(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 274 347 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
13.08.2008 Bulletin 2008/33

(21) Application number: **01917441.6**

(22) Date of filing: **04.04.2001**

(51) Int Cl.:
A61B 5/113 *(2006.01)*

(86) International application number:
PCT/IS2001/000008

(87) International publication number:
WO 2001/076467 (18.10.2001 Gazette 2001/42)

(54) **BREATHING MOVEMENT MEASUREMENTS AND APPARATUS**

ATMUNGSBEWEGUNGSMESSUNG UND GERÄT DAFÜR

MESURES DE MOUVEMENTS DE RESPIRATION ET APPAREIL CORRESPONDANT

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR

(30) Priority: **07.04.2000 IS 543200**
07.04.2000 US 195190 P

(43) Date of publication of application:
15.01.2003 Bulletin 2003/03

(73) Proprietor: **Remo Ehf.**
112 Reykjavik (IS)

(72) Inventor: **RAGNARSDOTTIR, Maria**
IS-105 Reykjavik (IS)

(74) Representative: **Fridriksson, Einar Karl**
Arnason Faktor
Intellectual Property Consulting
Gudridarstig 2-4
113 Reykjavik (IS)

(56) References cited:
EP-A- 0 919 184
DE-A- 3 109 026
GB-A- 2 192 713
US-A- 4 495 950
US-A- 4 664 130
US-A- 5 577 502
US-A- 5 588 439

EP 1 274 347 B1

Printed by Jouve, 75001 PARIS (FR)

Description

FIELD OF THE INVENTION

[0001] The present invention is within the field of physical measurements of body functions, specifically measurements of breathing movements of the chest and abdomen.

TECHNICAL BACKGROUND AND PRIOR ART

[0002] Many medical and physical conditions will affect the proper functioning of the breathing organs. The effects may be directly related to the physical condition of the lungs themselves and/or the many correlated functions that provide the breathing movements controlling the inspiration and expiration of the lungs. Several diseases have an effect on breathing movements and breathing patterns such that, e.g., movements of either the upper or lower chest or abdomen are diminished, affecting the proper respiration and ventilation of the subject. After operations on the chest or upper abdominal area, such as heart or lung operations where the chest has to be opened, subjects commonly have post-operative breathing complications.

[0003] Methods of measuring breathing movements include measuring the circumference of the chest and abdomen with a common measuring tape during inspiration and expiration (in- and out-breathing), such a measurement will, however, not give a simultaneous measuring during the same breath at more than one location. It is also difficult to obtain reproducible and precise measurements of changes in the circumference.

[0004] Respitrace (TM) is a device based on 'respiratory inductive pletysmography' and provides time-dependent circumference measurements at two different heights simultaneously (see, e.g., Verschakelen, J. A., Demets, M. G. Am. J. Resp. Critical Care Med. 151, 1995, 399 - 405). Two spirals are put around the subject and changes in the circumference change the length of the spirals and thus their electrical conductivity.

[0005] In studies with a magnetometer the change in diameter is measured at two points at the center of the subject, typically on the center of the sternum and on the abdomen (e.g., Sharp, J.T., et al. J. App. Physiol. 39, 1975, 608 - 618). Two pairs of electrical coils are placed in contact with the body of the subject such that one coil of each is in front of the body and the other is directly behind the body. An AC current is led to the posterior coils which induces an electromagnetic field between the posterior and anterior coils and a potential is measured in the anterior coils that changes as the distance between the coils changes with the breathing of the subject.

None of the above methods will allow a detailed and well-resolved analysis of breathing movements, such as e.g. to obtain symmetry-resolved data.

[0006] The Elite system (see US 4,706,296) used in a study by De Groote *et al.* (De Groote et al. J. Appl. Physiol. 83 (5): 1531-1537, 1997) measures chest wall motions by recording the position of markers placed on an object in motion by using television cameras that have different viewpoints. The system supplies the acquisition of two-dimensional frames for each camera and then computes 3D coordinates of each marker as a function of time. The system as described by De Groote *et al.* uses two television cameras, and the motion of different subsets of markers is determined by comparing image data from six successive acquisitions, where the orientation of the subject is changed relative to the cameras in between every two acquisitions.

[0007] No systems have however been suggested in the prior art, wherein breathing patterns are obtained by measuring the simultaneous movement of a plurality of points, wherein the movement is measured by the change in the distance from each point to a reference point, such that a breathing pattern may be obtained in a single acquisition.

[0008] In particular, no such methods have been suggested for measuring the symmetry of breathing movements, that is whether the left and right side of a subject show equal breathing movements or whether a particular breathing problem will affect one side of the body more than the other. This can be suspected, e.g., in many heart operations where the sternum is cleaved and the left side of the rib cage may be forced upwards 3,5 - 5,5 cm during the operation. No data however seems to be available in the medical literature, discussing or describing post-operative effects on breathing movements, after such invasive surgery, and indeed, the inventors are not aware of any data discussing symmetry/asymmetry of breathing and quantitative measurements thereof. Methods will therefore be appreciated, to monitor such post-operative conditions and other conditions which may affect breathing symmetry and other breathing parameters.

[0009] An earlier disclosure by the inventor outlines a possible setup for breathing movement measurements based on using distance sensors. (Ragnarsdóttir, Icel. Med J. vol. 85, no. 4, 1999, pp. 313-314.)

[0010] It has since been found that such an instrumental setup and other types of imaging devices can be used to determine breathing patterns which can be described by a novel set of breathing pattern parameters.

SUMMARY OF THE INVENTION

[0011] In a first aspect, the invention provides a method for measuring breathing movements as defined in claim 1. The method comprises measuring the simultaneous movement of a plurality of points of a human body, wherein the movement is measured by the change in the distance from each point of the plurality of points to one or more reference points, wherein the movement is measured over a time period so as to determine a breathing pattern.

[0012] In a further aspect, the invention discloses methods for evaluating the effect of a predetermined medical condition on breathing functions by determining breathing patterns by use of the methods according to the invention.

[0013] In yet a further aspect the invention provides an apparatus for determining breathing patterns of a human as defined in claim 10. The apparatus comprises an imaging device comprising one or more distance measurement devices that measure the change in distance from each point of a plurality of points to one or more reference points; for measuring the simultaneous movement of a plurality of points of a human body to obtain a breathing pattern.

[0014] In a preferred embodiment a method is provided for determining breathing patterns comprising: providing a set of data for breathing movement measurements over a period of time; entering the data into a computer; calculating with a computer program the breathing pattern parameters.

DETAILED DESCRIPTION

[0015] The method according to the invention for determining breathing patterns comprises measuring the simultaneous movement of a plurality of points of a human body. Breathing patterns is a concept used to describe breathing in physical terms. There is however, no commonly accepted general definition of the term. The inventor has defined a set of parameters that are useful to describe breathing patterns as are obtainable with the methods of the invention. The parameters are the following: type of breathing, rhythm of breathing, magnitude of breathing movements, frequency of breathing movements, and symmetry of breathing movements.

Type of breathing indicates whether the breathing movements are predominantly abdominal, low-costal or high-costal (upper costal) Rhythm of breathing is the time ratio between inspiration time and expiration time. Magnitude of breathing movements is the excursion of the diaphragm and ribs from FRC (functional residual capacity, i.e., the resting breathing position after expiration) to full inspiration in Vt (tidal volume, after resting inspiration) and VC (vital capacity, after maximum inspiration). Frequency of breathing movements is how often a person breathes in and out in a given period of time such as in one minute. Symmetry of breathing movements indicates whether the magnitude of breathing movements is the same on the left and right side of sternum.

[0016] An essential feature of the method of the invention is to provide simultaneous movement measurements of a plurality of points of a human subject.

In this context the term simultaneous is to be understood such that a simultaneous measurement of the movement of two points will provide comparable movement profiles for these two points in the same breath (inspiration and expiration). Consequently, using a computer program that controls the collection of measurement data through an electronic circuit, from a number of points consecutively but with a sufficient sampling frequency to provide comparable movement profiles for each point is to be understood in this context as a simultaneous measurement. A sufficient sampling frequency for this purpose is on the order of 1 to 10.000 Hz, such as, e.g., 1-100 Hz, including 2-25 Hz, such as 2-10 Hz.

[0017] According to the invention, the method for determining breathing patterns prescribes that the movement of the plurality of points be measured by the change in the distance from each point of the plurality of points to one or more reference points. This may be accomplished by any means for measuring distances known to the person skilled in the art.

[0018] It is a significant feature of the method according to the invention, that the movement is measured over a time period so as to determine a breathing pattern. The minimum length of the time period is determined by the frequency and regularity of the breathing of the subject and the need for obtaining a statistically reliable breathing pattern. For the frequency breathing pattern parameter, the time period needs to encompass more than one breath (inspiration and expiration), preferably at least 3, such as at least 5, including at least 5 to 10. In particular embodiments the time period is in the range of half a minute to one minute or a few minutes. However, it should be noted that the above described time period is a recommended time to obtain a breathing pattern, the method can be used as well for extended time periods, e.g., to monitor eventual change in the breathing pattern. Such extended time periods may be on the order of several minutes up to many hours, such as 0,5 to 1 hours or longer, including 12 to 24 hours or longer. Consequently, it is a highly advantageous feature of the method of the invention that a breathing pattern analysis may be obtained in a single acquisition, i.e. the movement of all points on which the analysis is based, is measured in the same acquisition, unlike e.g. prior art methods using the Elite system discussed above.

[0019] In a preferred embodiment of the invention the plurality of points on the body of a human subject comprises one or more points on each side of the sternum, more preferably the plurality of points is symmetrically distributed with respect to the sternum. It is to be understood that on each side of sternum' refers to each side of the body divided by the plane that may be defined by the sternum and spine.

[0020] According to the method of the invention, the breathing pattern to be determined may be defined by various parameters that sufficiency will describe the breathing pattern for any given study or application. According to the invention, the breathing patterns determined are defined by all of the breathing pattern parameters as described above.

[0021] It is a particularly useful feature of a preferred embodiment of the invention to obtain a symmetry breathing pattern parameter. To obtain a symmetry breathing parameter the movement of a minimum of two points, one point on each side of sternum, needs to be measured.

[0022] In a preferred embodiment of the invention, a computer system receives the movement measurement data obtained by the method of the invention and calculates selected breathing pattern parameters.

[0023] As mentioned, the invention provides in another aspect a method for evaluating the effect of a predetermined medical condition on breathing functions by determining breathing patterns with the method of the invention. Such an evaluation may be useful for any condition that is suspected to have any effect on the breathing functions and may be used to monitor progression or regression of such a condition, e.g., to asses recovery of or the effect of treatment on subjects suffering from the condition. Such conditions include orthopedic diseases; diseases of the breathing organs including emphysema, respiratory insufficiency, and asthma; post-operative conditions including conditions after operations of organs in the chest and/or abdomen such as lung operations, coronary bypass operations, operations of the digestion system; post-injury conditions; conditions due to sleeping disorders such as sleep apnea; and rheumatism conditions.

[0024] In a preferred embodiment of the invention, the effect evaluated is one that has or may have an asymmetrical effect on breathing functions, such as e.g. a post-operative condition after a chest operation.

[0025] In certain useful embodiments of the invention, the breathing patterns determined by the invention are further correlated with other physical and/or chemical functions of a human body by a simultaneous measurement selected from the group comprising: electroencephalographic measurements, electrocardiographic measurements, electromyographic measurements, nerve conduction measurements, heart rate measurements, blood pressure measurements, measurements with a pulse oxymeter, and sound measurements such as, e.g., snoring. All of the said other measurements can provide digital output signals that may easily be correlated in time with the measured breathing patterns.

[0026] In a further aspect of the invention, an apparatus as defined in claim 10 is provided for determining breathing patterns by the methods disclosed, said apparatus comprising an imaging device comprising one or more distance measurement devices that measure the change in distance from each point of the plurality of points to one or more reference points, for measuring the simultaneous movement of a plurality of points of a human body.

[0027] The apparatus is able to obtain data for a breathing pattern analysis in a single acquisition with the method of the invention, which is highly beneficial for obtaining high accuracy and precision of data, and to minimize inconvenience to measured subjects.

[0028] Preferably, the apparatus according to the invention measures the simultaneous movement of a plurality of points symmetrically distributed with respect to the sternum.

[0029] The apparatus according to the invention determines breathing patterns by a selected set of breathing pattern parameters, preferably such as those described above.

[0030] According to the invention, the apparatus further comprises a computer system that utilizes the output signals from said imaging device for calculating breathing pattern parameters. Such a computer system may be able to present the breathing pattern parameters on an output device such as a screen and/or a printer.

[0031] A further useful embodiment of the invention comprises a synchronized connection to one or more medical measurement means such as an electroencephalographic recording device, an electrocardiographic recording device, an electromyographic recording device, sonographic recording device, a nerve conduction measurement device, a heart rate meter, a pulse oxymeter, a blood pressure meter and a microphone. Said means can all provide digital output data that may be correlated in time with breathing patterns determined by the invention, thus providing useful methods for monitoring human subjects whether it is to evaluate a certain medical or physical condition (e.g. sleep).

[0032] An imaging device of the apparatus according to the invention may be any imaging device found to be practical for the purpose and known to the person skilled in the art and able to obtain data for determining the position and/or the movement of selected points with a sufficient precision.

[0033] In one embodiment, such an imaging device comprises a plurality of distance measurement devices held on a frame such that they are spatially and directionally adjustable. Such distance measurement devices are commercially available based on different physical interactions and include ultrasonic distance measurement sensors and optical distance sensors based on reflected light.

[0034] In a preferred embodiment, the apparatus according to the invention measures the absolute movement in space of the plurality of points, however, useful and reliable data may be obtained by measurement of movement in a particular direction such as the anterior-posterior direction which is the dominating direction of movement for the frontal area of the chest and abdomen.

[0035] In another embodiment, the imaging device of the apparatus comprises one or more cameras such as a CCD video camera, providing one or more images of the plurality of points on the body of the subject, and of one or more

fixed reference points, said apparatus further comprising a computer system that calculates the distance from each point of the plurality of points to one or more of the said one or more reference points and thereby determines the movement of the plurality of points.

[0036] A further embodiment of the invention relates to the method for determining breathing patterns, the method comprising:

a) providing a set of data for breathing movement measurements over a period of time;
b) entering the data into a computer;
c) calculating with a computer program the breathing pattern parameters.

[0037] The said set of data can be obtained by any of the methods described above. The data should be of sufficient sampling frequency to provide reliable and comparable, simultaneous movement profiles as described above. A computer program is used to calculate breathing pattern parameters such as those described above. Preferably all of the above-described parameters are calculated and used to determine breathing patterns.

[0038] Breathing pattern parameters may be calculated in the following way:
For each point the direction of movement is determined as the direction between the 'minimum' and 'maximum' point in the cyclical movement of each point during breathing. Optionally, a pre-determined direction is selected, such as the anterior-posterior direction. For each point, a movement vs. time function is determined with time on the x-axis and the movement along the movement direction or the preselected direction on the y-axis. Inspiration time is the time from a minimum to a maximum point and expiration time is the time from a maximum to a minimum point. The magnitude of breathing for each point is thus the difference between a maximum and minimum point with respect to the y-axis. Frequency of breathing may thus be calculated as the number of maximum points in a given time such as per minute, though one can also calculate the number of breathing cycles including partial breathing cycles, (e.g. if the measurement starts just before an inspiration and ends before an expiration) and rhythm of breathing is the average ratio between inspiration and expiration time.
To be able to calculate the 'type of breathing' parameter, points need to be selected at least at three heights of the body such that there is one point at the upper part of the ribs to determine 'high-costal' breathing, one point at the lower part of the ribs to determine 'low-costal' breathing, and one point at the abdomen to determine abdominal breathing. To determine a 'symmetry of breathing' parameter at least one point on each side of sternum needs to be selected as described above. A 'symmetry of breathing' parameter can then calculated simply as the difference in the magnitude of breathing for these two points.

EXAMPLES

Example 1: BMM apparatus with six distance measurement devices

[0039] The apparatus comprises six ultrasonic distance sensors (Ultrasensor™, Ultra-U rev. B, Senix Corp. VT, USA), these are held by clamps on a frame comprising a larger angled arm and two smaller arms mounted on the larger arm. Each smaller arm bears three sensors that can be adjusted, both by moving the clamps along the arm and adjusting the angle of the sensor with respect to the arm, in such a way the sensors may be directed to selected points. The larger arm is mounted on table can be rotated such that the sensors are placed directly above a human subject lying on a bench, symmetrically with respect to the sternum of the subject, three sensors on each side of the sternum. The smaller arms can be rotated on the larger arm from a horizontal position to a vertical position in order to measure a subject in a lying to sitting position and in any inclination in-between.
A signal relay box receives signals from the sensors and forwards to a personal computer. The personal computer is programmed to calculate breathing pattern parameters with the signals received from the signal relay box.

Example 2: Measurement of breathing movements with BMM apparatus

[0040] The apparatus from Example 1 was used to obtain breathing patterns for a human subject. The subject was laid down on a bench to a horizontal position. The larger arm of the BMM apparatus is turned such that that the two smaller arms are above and diagonal with the body of subject. The sensors are adjusted such that three sensors are directed to each side of the sternum, to points on a straight line diagonal with the body of the subject from the centerpoint of the collar bone (the centerpoint between *articulatio stemoclavicularis* and *articulatio acromioclavicularis)*. The position of the points on the line is by the fourth rib, at the bottom rib, and at the height of the navel. Half-spheres of styrofoam are attached to the surface of the body of the subject, at the points that the sensors are directed at to give a better defined point of measurement for the interacting beam from the sensor.

Example 3: Breathing pattern determined for a human subject

[0041] A 30 years old male subject with no history of medical conditions affecting the breathing functions was subjected to breathing pattern analysis with the method of measurement as described in the Example 2. Measurements were recorded for 30 sec. for resting breathing and 59 sec. for maximum capacity breathing.
The following breathing pattern parameters were determined for each measurement:

Table 1:

		Abdominal		Upper costal		Lower costal	
		left	right	left	right	left	right
resting	magnitude [mm]	14.4±2.4	14.4±2.4	3.0±0.5	2.5±0.2	4.0±0.4	4.0±0.3
	frequency [min^{-1}]	16.7	16.7	16.7	16.7	16.7	16.7
	rhythm	1/0.83	1/0.83	1/0.83	1/0.83	1/0.83	1/0.83
	symmetry	0.0		0.5		0.0	
deep capacity	magnitude [mm]	37.2±0.4	39.3±0.2	17,3±1,7	17,6±1,0	13.0±0.5	15.6+0.3
	frequency [min^{-1}]	8.7	8.7	8.7	8.7	8.7	8.7
	rhythm	1/0.92	1/0.92	1/0.92	1/0.92	1/0.92	1 /0.92
	symmetry	2.1		2.6		1.0	

Example 4: Average breathing patterns determined for healthy subjects

[0042] The breathing pattern of 100 healthy individuals, 50 men and 50 women, were determined to obtain average values for breathing pattern parameters. The results are shown in table 2, divided by age and sex. Each group represents 10 individuals. 'Type' indicates the height points with greatest movement, 'RA' represents average range (magnitude) of both abdominal points, 'RLC' and 'RUC' are corresponding values for lower costal and upper costal measurements, frequency represents number of breathing cycles per minute. A '+' sign in the symmetry column represent symmetric breathing.

Table 2a: resting breathing

Women	**Type**	**RA**	**RLC**	**RUC**	**Rhythm**	**Freq.**	**Symmetry**
All	Abdominal	6.49	3.87	3.38	100 / 90	14.0	+
20-29	Abdominal	4.95	3.94	4.02	100/104	14.0	+
30-39	Abdominal	7.06	3.67	3.07	100/80	12.6	+
40-49	Abdominal	7.26	4.03	4.11	100 / 96	13.9	+
50-59	Abdominal	8.22	3.43	3.01	100 / 91	14.1	+
60-69	Abdominal	7.66	4.19	2.53	100 / 78	15.4	+
Men	**Type**	**RA**	**RLC**	**RUC**	**Rhythm**	**Freq.**	**Symmetry**
All	Abdominal	7.47	3.35	2.64	100/84	14.0	+
20-29	Abdominal	5.01	2.92	2.73	100/98	14.0	+
30-39	Abdominal	7.31	3.23	3.10	100/92	12.6	+
40-49	Abdominal	8.71	4.42	3.21	100/75	13.9	+
50-59	Abdominal	8.74	3.24	2.36	100/81	14.1	+
60-69	Abdominal	7.34	3.10	2.04	100/73	15.4	+

Table 2b: deep breathing

Women	Type	RA	RLC	RUC	Rhythm	Freq.	Symmetry
All	UC	17.52	16.01	18.04	100/84	7.3	+
20-29	UC	13.94	18.08	19.93	100/98	7.7	+
30-39	Abd	20.66	16.38	19.62	100/92	7.0	+
40-49	UC	17.52	16.38	19.62	100/75	7.0	+
50-59	Abd	20.59	17.03	18.23	100/81	8.0	+
60-69	Equal	15.05	16.05	16.84	100/73	7.0	+
Men	**Type**	**RA**	**RLC**	**RUC**	**Rhythm**	**Freq.**	**Symmetry**
All	Abdominal	24.68	19.72	18.37	100/82	7.4	+
20-29	Abdominal	26.65	24.01	21.75	100/75	6.6	+
30-39	Abdominal	23.12	14.25	17.25	100/84	7.0	+
40-49	Abdominal	23.53	19.07	16.79	100/89	8.8	+
50-59	Abdominal	26.09	18.81	19.72	100/80	7.3	+
60-69	Abdominal	23.61	22.47	16.11	100/84	7.3	+

Claims

1. A method for measuring breathing movements comprising measuring the simultaneous movement of a plurality of points of a human body, wherein the movement is measured by the change in the distance from each point of the plurality of points to one or more reference points, wherein the movement is measured over a time period so as to determine a breathing pattern, the breathing pattern defined by breathing pattern parameters comprising all of the following type of breathing, rhythm of breathing, magnitude of breathing movements, frequency of breathing movements and symmetry of breathing movements, where type of breathing indicates whether the breathing movements are predominantly abdominal, low-costal or high-costal.

2. The method according to claim 1, wherein a breathing pattern analysis is obtained for a subject in a single acquisition.

3. The method according to claim 1, wherein the plurality of points comprises one or more points on each side of the sternum.

4. The method according to claim 1, wherein the plurality of points is symmetrically distributed with respect to the sternum.

5. The method according to claim 1, wherein a computer system receives movement measurement data and calculates the breathing pattern parameters.

6. The method according to claim 1, further comprising correlating breathing patterns with other physical and/or chemical functions of a human body by a simultaneous measurement selected from the group comprising: electroencephalographic measurements, electrocardiographic measurements, electromyographic measurements, sonographic measurements, heart rate measurements, measurements with a pulse oxymeter, blood pressure measurements, and sound measurement such as for snoring.

7. A method for evaluating the effect of a predetermined medical condition on breathing functions by measuring breathing patterns according to any of claims 1 to 6.

8. The method according to claim 7, wherein the medical condition is selected from the group comprising diseases of the breathing organs including emphysema, respiratory insufficiency, and asthma; post-operative conditions including conditions after operations of organs in the chest and/or abdomen such as lung operations, coronary bypass

operations, operations of the digestion system; post-injury conditions; and rheumatism conditions.

9. The method according to claim 8, wherein the effect evaluated is an asymmetrical effect on breathing functions.

10. An apparatus for determining breathing patterns of a human comprising:

an imaging device comprising one or more distance measurement devices that measure the change in distance from each point of a plurality of points to one or more reference points; for measuring the simultaneous movement of a plurality of points of a human body to obtain a breathing pattern,
a computer system that utilizes the output signals from said imaging device for calculating breathing pattern parameters defining the breathing pattern.

wherein the breathing pattern is defined by breathing pattern parameters comprising all of the following: type of breathing, rhythm of breathing, magnitude of breathing movements, frequency of breathing movements, and symmetry of breathing movements and
where in the type of breathing indicates whether the breathing movements are predominantly abdominal, low-costal or high-costal.

11. An apparatus according to claim 10, which is adapted to obtain data for a breathing pattern analysis in a single acquisition.

12. An apparatus according to claim 10, that measures the simultaneous movement of a plurality of points symmetrically distributed with respect to the sternum.

13. An apparatus according to claim 10 further comprising a synchronized connection to one or more medical measurement means selected from the group comprising: an electroencephalographic recording device, electrocardiographic recording device, electromyographic recording device, nerve conduction measurement device, sonographic recording device, heart rate meter, blood pressure meter and microphone.

14. An apparatus according to claim 10, wherein the computer system presents the breathing pattern parameters on an output device such as a screen and/or a printer.

15. An apparatus according to claim 10, wherein the imaging device comprises a plurality of distance measurement devices held on a frame such that they are spatially and directionally adjustable.

16. An apparatus according to claim 10, wherein anterior-posterior breathing movements are measured for each point of the plurality of points.

17. An apparatus according to claim 10, wherein the imaging device is an optical imaging device such as one or more cameras, providing an image of the plurality of points on a human body and one or more fixed reference points.

18. A method for determining breathing patterns, according to claim 1, comprising:

a) providing a set of data for breathing movement measurements over a period of time:
b) entering the data into a computer;
c) calculating with a computer program said breathing pattern parameters.

Patentansprüche

1. Verfahren zum Messen von Atmungsbewegungen, umfassend das Messen der gleichzeitigen Bewegung mehrerer Punkte eines menschlichen Körpers, wobei die Bewegung durch die Veränderung in der Distanz von jedem Punkt der mehreren Punkte zu einem oder mehreren Referenzpunkten gemessen wird, wobei die Bewegung über einen Zeitraum gemessen wird, um ein Atmungsmuster zu bestimmen, wobei das Atmungsmuster durch Atmungsmusterparameter definiert ist, welche alle der Folgenden umfassen: Art der Atmung, Atmungsrhythmus, Größenordnung der Atmungsbewegungen, Häufigkeit der Atmungsbewegungen und Symmetrie der Atmungsbewegungen, wobei die Art der Atmung anzeigt, ob die Atmungsbewegungen vorrangig abdominal, im Bereich der unteren Rippen oder im Bereich der oberen Rippen erfolgen.

2. Verfahren nach Anspruch 1, wobei eine Atmungsmusteranalyse für eine Testperson in einer einzelnen Erfassung erhalten wird.

3. Verfahren nach Anspruch 1, wobei die mehreren Punkte einen oder mehrere Punkte auf jeder Seite des Sternums umfassen.

4. Verfahren nach Anspruch 1, wobei die mehreren Punkte hinsichtlich des Sternums symmetrisch verteilt sind.

5. Verfahren nach Anspruch 1, wobei ein Computersystem Bewegungsmessungsdaten empfängt und die Atmungsmusterparameter berechnet.

6. Verfahren nach Anspruch 1, ferner umfassend das Korrelieren von Atmungsmustern mit anderen physikalischen und/oder chemischen Funktionen eines menschlichen Körpers durch eine gleichzeitige Messung ausgewählt aus der Gruppe, welche Folgende umfasst: elektroenzephalographische Messungen, elektrokardiographische Messungen, elektromyographische Messungen, sonographische Messungen, Herzfrequenzmessungen, Messungen mit einem Pulsoxymeter, Blutdruckmessungen und Lautstärkenmessung wie für das Schnarchen.

7. Verfahren zum Bewerten der Auswirkung einer vorbestimmten Krankheit auf die Atmungsfunktionen durch das Messen von Atmungsmustern nach einem der Ansprüche 1 bis 6.

8. Verfahren nach Anspruch 7, wobei die Krankheit aus der Gruppe ausgewählt ist, welche Erkrankungen der Atmungsorgane umfasst, einschließlich Emphysem, Atmungsinsuffizienz und Asthma; postoperative Beschwerden, einschließlich Beschwerden nach Operationen von Organen in der Brust und/oder im Abdomen wie Lungenoperationen, Herz-Bypass-Operationen, Operationen des Verdauungssystems; Beschwerden nach Verletzungen und Rheumatismusbeschwerden.

9. Verfahren nach Anspruch 8, wobei die bewertete Auswirkung eine asymmetrische Auswirkung auf Atmungsfunktionen ist.

10. Vorrichtung zum Bestimmen von Atmungsmustern eines Menschen, aufweisend:

ein Bildgebungsgerät, welches eines oder mehrere Distanzmessgeräte aufweist, welche die Veränderung in der Distanz von jedem Punkt mehrerer Punkte zu einem oder mehreren Referenzpunkten messen; zum Messen der gleichzeitigen Bewegung mehrerer Punkte eines menschlichen Körpers zum Erhalt eines Atmungsmusters,
ein Computersystem, welches die Ausgabesignale von dem Bildgebungsgerät für die Berechnung von Atmungsmusterparametern nutzt, welche das Atmungsmuster definieren,
wobei das Atmungsmuster durch Atmungsmusterparameter definiert ist, welche alle der Folgenden umfassen: Art der Atmung, Atmungsrhythmus, Größenordnung der Atmungsbewegungen, Häufigkeit der Atmungsbewegungen und Symmetrie der Atmungsbewegungen, und
wobei die Art der Atmung anzeigt, ob die Atmungsbewegungen vorrangig abdominal, im Bereich der unteren Rippen oder im Bereich der oberen Rippen erfolgen.

11. Vorrichtung nach Anspruch 10, welche zum Erhalt von Daten für eine Atmungsmusteranalyse in einer einzelnen Erfassung geeignet ist.

12. Vorrichtung nach Anspruch 10, welche die gleichzeitige Bewegung mehrerer Punkte misst, welche hinsichtlich des Sternums symmetrisch verteilt sind.

13. Vorrichtung nach Anspruch 10, welche ferner eine synchronisierte Verbindung zu einem oder mehreren medizinischen Messmitteln aufweist, welche aus der Gruppe ausgewählt sind, die Folgende umfasst: ein elektroenzephalographisches Aufzeichnungsgerät, ein elektrokardiographisches Aufzeichnungsgerät, ein elektromyographisches Aufzeichnungsgerät, ein Nervenleitungsmessgerät, ein sonographisches Aufzeichnungsgerät, einen Herzfrequenzmesser, einen Blutdruckmesser und ein Mikrophon.

14. Vorrichtung nach Anspruch 10, wobei das Computersystem die Atmungsmusterparameter auf einem Ausgabegerät wie einem Bildschirm und/oder einem Drucker darstellt.

15. Vorrichtung nach Anspruch 10, wobei das Bildgebungsgerät mehrere Distanzmessgeräte aufweist, die auf einem

Rahmen gehalten werden, so dass sie räumlich und in ihrer Richtung einstellbar sind.

16. Vorrichtung nach Anspruch 10, wobei Atmungsbewegungen von vorn nach hinten für jeden Punkt der mehreren Punkte gemessen werden.

17. Vorrichtung nach Anspruch 10, wobei das Bildgebungsgerät ein optisches Bildgebungsgerät ist, wie eine oder mehrere Kameras, welche ein Bild der mehreren Punkte auf einem menschlichen Körper und eines oder mehrerer feststehender Referenzpunkte bereitstellen.

18. Verfahren zum Bestimmen von Atmungsmustern nach Anspruch 1, umfassend:

a) das Bereitstellen eines Satzes von Daten für Atmungsbewegungsmessungen über einen Zeitraum;
b) das Eingeben der Daten in einen Computer;
c) das Berechnen der Atmungsmusterparameter mit einem Computerprogramm.

Revendications

1. Méthode permettant de mesurer les mouvements respiratoires, comprenant le mesurage du mouvement simultané d'une pluralité de points sur le corps humain, dans laquelle le mouvement est mesuré par une modification dans la distance de chacun des points parmi la pluralité de points par rapport à un ou plusieurs points de référence, le mouvement étant mesuré sur une certaine durée afin de déterminer un modèle respiratoire, le modèle respiratoire défini par des paramètres de modèle respiratoire comprenant l'ensemble des éléments suivants : type de respiration, rythme respiratoire, magnitude des mouvements respiratoires, fréquence des mouvements respiratoires et symétrie des mouvements respiratoires, le type de respiration indiquant si les mouvements respiratoires se situent principalement au niveau de l'abdomen, des côtes hautes ou des côtes basses.

2. Méthode selon la revendication 1, dans laquelle une analyse de modèle respiratoire est obtenue pour un sujet au cours d'une acquisition unique.

3. Méthode selon la revendication 1, dans laquelle la pluralité de points comprend un ou plusieurs points de chaque côté du sternum.

4. Méthode selon la revendication 1, dans laquelle la pluralité de points est répartie symétriquement par rapport au sternum.

5. Méthode selon la revendication 1, dans laquelle un système informatique reçoit les données de mesure des mouvements respiratoires, et calcule les paramètres du modèle respiratoire.

6. Méthode selon la revendication 1, comprenant en outre modèles respiratoires corrélatifs, avec d'autres fonctions physiques et/ou chimiques d'un corps humain, par un mesurage simultané sélectionné parmi le groupe comprenant : mesures d'électro-encéphalogramme, mesures électro-cardiographiques, mesures électromyographiques, mesures sonographiques, mesures du rythme cardiaque, mesures à l'aide d'un oxymètre de pouls, mesures de la pression artérielle et mesures de sons tels que les ronflements.

7. Méthode pour l'évaluation de l'effet d'une condition médicale prédéterminée sur les fonctions respiratoires, par la mesure de modèles respiratoires selon l'une des revendications 1 à 6.

8. Méthode selon la revendication 7, dans laquelle la condition médicale est sélectionnée parmi le groupe comprenant : maladies touchant les organes respiratoires, y compris l'emphysème, l'insuffisance respiratoire et l'asthme ; conditions postopératoires, y compris les conditions suivant des opérations d'organes situés au niveau de la poitrine et/ou de l'abdomen, telles que les opérations pulmonaires, les opérations de pontage coronaire, les opérations du système digestif ; conditions après un accident ; et les conditions liées aux rhumatismes.

9. Méthode selon la revendication 8, dans laquelle l'effet évalué est un effet asymétrique sur les fonctions respiratoires.

10. Appareil destiné à déterminer les modèles respiratoires d'une personne, comprenant :

un dispositif d'imagerie, comprenant un ou plusieurs dispositifs de mesure de distance, qui mesurent le changement dans la distance entre chaque point parmi une pluralité de points et un ou plusieurs points de référence ; pour mesurer le mouvement simultané sur une pluralité de points d'un corps humain, afin d'obtenir un modèle respiratoire,

dans lequel le modèle respiratoire est défini par des paramètres de modèle respiratoire, comprenant l'ensemble des éléments suivants : type de respiration, rythme respiratoire, magnitude des mouvements respiratoires, fréquence des mouvements respiratoires et symétrie des mouvements respiratoires, et

dans lequel le type de respiration indique si les mouvements respiratoires viennent principalement de l'abdomen, des côtes hautes ou des côtes basses.

11. Appareil selon la revendication 10, adapté pour obtenir des données destinées à une analyse de modèle respiratoire au cours d'une acquisition unique.

12. Appareil selon la revendication 10, mesurant le mouvement simultané d'une pluralité de points répartis de façon symétrique par rapport au sternum.

13. Appareil selon la revendication 10, comprenant en outre une connexion synchronisée à un ou plusieurs moyens de mesure médicale, sélectionnés parmi le groupe comprenant : un dispositif d'enregistrement électro-encéphalographique, un dispositif d'enregistrement électro-cardiographique, un dispositif d'enregistrement électromyographique, un dispositif d'enregistrement des conductions nerveuses, un dispositif d'enregistrement sonographique, un dispositif de mesure du rythme cardiaque, un dispositif de mesure de la pression artérielle et un microphone.

14. Appareil selon la revendication 10, dans lequel le système informatique présente les paramètres de modèle respiratoire sur un périphérique de sortie, tel qu'un écran et/ou une imprimante.

15. Appareil selon la revendication 10, dans lequel le dispositif d'imagerie comprend une pluralité de dispositifs de mesure de distance, maintenus sur un cadre de manière à pouvoir être réglés de façon directionnelle et spatiale.

16. Appareil selon la revendication 10, dans lequel des mouvements respiratoires antérieurs-postérieurs sont mesurés pour chaque point parmi la pluralité de points.

17. Appareil selon la revendication 10, dans lequel le dispositif d'imagerie est un dispositif d'imagerie optique, tel qu'une ou plusieurs appareils photo, fournissant une image de la pluralité de points sur le corps humain, et un ou plusieurs points de référence déterminés.

18. Méthode permettant de déterminer des modèles respiratoires selon la revendication 1, comprenant :

a) génération d'une série de données pour les mesures de mouvements respiratoires sur une certaine durée ;
b) saisie des données dans un ordinateur ;
c) calcul desdits paramètres de modèle respiratoire, à l'aide d'un programme informatique.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 4706296 A **[0006]**

Non-patent literature cited in the description

- **VERSCHAKELEN, J. A. ; DEMETS, M. G.** *Am. J. Resp. Critical Care Med.,* 1995, vol. 151, 399-405 **[0004]**
- **SHARP, J.T. et al.** *J. App. Physiol.,* 1975, vol. 39, 608-618 **[0005]**
- **DE GROOTE et al.** *J. Appl. Physiol.,* 1997, vol. 83 (5), 1531-1537 **[0006]**
- **RAGNARSDÓTTIR.** *Icel. Med J.,* 1999, vol. 85 (4), 313-314 **[0009]**

专利名称(译)	呼吸运动测量和装置		
公开(公告)号	EP1274347B1	公开(公告)日	2008-08-13
申请号	EP2001917441	申请日	2001-04-04
[标]申请(专利权)人(译)	REMO EHF		
申请(专利权)人(译)	REMO EHF.		
当前申请(专利权)人(译)	REMO EHF.		
[标]发明人	RAGNARSDOTTIR MARIA		
发明人	RAGNARSDOTTIR, MARIA		
IPC分类号	A61B5/113 A61B5/00 A61B5/0402 A61B5/0476 A61B5/0488 A61B5/08 A61B5/145		
CPC分类号	A61B5/1135 G16H30/20 G16H50/20		
优先权	5432 2000-04-07 IS 60/195190 2000-04-07 US		
其他公开文献	EP1274347A2		
外部链接	Espacenet		

摘要(译)

一种用于通过测量人类对象的多个点的同时移动来测量呼吸运动和确定呼吸模式，使得可以基于在单次获取中获得的数据来确定呼吸模式的方法和装置。该方法提供对称呼吸模式参数。

Table 1:

		Abdominal		Upper costal		Lower costal	
		left	right	left	right	left	right
resting	magnitude [mm]	14.4±2.4	14.4±2.4	3.0±0.5	2.5±0.2	4.0±0.4	4.0±0.3
	frequency [min^{-1}]	16.7	16.7	16.7	16.7	16.7	16.7
	rhythm	1/0.83	1/0.83	1/0.83	1/0.83	1/0.83	1/0.83
	symmetry	0.0		0.5		0.0	
deep capacity	magnitude [mm]	37.2±0.4	39.3±0.2	17,3±1,7	17,6±1,0	13.0±0.5	15.6+0.3
	frequency [min^{-1}]	8.7	8.7	8.7	8.7	8.7	8.7
	rhythm	1/0.92	1/0.92	1/0.92	1/0.92	1/0.92	1 /0.92
	symmetry		2.1	2.6		1.0	