if the deviation of the determined Mayer wave component from the reference value exceeds a predetermined threshold. If the Mayer wave oscillations decrease compared to the reference value or a normal template the risk of a coming cardiac event is increasing.

[0024] According to yet another advantageous embodiment of the device according to the invention its heart stimulator comprises controlling means for controlling the heart stimulation therapy depending on detected status of the patient's heart disease. A timing of the electric stimulation or pacing therapy which is not optimized will create an increased sympathetic tonus. This will stress the autonomic regulation and reduce the variability of physiologic signals and Mayer wave oscillations. With an optimal pacing therapy, viz. optimal stimulation rate, and optimal AV- and W-delays, the oscillation amplitude will be at its maximum.

Brief Description of the Drawings.

[0025] To further explain the invention an embodiment of the device according to the invention will be described in greater details with reference to the accompanying drawings on which figures 1 and 2 show dynamic blood pressures measured non-invasively on two different patients, figure 3 shows heart rates, HR, measured on patients of various NYHA, New York Heart Association, classes, figure 4 shows a physiologic parameter calculated from a measured impedance signal together with respiration and Mayer wave oscillations, figure 5 is a block diagram illustrating an embodiment of the device according to the invention, and figures 6 and 7 show qualitatively frequency spectra of a measured physiologic parameter having VLF and LF Mayer wave components as well as a respiration frequency component for two patients with different health status.

Detailed Description of a Preferred Embodiment

[0026] Figures 1 and 2 show dynamic blood pressures measured non-invasively on two different patients as a function of time.

[0027] Figure 1 shows pressure variations measured on a female, Congestive Heart Failure, CHF, patient of 64 years, NYHA class 2, i.e. class 2 according to the New York Heart Association classification, and suffering from Left Bundle Branch Block, LBBB. The time scale of the shown diagram is 8 sec/division. As appears the systolic pressure varies with a Mayer wave frequency of 20-30 mHz and the average systolic pressure amounts to 115.59 mmHg.

[0028] Figure 2 shows corresponding pressure variations measured on a male CHF patient of 69 years, NYHA class III and suffering from LBBB. The time scale of the shown diagram is 20 sec/division. The systolic pressure varies with a Mayer wave frequency of 15-20 mHz and the average systolic pressure amounts to 97.20 mmHg.

[0029] A periodic Mayer wave variability appears clearly in the measured blood pressures of both these CHF patients.

[0030] Figure 3 illustrates results of heart rates, HR, measurements on two NYHA class 2 patients, three NYHA class 3 patients and one NYHA class 4 patient. For each patient mean value, standard error, SE,. and $\pm$1.96*SE are indicated for the measured HR. The diagrams in figure 3 show that SE decreases with increasing NYHA class number, viz. HRV decreases with increasing NYHA class or with increasing severity of the cardiac disease.

[0031] The upper curve in figure 4 shows qualitatively a physiologic parameter as a function of time, calculated from an impedance signal measured over LV. Each dot of the curve represents a calculated parameter value for each heartbeat.

[0032] The parameter values could be calculated from another measured physiologic signal as well.

[0033] The lower curve a in figure 4 represents a Mayer wave and the lower curve b the respiration. Both the Mayer wave and the respiration are influencing the measured parameter depending on the physiologic state of the patient.

[0034] The measurements illustrated in figure 4 are performed continuously. The measurements could, however, alternatively be performed periodically, e. g. once per hour.

[0035] Figure 5 is a block diagram of an embodiment of the device according to the invention. The device comprises a sensor 2 for measuring a physiologic parameter which is affected by the status of a cardiovascular dis-

ease associated with sympathetic activation. A signal recorder 4 is provided for recording the parameter data. Data are measured continuously, e.g. with a frequency of 128 Hz, and at least one parameter data value is calculated for each heartbeat. To be able to find VLF Mayer oscillations, of typically 40 mHz, the recording must be performed during several minutes. The data are processed in a data processor 6 and a string of a few hundred data points are stored in a memory 8. In the signal processor 8 the data string is digitally filtered to separate the Mayer wave components and the respiration component and to determine their amplitudes. The spectrogram thus determined is also stored in the memory 8.

[0036] As an alternative the data processor 6 can comprise a Fourier transforming means for localising the mentioned frequency components and determining their amplitudes.

[0037] The data processor 6 also comprises an analysor for analyzing the determined Mayer wave components in relation to a predetermined reference value to determine the status of the cardiovascular disease. In practice the analysor is preferably adapted to analyze the determined Mayer wave spectrogram in relation to a predetermined template spectrogram to determine the status of the cardiovascular disease.

[0038] The embodiment in figure 5 also comprises a heart stimulator in the form of a pacemaker 10 for delivering electric stimulation pulses to a patient's heart. A control unit 12 is provided to receive from the data processor 6 the result of the above described analysis for controlling the pacemaker therapy depending on the detected status of the patient's cardiovascular disease.

[0039] A continuous recording of the Mayer wave spectrogram can be used for making an early detection of a changed cardiac status, as discussed above. The device shown in figure 5 thus also comprises a notifyer 14 connected to the data processor 6 for setting a flag indicating that the patient should visit his medical doctor for a health control or change in drug administration, if the analysis shows that the determined Mayer wave component deviates from a predetermined reference value with more than a predetermined threshold.

[0040] As disclosed above a physiologic parameter which is affected by the status of a cardiovascular disease associated with sympathetic activation is measured by the electric bio-impedance. Appropriate filtering of the peak to peak amplitude, or the integrated area of the systolic contraction strength in the dynamic impedance signal is made. By this filtering the Mayer waves can be discriminated from the respiration rhythm, because the Mayer wave oscillations have a significantly lower frequency the respiration signal. This is illustrated in figures 6 and 7 and also by curves a and b in figure 4. Both respiration and the heart rhythm can be measured separately, which facilitates distinguishing the two types of waves.

[0041] Figures 6 and 7 thus qualitatively illustrate frequency spectra of a physiologic parameter, e.g. the systolic blood pressure, with strong VLF and LF Mayer waves present in figure 6 and with weak Mayer waves present in figure 7. The amplitude of the respiration component, Resp, is substantially constant in the two figures.

[0042] The strong Mayer wave oscillations in figure 6 may be a good sign for the status of the patient's health. In the situation illustrated in figure 7, on the other hand, the amplitude of the Mayer wave oscillations has decreased compared to a normal template, which means an increased risk for a preceding heart event.

[0043] Also, if the timing of the pacing therapy is not optimized an increased sympathetic tonus will be created. This will stress the autonomic regulation and reduce the variability of physiological signals, and consequently reduce the Mayer wave oscillations, as illustrated in figure 7. An optimal pacing therapy will, however, result in a large signal variety and a maximum Mayer wave oscillation amplitude, cf. figure 6.

[0044] The LF and VLF Mayer wave oscillations should be measured with the patient at rest, when few other disturbances are present The blood pressure and the left ventricular volume will vary with the body position and workload, which makes detection of Mayer waves difficult for unstable situations of the patient. It is also important that the patient is awake, i.e. conscious, at the measurement. Activity sensors and body position sensors as well as a real time clock can therefore be used to ensure repetitive and correct measuring conditions.

[0045] As mentioned above a reference value or a reference template of normal HRV is used in the analysis of the measured Mayer wave oscillations. Such a reference value or template is preferably created automatically during the first day(s) and stored in the device. This procedure for determining the reference value or template is repeated after a follow-up, when the patient's health status is known.

[0046] The low frequency wave oscillations in the ANS, which cause detectable variations in several different physiologic parameters and which are called Mayer waves in this application, are also named in the literature Traube-Hering-Mayer waves, Hering's waves, Traube's waves, Traube-Hering curves, Traube-Hering waves and Mayer's waves.

Claims

1. An implantable cardiac device comprising:

- a heart stimulator (10, 12) configured to electrically stimulate the heart of a patient,
- detecting means (2, 4) configured to measure a physiologic parameter which is affected by the status of a cardiovascular disease associated with sympathetic activation, said detecting means (2, 4) comprising measuring means (2) arranged to measure, as said physiologic parameter, electrical transcardiac bio-impedance

indicative of a mechanical change in at least one of the four chambers of the heart, wherein said measuring means (2) are adapted to measure the electrical transcardiac bio-impedance i) quadropolarly between right atrium and right ventricle, ii) bipolarly in the right ventricle or iii) over the left ventricle;
- signal processing means (6) configured to determine at least one of a low frequency (LF) and a very low frequency (VLF) Mayer wave component in said physiological parameter, and
- an analysor (6) configured to analyze said determined Mayer wave component in relation to a predetermined reference value to determine said status of said cardiovascular disease.

2. The device according to claim 1, **characterized in that** said measuring means (2) comprise two electrodes, one adapted for positioning in the right ventricle and the other adapted for positioning in a coronary vein on the left ventricle.

3. The device according to claim 1, **characterized in that** said measuring means (2) comprise electrodes, adapted for epicardial location.

4. The device according to claim 1, **characterized in that** said measuring means (2) are arranged to measure the left ventricular contractility.

5. The device according to claim 4, **characterized in that** said analysor (6) is arranged to determine the slope of a predetermined portion of the signal, corresponding to the measured bio-impedance, as a measure of the left ventricular contractility.

6. The device according to claim 1, **characterized in that** said measuring means (2) are arranged to measure mechanical changes in at least one of the quantities mechanical AR-interval, and pre-ejection period.

7. The device according to claim 1, **characterized in that** said detecting means (2,4) is arranged to measure said physiologic parameter for a period of at least several minutes, and **in that** said signal processing means (6) are arranged to calculate at least one corresponding data sample per heartbeat.

8. The device according to claim 7, **characterized in that** a memory (8) is provided for storing said data samples and **in that** a filter is provided for filtering said stored data and determining the amplitudes of LF and/or VLF Mayer wave components.

9. The device according to claim 6, **characterized in that** a memory (8) is provided for storing said data samples and **in that** a Fourier transforming means is provided for determining LF and/or VLF Mayer wave components of said measured physiologic parameter as well as the amplitudes of these components.

10. The device according to claim 1, **characterized in that** said signal processing means (6) are adapted to determine the spectrogram of at least one of the Mayer wave components, and **in that** said analysor (6) is adapted to analyze said determined spectrogram in relation to a predetermined template spectrogram to determine the said status of the said cardiovascular disease.

11. The device according to any one of the preceding claims, **characterized in that** an alerting means (14) is provided to alert the patient to contact a medical doctor, if the deviation of said the determined Mayer wave component from said reference value exceeds a predetermined threshold.

12. The device according to any one of the preceding claims, **characterized in that** its heart stimulator (10,12) comprises controlling means for controlling the heart stimulation therapy depending on detected status of the patient's heart disease.

Patentansprüche

1. Implantierbare Herzvorrichtung, umfassend:

- einen Herzschrittmacher (10, 12), der ausgestaltet ist zur elektrischen Stimulierung des Herzen eines Patienten,
- Erfassungsmittel (2, 4), die ausgestaltet sind zur Messung eines physiologischen Parameters, der von dem Status einer kardiovaskulären Krankheit in Zusammenhang mit einer sympathischen Aktivierung beeinflusst ist, wobei die Erfassungsmittel (2, 4) Messmittel (2) umfassen, die angeordnet sind, um als physiologische Parameter die elektrische transkardiale Bio-Impedanz zu messen, die eine mechanische Veränderung in mindestens einer der vier Herzkammern anzeigt, wobei die Messmittel (2) dazu eingerichtet sind, um die elektrische transkardiale Bio-Impedanz i) quadropolar zwischen dem rechten Vorhof und der rechten Herzkammer, ii) bipolar in der rechten Herzkammer oder iii) über der linken Implantierbare Herzvorrichtung zu messen, umfassend:
- Signal verarbeitende Mittel (6), die ausgestaltet sind zur Ermittlung mindestens einer aus einer Mayer-Wellen-Komponente mit niedriger Frequenz (LF) und sehr niedriger Frequenz (VLF) in dem physiologischen Parameter, und
- einen Analysator (6), der ausgestaltet ist zur

Analyse der ermittelten Mayer-Wellen-Komponente in Bezug auf einen vorgegebenen Referenzwert, um den Status der kardiovaskulären Krankheit zu ermitteln.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Messmittel (2) zwei Elektroden umfassen, wobei eine zur Anordnung in der rechten Herzkammer eingerichtet ist und die andere zur Anordnung in einer Koronarvene auf der rechten Herzkammer eingerichtet ist.

3. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Messmittel (2) Elektroden umfassen, die für eine epikardiale Anordnung eingerichtet sind.

4. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Messmittel (2) angeordnet sind zur Messung der linksventrikulären Kontraktilität.

5. Vorrichtung nach Anspruch 4, **dadurch gekennzeichnet, dass** der Analysator (6) angeordnet ist zur Ermittlung der Steigung eines vorgegebenen Abschnitts des Signals, das der gemessenen Bio-Impedanz entspricht, als Maß für die linksventrikuläre Kontraktilität.

6. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Messmittel (2) angeordnet sind zur Messung mechanischer Veränderungen bei mindestens einer der Mengen mechanischer AR-Intervall und Vor-Auswurf-Zeitintervall.

7. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Erfassungsmittel (2, 4) angeordnet sind zur Messung der physiologischen Parameter für eine Dauer von mindestens einigen Minuten, und dass die Signal verarbeitenden Mittel (6) angeordnet sind zur Berechnung von mindestens einer entsprechenden Datenprobe pro Herzschlag.

8. Vorrichtung nach Anspruch 7, **dadurch gekennzeichnet, dass** ein Speicher (8) bereitgestellt ist zum Speichern der Datenproben und dass ein Filter bereitgestellt ist zum Filtern der gespeicherten Daten und zum Ermitteln der Amplituden von LF- und/oder VLF-Mayer-Wellen-Komponenten.

9. Vorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** ein Speicher (8) bereitgestellt ist zum Speichern der Datenproben und dass ein Fourier-Transformationsmittel bereitgestellt ist zum Ermitteln von LF- und/oder VLF-Mayer-Wellen-Komponenten der gemessenen physiologischen Parameter sowie der Amplituden dieser Komponenten.

10. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Signal verarbeitenden Mittel (6) dazu eingerichtet sind, das Spektrogramm von mindestens einer der Mayer-Wellen-Komponenten zu ermitteln, und dass der Analysator (6) dazu eingerichtet ist, das ermittelte Spektrogramm in Bezug auf eine vorgegebene Spektrogramm-Vorlage zu analysieren, um den Status der kardiovaskulären Krankheit zu ermitteln.

11. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** eine Warnvorrichtung (14) bereitgestellt ist, um dem Patienten zu melden, einen Arzt zu kontaktieren, falls die Abweichung der ermittelten Mayer-Wellen-Komponente von dem Referenzwert einen vorgegebenen Grenzwert überschreitet.

12. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Herzschrittmacher (10, 12) Steuermittel zum Steuern der Herzstimulationstherapie in Abhängigkeit von dem ermittelten Status der Herzkrankheit des Patienten umfasst.

Revendications

1. Dispositif cardiaque implantable comprenant :

- un stimulateur cardiaque (10, 12) configuré pour stimuler électriquement le coeur d'un patient,
- des moyens de détection (2, 4) configurés pour mesurer un paramètre physiologique qui est affecté par l'état d'une maladie cardiovasculaire associée à l'activation sympathique, lesdits moyens de détection (2, 4) comprenant des moyens de mesure (2) arrangés pour mesurer, en tant que lesdits paramètres physiologiques, la bio-impédance transcardiaque électrique indiquant un changement mécanique dans au moins l'une des quatre cavités du coeur, dans lequel lesdits moyens de mesure (2) sont conçus pour mesurer la bio-impédance transcardiaque électrique i) quadripolairement entre l'oreillette droite et le ventricule droit, ii) bipolairement dans le ventricule droit ou iii) sur le ventricule gauche ;
- des moyens de traitement de signal (6) configurés pour déterminer au moins l'une parmi une composante d'onde Mayer basse fréquence (LF) et très basse fréquence (VLF) dans ledit paramètre physiologique, et
- un analyseur (6) configuré pour analyser ladite composante d'onde Mayer déterminée relativement à une valeur de référence prédéterminée pour déterminer ledit état de ladite maladie cardiovasculaire.

2. Dispositif selon la revendication 1, **caractérisé en ce que** lesdits moyens de mesure (2) comprennent deux électrodes, une conçue pour le positionnement dans le ventricule droit et l'autre conçue pour le positionnement dans une veine coronaire sur le ventricule gauche.

3. Dispositif selon la revendication 1, **caractérisé en ce que** lesdits moyens de mesure (2) comprennent des électrodes, conçues pour la localisation épicardique.

4. Dispositif selon la revendication 1, **caractérisé en ce que** lesdits moyens de mesure (2) sont arrangés pour mesurer la contractilité ventriculaire gauche.

5. Dispositif selon la revendication 4, **caractérisé en ce que** ledit analyseur (6) est arrangé pour déterminer la pente d'une portion prédéterminée du signal, correspondant à la bio-impédance mesurée, en tant que mesure de la contractilité ventriculaire gauche.

6. Dispositif selon la revendication 1, **caractérisé en ce que** lesdits moyens de mesure (2) sont arrangés pour mesurer les changements mécaniques dans au moins l'une des quantités d'intervalle-AR mécanique, et de la période de pré-éjection.

7. Dispositif selon la revendication 1, **caractérisé en ce que** lesdits moyens de détection (2, 4) sont arrangés pour mesurer ledit paramètre physiologique pendant une période d'au moins plusieurs minutes, et **en ce que** lesdits moyens de traitement de signal (6) sont arrangés pour calculer au moins un échantillon de données correspondantes par battement de coeur.

8. Dispositif selon la revendication 7, **caractérisé en ce qu'**une mémoire (8) est prévue pour stocker lesdits échantillons de données et **en ce qu'**un filtre est prévu pour filtrer lesdites données stockées et déterminer les amplitudes des composantes d'onde Mayer basse fréquence (LF) et/ou très basse fréquence (VLF).

9. Dispositif selon la revendication 6, **caractérisé en ce qu'**une mémoire (8) est prévue pour stocker lesdits échantillons de données et **en ce que** des moyens de transformation de Fourier sont prévus pour déterminer des composantes d'onde Mayer basse fréquence (LF) et/ou très basse fréquence (VLF) dudit paramètre physiologique mesuré ainsi que les amplitudes de ces composantes.

10. Dispositif selon la revendication 1, **caractérisé en ce que** lesdits moyens de traitement de signal (6) sont conçus pour déterminer le spectrogramme d'au moins l'une des composantes d'onde Mayer, et **en ce que** ledit analyseur (6) est conçu pour analyser ledit spectrogramme déterminé relativement à un spectrogramme de modèle prédéterminé afin de déterminer ledit état de ladite maladie cardiovasculaire.

11. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** des moyens d'alerte (14) sont prévus pour alerter le patient pour qu'il contacte un médecin, si l'écart de ladite composante d'onde Mayer déterminée à partir de ladite valeur de référence dépasse un seuil prédéterminé.

12. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** son stimulateur cardiaque (10, 12) comprend des moyens de commande pour commander la thérapie de stimulation cardiaque en fonction de l'état détecté de la maladie cardiaque du patient.

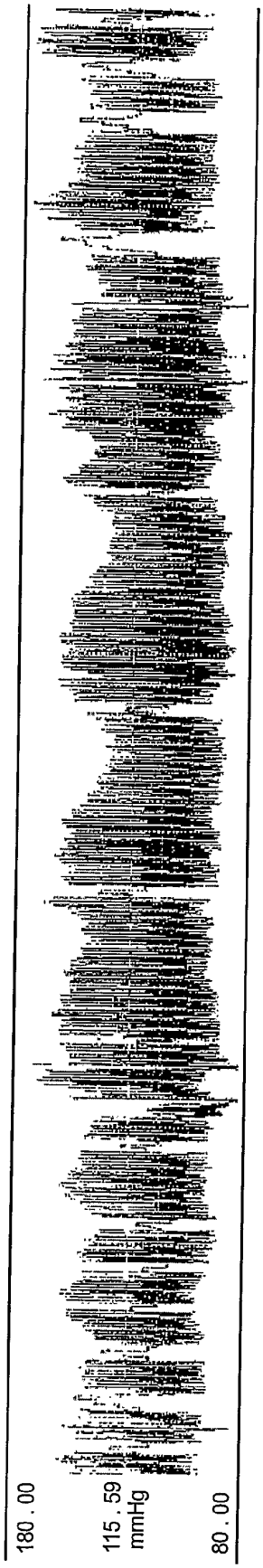

Fig. 1

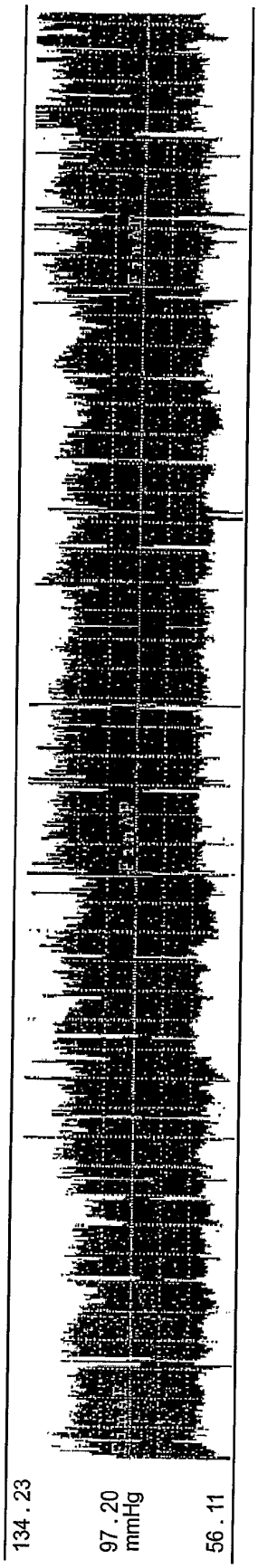

Fig. 2

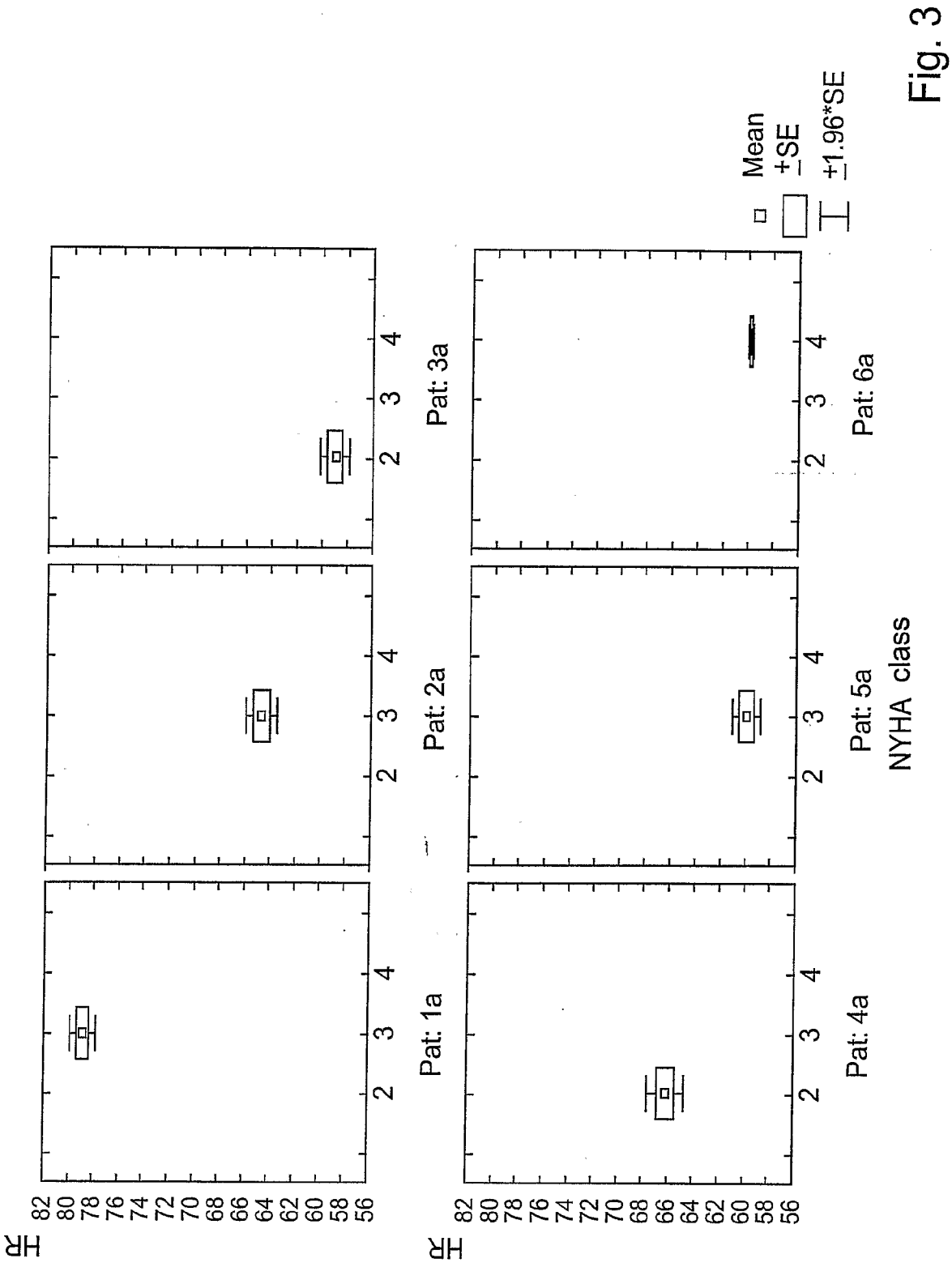
HR
82
80
78
76
74
72
70
68
66
64
62
60
58
56
2
3
4
Pat: 1a
Pat: 2a
Pat: 3a
Pat: 4a
Pat: 5a
Pat: 6a
NYHA class
Mean
±SE
±1.96*SE

Fig. 3

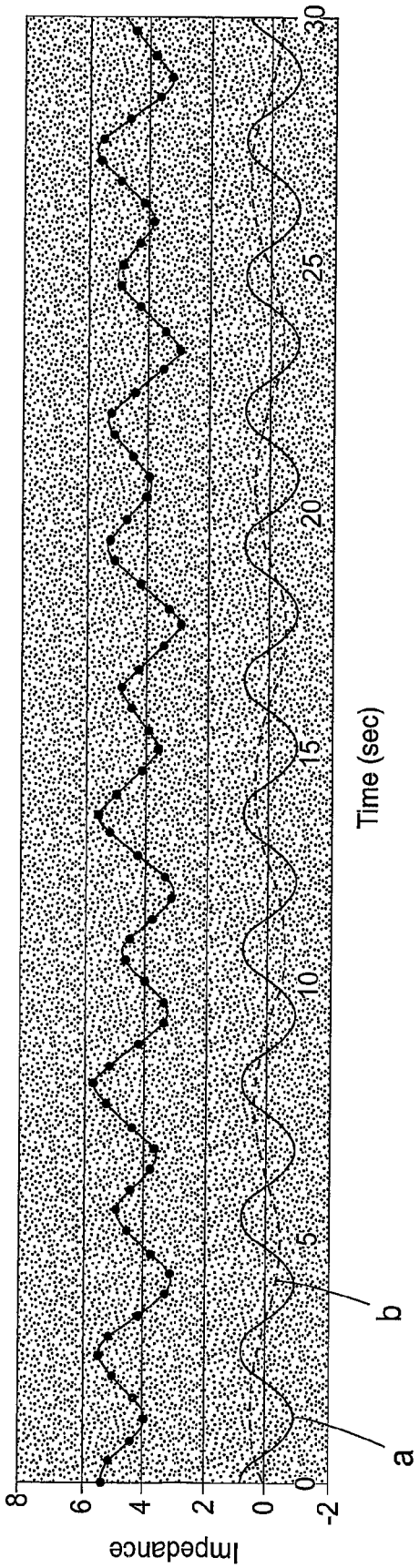
Impedance
8
6
4
2
0
-2
0
5
10
15
20
25
30
Time (sec)
a
b

Fig. 4

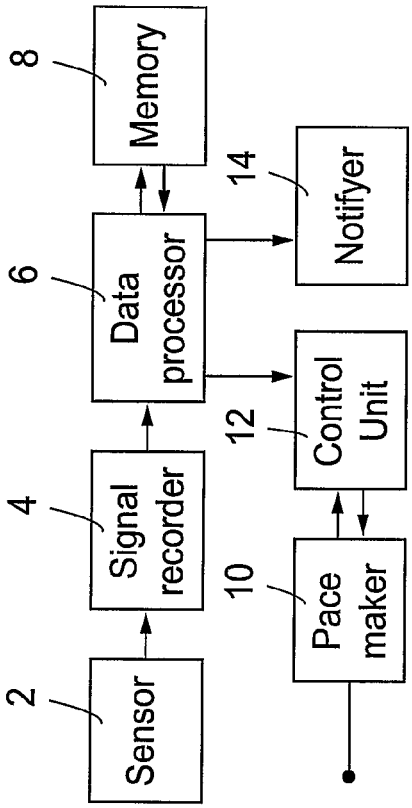
2
Sensor
4
Signal recorder
6
Data processor
8
Memory
10
Pace maker
12
Control Unit
14
Notifyer

Fig. 5

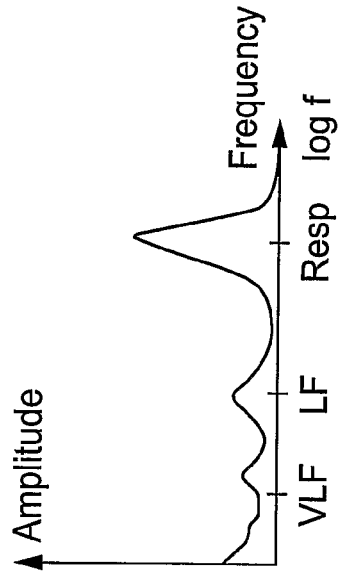
Amplitude
Frequency
VLF
LF
Resp
log f

Fig. 7

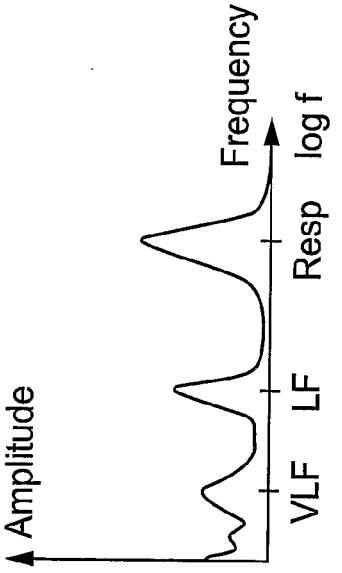
Amplitude
Frequency
VLF
LF
Resp
log f

Fig. 6

REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	一种用于监测心血管疾病状态的可植入心脏装置和方法		
公开(公告)号	EP2129431A4	公开(公告)日	2013-08-28
申请号	EP2007747963	申请日	2007-03-23
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当前申请(专利权)人(译)	ST.犹达医疗用品AB		
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发明人	HOLMSTRÖM, NILS ÖHLANDER, MALIN NOREN, KJELL BLOMQVIST, ANDREAS LJUNGSTRÖM, KARIN		
IPC分类号	A61N1/365 A61N1/37 A61B5/00 A61B5/0215 A61B5/024 A61B5/053		
CPC分类号	A61N1/36521 A61B5/0215 A61B5/02405 A61B5/053 A61B5/4035 A61B5/4836 A61B5/7257 A61N1/36564 A61N1/36578 A61N1/36592 A61N1/3702		
其他公开文献	EP2129431A1 EP2129431B1		
外部链接	Espacenet		

摘要(译)

植入式心脏装置具有用于电刺激患者心脏的心脏刺激器，检测器，其测量受与交感神经激活相关的心血管疾病状态影响的生理参数，信号处理器确定至少一个低频率，LF，以及测量参数中的极低频率，VLF，Mayer波分量，以及分析器，其自动分析与预定参考值相关的确定的Mayer波分量，以确定心血管疾病的状态。检测器是心 - 机械参数检测器，其测量心脏的四个腔室中的至少一个腔室中的机械变化作为所述生理参数。在用于监测与具有可植入电心脏刺激器的患者的交感神经激活相关的心血管疾病状态的相应方法中，测量受心脏病影响的生理参数。确定参数中的低频，LF和极低频率VLF，Mayer波分量中的至少一个，并且相对于预定参考值分析波分量以确定心血管疾病的状态。测量心脏的四个腔室中的至少一个腔室中的机械变化作为生理参数。