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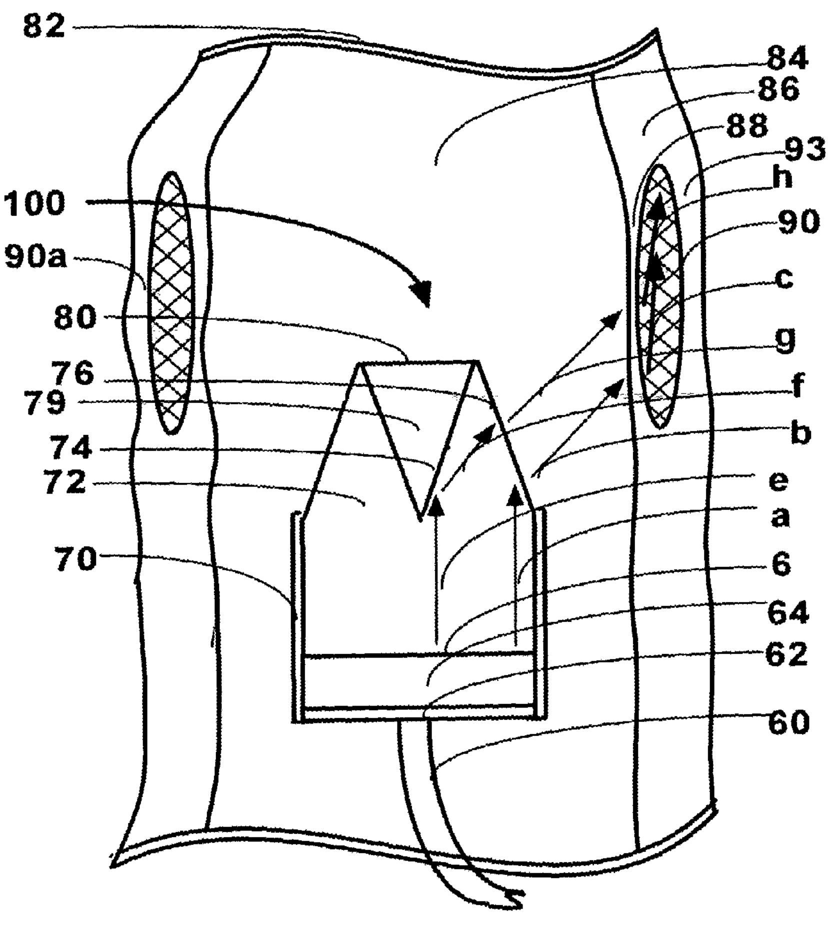
(54) Title: METHOD AND APPARATUS FOR ALTERING ACTIVITY OF TISSUE LAYERS



(57) Abstract: The present invention concerns ultrasonic methods and devices for altering activity of layers of natural- or of artificial tissues and organs, and for altering activity of particular components within said layers, while minimizing alterations in neighboring layers located deeper to- or outer to- treated layer. It is carried out by focused or non focused irradiation at certain angles and preferably via cooling medium, so to at least partially create surface waves propagating in the appropriate layers, and altering their activity, while leaving the other layers essentially intact. System can allow also monitoring of beam location and of effect. The device can be constructed for either superficial treatment, or minimal invasive treatment , of layered tissues and organs. It can be used as stand alone or add on device in cosmetic and clinical applications.

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METHOD AND APPARATUS FOR ALTERING ACTIVITY OF TISSUE LAYERS

FIELD OF THE INVENTION

The present invention generally concerns methods and devices for altering biological activity using mechanical vibrations, and more particularly to ultrasonic methods and devices for altering activity of tissue- or of organ layers, and for altering activity of particular components within said tissue or organ layers, while minimizing alterations in neighboring tissue or organ layers located deeper to- or outer to- treated layer.

BACKGROUND OF THE INVENTION

The human body, as the body of other multi-cellular living creatures, is made of numerous cell types, forming tissues and organs, or organ components. Each of the tissues and each of the organs is mostly arranged as multi layer tubular or flat structure. For instance blood vessels, digestive tract, fragments of the respiratory system, long bones or uterus are multi layered tubular structures, whereas the skin is an example of a multi layer flat structure.

The term *"layer"* according to this invention refers to a morphologically or histologically distinguished layer, which compose a layered part of a tissue or of an organ. A layer might be composed also of several morphological layers having different cell types, for instance the dermal zone of the skin, or being composed of bulk of a single cell type, for instance the smooth muscle cells of the coronary arteries. Essentially, there are differences in the density, elasticity and other mechanical properties of the different layers of a tissue-, or of an organ structure. For instance, there is a clear mechanical difference between the blood liquid located at the blood-vessel lumen, and between the more rigid vessel wall. In the uterus, the endometrium which is a rather loose tissue loaded with angiogenetic processes and blood, differs in its mechanical properties from the deeper compact musculature bulk of the uterus. In the skin the dermal zone, composed largely of collagen fibers, significantly differ in its mechanical properties from both superficial epidermis and from the deeper subcutaneous adipose zone, composed largely of fat cells.

At times it is desired to affect part of, or an entire layer of tissue or organ at particular body zone, or to affect particular components of certain layer without affecting the surrounding tissue- or organ layers. This is a common need in both medical and cosmetic arenas.

In the cardiovascular system, for instance, the stenotic and the restenotic narrowing and the subsequent obliteration or mal performance of the coronary arteries cause significant morbidity and mortality. It requires bypass surgery or minimal invasive manipulations with angioplasty and stents for stenosis, and much less treatment options during the restenosis phase. It is then, or preferably even earlier as preventative procedure, desired to selectively and precisely affect the entire tubular layer of the smooth muscle cells of the tubular coronary blood vessels, so to prevent or to cease the restenosis, without affecting the lumenal endothelial cells,

In the digestive tract it is occasionally essential to selectively affect benign polyps, so to prevent cancerous transformations, without affecting the towards-lumen cover of moist epithelial tissue. In the uterus it is occasionally needed to affect the endometrium facing the uterus lumen, so to cease excessive menstrual bleeding in a non-ablative manner and without affecting the deeper uterus tissues.

In the skin it might be needed to affect certain components located in particular layers, for instance hair follicles, pigment cells, or blood capillaries. It might be further needed to affect entire layers of the skin, for instance affecting the epidermal layer for juvenile look, or affecting the dermal zone for wrinkle removal.

In the respiratory system, it might be needed to affect obstacles of the pulmonary bronchi, without harmfully affecting the alveoli or pneumocytes, and without initiating hemorrhage due to harmful effect of cavitation on the air spaces.

Several methods and devices have been developed for affecting tissues, organs and their components. Said methods largely emphasize on non- to minimal invasive procedures using different energy sources, including laser, microwave, radio frequency, or ultrasound as affective elements. These methods, however, do not create selective effect derived from the different mechanical properties of the different layers, to create the create layer restricted desired effect.

When therapeutic ultrasound is used, the tissues in the beam path absorb energy and suffer damage, which otherwise can be employed to affect the particular desired location of effect. According to the teaching of US6206843 one way to solve this excessive damage, for instance when treating blood vessels, is by applying acoustic pressure and subsequently ablative procedure at reduced time and intensity and with less side effects.

At times, it is desired to cause alterations in certain layer of multi layered tissues or organs, without affecting layers located deeper or superficial to treated zone.

SUMMARY OF THE INVENTION

The present invention concerns a method and device for ultrasonically affecting and causing alteration of a certain layer of a multi layered tissue or organ, in a non invasive or minimally invasive procedures, and with minor effects on other layers of the said treated tissue or organ. It is performed by using the different mechanical properties of the different tissue or organ layers, and the subsequent difference in the relevant sound velocity of the different layers, as selective element for guiding the ultrasonic waves. The mechanical differences between layers, and between layers and the ambient media, combined with leading element of irradiation angle, enable shifting of the waves towards surface waves running in particular layers at least partially parallel or almost parallel to the surface, and therefore affecting particular layers parallel to the tissue or organ surface without affecting, e.g., deeper tissues. During irradiation surface is preferably being cooled, enabling creating effects, including thermal effects, at layers deeper to the surface leaving the surface intact.

When ultrasonic irradiation hits structure at an oblique angle, beam is split to three major components, reflected longitudinal waves, transmitted longitudinal waves and shear waves. Whereas the reflected angle of the waves is always equal to the irradiation incident angle, the angle of the refracted waves is determined by the properties of the two media, in particular by the sound speed in both media. The direction of propagation of the transmitted waves in the structure therefore changes and is different from the direction or angle of irradiation.

In general, when irradiating an object at a certain angle between a perpendicular axis to the object and the irradiation force, and from a zone A having certain characteristic of sound velocity, into another zone B (the object) characterized by a higher sound velocity, the refracted irradiated ultrasonic waves in the object will tend to run in an angle higher than the irradiation angle, towards running at least partially in parallel to the object surface.

For instance when irradiating from water (sound velocity of about 1500 m/sec) into the skin (sound velocity of about 1,700 m/sec), at an angle greater than about 60 degrees with respect to perpendicular axis, then majority of the refracted waves will run parallel, or almost parallel to the skin surface, as surface waves. Typically this said angle of 60 degrees is a critical angle for the skin, where most longitudinal waves transferred into interface nature, a rather mixed mode of longitudinal and of shear waves. This combined mode is also characterized by high attenuation and therefore create demarcated effect at attenuation zone, and essentially do not penetrate or affect other locations. Said interface waves, at least partially run in parallel to the surface, and therefore termed surface waves. When treating layered tissues or organs it provides significant advantage to treat particular layers without affecting the ambient layers, outer to or deeper to treatment zone.

A common way to create surface waves, in particular in the form of shear waves, is to transmit longitudinal waves through water or gel. Water does not support shear waves and therefore at the interface, between the water and the irradiated object, there is a reflected longitudinal back into the water and two wave modes refracted into the irradiated object - a longitudinal and is a shear wave. So the water liquid serves as essential element in the creation of these shear waves. The other way to create shear waves is by using a probe which directly excites shear waves. In order to transmit these shear waves into the irradiated object, the coupling between the probe and the said object must be a liquid of a very high viscosity, or a sticky solid.

It shall be noted, however, that waves running in parallel to the surface can be also of other mode, including purely longitudinal waves. This can be done, for instance by irradiating the object in a certain direction essentially parallel to the object surface. This irradiation is carried out while considering the natural morphology of the object, or alternatively with artificially modified morphology of the irradiated object.

When ultrasonic irradiation to a structure is originated from more than one ultrasonic source, the total disturbance at each point of the irradiated structure is the vectorial sum of the different particular mechanical disturbances produced by each ultrasonic wave source.

The static forces which are created when ultrasonic waves undergo changes in their direction (or in amplitude) further induce radiation pressure. Surface waves, however, as well as the combined interface mode, can produce all effects that can be created by regular longitudinal waves, including thermal and non thermal effects, heating and ablation, cavitation, microstreaming and shear stress, pressure, radiation force, torque and streaming.

According to a first aspect, the present invention concerns a method for affecting superficial layers of tubular or flat tissues or organs comprising: applying to said tissues or organs ultrasonic irradiation at an angle which produces ultrasonic waves at least a portion of which propagates in said superficial layers and at least partially in parallel to the skin surface. The procedure can be carried out as stand alone, or be combined by another ultrasonic irradiation, perpendicular or in another angle to the said tissue or organ, so to have a constructive vectorial sum of effects. The oblique irradiation, source of the affecting surface waves, might be combined also with another source of energy irradiation.

The term "*ultrasonic surface waves*" in the context of the present invention, refers to ultrasound waves which direction of propagation is at least partially, and preferably largely, parallel to that of the tissue- or of the organ surface, as the case might be. The surface waves may be produced by a combination of different wave modes, however at least one of the following wave modes should constitute the surface waves: longitudinal waves, shear waves, bending waves or torsion waves.

By one embodiment of this aspect, the propagation of the ultrasonic surface waves is precisely at the organ surface, e.g., at the interface between the uterus endometrium and the inner uterus lumen. However, in accordance with a preferred embodiment of the invention, the propagation of the ultrasonic surface waves is carried inside the endometrium, a short distance deeper than its lumenal surface. Such an embodiment ensures that the main effects of the ultrasonic energy, are achieved in a certain layer of a specific depth of the uterus where appropriate destructive effect is needed, while deeper layers are not penetrated by the energy and therefore do not absorb it and are not affected. The depth of the treated layer is typically between several mm to tens mm.

By another embodiment of this aspect, the propagation of the surface wave is deeper to the organ surface, e.g., at the smooth muscle layer of a coronary artery. In accordance with this embodiment of the invention, the irradiation is from the vessel lumen and in direction of the length axis of the vessel. The propagation of the ultrasonic waves in the target is carried out at the muscle layer of the vessel, leaving the internal endothelial cells intact. In this embodiment, the blood inside the vessel is used as both ultrasonic coupling agent, and as cooling liquid, further provides heat protection for the inner endothelial cells by conduction and convection. Irradiation is in a minimally invasive procedure.

By another embodiment of this aspect, the propagation of the surface waves is through the entire layers of the organ, e.g., at the wall of the urine bladder. In accordance with this embodiment of the invention, the irradiation is along the three major layers of the bladder to create there an effect, leaving the surrounding tissue and the content of the bladder intact. Irradiation is in a minimally invasive procedure.

By another embodiment of this aspect, the method is used as add-on to another method to achieve synergic effect. According to the teaching of pending application PCT IL99/00533, the ultrasound waves are transmitted at a rather high intensity, along hair shafts by using the hair as wave guides, till dissipation at the follicle, for hair removal. According to the present invention, ultrasonic waves are transmitted as surface waves and reach the hair follicle at an angle which is essentially perpendicular to the direction of the growth of the hair shaft. A combined method suggests irradiation of surface waves together with irradiation via the hair shaft at lower intensity. Ultrasonic characteristics for the two irradiations shall be those that when combined together the total disturbance at the follicle area of the hair will be constructive. Furthermore, the combined method will advantage the different sensitivity of skin's components to heat. The follicle cells (which are of epidermal origin) are sensitive to heat and will receive vectorial combination of the two irradiations. Concomitantly, the collagen fibers which covers the follicles invaginations, are much less sensitive and will anyhow receive only the surface wave irradiation. This will provide improved hair removal.

It shall be noted that the perpendicular direction of the waves ensures that energy irradiation has only a superficial effect, since the wave propagation which is perpendicular to follicles is also parallel to skin surface, and therefore essentially energy does not propagate to deeper regions of the skin and also the skin surface remains intact. The second irradiation source, in addition to the surface waves, might be virtually any other type including laser, RF, microwave and the like.

In order to minimize side effects to the irradiated tissue or organ, a cooling agent might be applied to the said tissue or organ, so that the surface of the treated zone is cooled while the effects, including heat, are built in the appropriate deeper layers of the treated zone. Examples of cooling agents are: water or cooling gels. According to the treatment site, cooling agents might be also body natural fluids such as blood, urine and the like. Under both circumstances the cooling agents in addition to convection and conduction of heat, might serve also in the actual creation of the surface waves, as explained above. Altering parameters, such as cooling temperature, might affect depth and intensity of the created biological alteration.

The angle of irradiation used to produce mainly surface waves should be calculated and chosen empirically, while considering mainly the characteristics of the media the waves travel in, and also the mechanical characteristics of the system, the cooling medium and ultrasound irradiation parameters. The frequency or intensity of the ultrasound do not affect the critical angle for the creation of surface waves. Surface waves might be created also by modifying the morphology of irradiated tissue or organ so waves will run initially in parallel to the surface.

The ultrasonic parameters used with the appropriate surface waves are interconnected, so that when reducing intensity at certain frequency, the reduction of total energy can be compensated by increasing duration of the energy application; or when increasing frequency, resulting in increase in flow of energy (assuming that both reach desired depth), the increase may be compensated by decrease in intensity treatment duration etc. Focused beam, either regular or by phase array might be used to increase irradiation intensity of a layer, whereas increased frequency might be used to reduce the travel length of the waves in a layer.

The parameters required for creation alterations in layers of tissues or organs in accordance with the surface wave aspect of the invention are as follows:

Frequency: 20 kHz – 50 MHz, preferably 200 kHz -3 MHz;

Intensity: 0.001 Watt – 1000 Watts, preferably 0.1-5 Watt or several hundreds Watt for regular and focused beam, respectively;

Duration: 0.001 sec. – 10 min., preferably split of second till seconds, and tens of seconds till few minutes for focused beam and for regular beam, respectively..

Mode: pulsative or continuous.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention and further methods devices and features thereof, reference is made to the attached non limiting drawings wherein:

Figure 1 shows angles of ultrasound irradiation required for production of surface waves in accordance with the invention;

Figure 2 shows a schematic device and system for carrying out the method of the invention; and

Figure 3 shows another embodiment of a system for carrying out the method of the invention for minimally invasive procedure.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Therapeutic ultrasound partially affects via temperature elevation. The temperature increase of a medium through which ultrasound wave propagate is a result of the absorbance accompanied by the acoustic beam attenuation. Absorbance and attenuation are higher when frequency is higher, and accordingly the intensity of the acoustic beam reduces exponentially along the beam path. Intensity is significantly reduced also when using shear waves or interface waves. The former are waves of shear stress along the plane of wave propagation which attenuates up to four order faster than longitudinal waves, which are waves that propagate with compression and decompression along the direction of wave propagation. The interface waves are combined mode of essentially longitudinal and stress waves, having combined characteristics.

Ultrasonic irradiation being applied to biological object in a direction oblique to the surface, can produce different wave types. It can produce non surface waves, including longitudinal and shear waves which might penetrate deeper into the tissue. Concomitantly, and occasionally alternatively, it can produce mixed mode of two first types that essentially run in parallel to the skin surface, termed surface waves.

The surface waves become a significant part of the total propagated energy, when angle between perpendicular axis and the irradiation axis is higher than a critical angle. It can be presented also as the angle between irradiation axis and the irradiated biological object, and then angle shall be smaller than a critical angle. Mostly the range of critical angle between biological surface and wave front is in the range of 10-30 degrees (equivalent to 60-80 degrees from perpendicular axis), but it largely depends on the mechanical properties of the media.

There are two extreme cases. At one case and certain angle most of the energy is featured as surface waves. At this angle longitudinal waves essentially do not penetrate the depth of the object, but partly reflected, and mostly creates together with shear waves the surface waves. For instance, for the skin at the angles of 10-30 from the skin, most of the waves will be surface waves, whereas above 30 most waves will penetrate into deeper layers of the skin. The other extreme case is below about 5 degrees between irradiating force and object (e.g., the skin), where most of the energy will be reflected from the skin object.

Shear forces are created by propagation of the shear waves. The method consists of the transmission of longitudinal waves A_i through liquid or gel. Liquid, such as water, does not support shear waves, whereas solids does. Therefore at the surface interface, between the water and skin, there is a reflected longitudinal wave **r** into the water and two refracted waves into the skin. One wave is longitudinal A_L and the other one is a shear wave A_s, as shown in **Figure 1**.

The intensity partition, between the said two refracted waves in the skin depends on the angle between the irradiation source and the perpendicular axis, incident angle θ_I , and the physical properties of the liquid and the tissue. The physical properties of the liquid, water for example, and of the tissue, skin for example, are known (for instance at: Nyborg L.N. Biological effects of ultrasound: mechanisms and clinical applications, NCRP pub., Bethesda, Maryland (1983)). The longitudinal velocity for skin is given as c_ℓ=1720±45 m/s, and the density ρ=924±24 kg/m^3. An average of 60 ratios of c_s/c_ℓ of different materials gives c_s/c_ℓ=0.51±0.8 and accordingly we estimated c_s=880m/s. For water following characteristics were taken: c_w=1487m/s and ρ=999kg/m^3 , all at a temperature of 25°c. Relation between incident angle - θ_i and angles of a reflected longitudinal θ_r, transmitted longitudinal θ_L and transmitted shear θ_s wave were found from the next Snell equation relation:

$$\frac{c_\omega}{\sin\theta_I} = \frac{c_\omega}{\sin\theta_r} = \frac{c_\omega}{\sin\theta_L} = \frac{c_s}{\sin\theta_s}$$

Angles θ_I, θ_r, θ_L and θ_s are all measured in perpendicular to the tissue, the skin surface in this example. θ_I is always equal to θ_r. The incident angle is called *"critical angle"* θ_c when $c_w/(c_l*\sin(\theta_i))>1$, because at angles above this angle, the transmitted longitudinal wave does not penetrate the skin surface but reflected from it. At this angle, however, the longitudinal waves essentially run in parallel to the skin surface. For the above mentioned sound velocities in this non-limiting example, θ_c is equal to **69** degrees. Directions of a reflected longitudinal and transmitted longitudinal and shear waves at the critical angle are demonstrated in **Fig. 1**. At the critical angle an angle between skin surface and transmitted longitudinal wave is **5.5** degrees , i.e., almost parallel to the skin surface, and angle of transmitted shear waves is **54** degrees.

Figure 2 is a non limiting example of system **99** for altering activity of superficial layer by application of ultrasonically created surface waves to the treated area. The irradiating element, a focusing transducer **40** having concave irradiating surface **44**, is located in the container **13**, for instance a cylinder, which is filled with degassed water to prevent non desired cavitation in the media outside of treated object **35**. The cylinder end is a flexible concertina-like sleeve **14**, which can be changed in the general direction of arrow **15**. Flexion of the sleeve **14** changes angle between schematic focused beam **12**, with borders of wave propagation **16** and **16a**, and between the target surface **34**. Said angle can be calibrated accordingly to reach the appropriate angle so to initiate desired effect at desired layers.

After impinging surface **34** waves propagate in general direction of arrows **19** and **19a**, having focus zone **42** at treated area. Affected layer **18** is located at superficial layer of treated zone **35**, and can be distinguished by schematic border of effect **35a**.

Degassed water in the container **13** circulates through tubes **20** and **21** to, and from water container **39**, by pump **23**. Circulated water serve both as a cooling agent as well as an ultrasonic coupling agent. Control unit **22** regulates water temperature and flow rate of the circulated water, by affecting pump **23** and potential cooling unit (not shown). Due to the possible cooling effect, and if and when the layer alteration source is thermal, surface of zone **34** can remains cooled and intact whereas profile of elevated temperature is built deeper in the treated zone. However, cooling is only a preferred embodiment, and water might be served only as coupling agent.

Signal generator **25** and amplifier **26**, are connected with each other and with transducer **40** by appropriate cables **41** and **27** respectively. Optionally both signal generator and amplifier can be constructed as an integral component enabling changing frequency and intensity of ultrasonic irradiation.

To reach homogenous skin treatment without differences between ultrasonic areas of maximas / minimas, the container **13** and the transducer **40** can be slightly moved by driver **28** in the direction of arrow **29**. Mechanical force-creating element **30**, which might be for instance a motor, electromagnet or ultrasonic probe, is mounted into device body **31** and causes the motion of driver **28**.

Control of the different controllable processes, such as ultrasonic signal generation, water pump, movement of transducer, angle of irradiation and the like is carried out by central control unit **32**, which simultaneously may receive data from different controllers.

The system might contain also on-line monitoring unit to locate location of beam and effect created at desired layer. Monitoring can be performed with the same ultrasonic device, for instance when working alternately between affecting and monitoring phases, and data obtained is further analyzed and possibly stored and implanted by the control unit **32**.

The system might further contain means for continuous movement over the desired location. Optionally the entire system, possibly with reduced cooling effect, might be integrated into a hand held consumer device.

Figure 3 is a non limiting example of device **100** for radial irradiation, distal part of the entire system, for altering activity of a layer located in middle-depth of a tubular organ, part of which is schematically given in cross section as target **82**. Said target is composed of lumen **84** with natural body fluids, and of organ wall **86**. The device is preferably inserted to desired location using conventional guiding means, for instance a catheter.

Signal transmitted via cable **60** deliver signal to activate ultrasonic creating mean, probe or transducer **64**, via matching **62**. Said ultrasonic creating mean irradiates ultrasonic waves that propagate via horn **72**, and from there into the tissue. Irradiation can be performed also without the horn, providing that the irradiating source is in appropriate angle towards the target wall **86**. However, the horn is partially covered by ultrasonic absorbing medium **70**, preventing irradiation from non appropriate parts and directions of the irradiation device **100**.

Schematic ultrasonic wave **a**, irradiated from surface **68** of the ultrasonic creating mean **64**, propagates towards oblique device wall **76**, being refracted into lumen **84** as wave **b**, impinges inner side of organ wall **86**, being further refracted and propagates as surface, or close to surface wave **c** in said organ wall **86**. Another schematic wave **e** impinges oblique device-wall **74**. Space **79** located between cone margins **74** (radial, as the entire device in this example) and distal wall **80** is composed of material of high ultrasonic attenuation, such as air, and therefore surface **74** acts as reflector. Schematic wave **e** is reflected from wall **74**, and continues as schematic wave **f**. The later propagates, impinge wall **76**, refracted and continues as wave **g**, which further propagates, impinge and refracted at inner side of organ wall **86** in the general direction of schematic wave **h**.

The vectorial contribution of schematic waves **c** and **h**, in organ wall **86**, creates demarcated layered effect, along the long axis of tubular organ **82**. Affected zones **90**, and **90a**, which actually refer to the same affected radial zone, are located in mid layer of organ wall **86**. The combined mode of both reflected waves, and waves directly refracted into the same location, increases the local effect. Assuming heat initiated effect, area **88**, in the lumenal side of organ wall **86** remains intact due to the convection and conduction of heat by the natural body fluids of the lumen. Area **93** remains intact since waves propagates in the organ wall **86** in particular in parallel to- or close to parallel to the surface, and without essentially propagating into and affecting deeper layers.

While there have been shown preferred embodiments of ultrasonic methods and devices for altering activity of layers of tissues and of organs, it is to be understood that many changes may be made therein without departing from the spirit of the invention. The invention embraces any and all changes, modifications, alternatives or rearrangements of the method and device as defined by the claims, including the use of method and device for non-biological structures.

CLAIMS:

1. A method for affecting at least part of a certain layer of a layered biological structure composed of layers having different mechanical characteristics, comprising:

applying to said structure an ultrasound irradiation from at least one source, and at a certain range of irradiation angle, which produces ultrasonic waves at least a portion of said waves penetrate the biological structure and propagate in a certain layer at least partially in parallel to the structure surface, thereby causing alteration of the bulk of the layer they propagate in, without substantially propagating in- and altering neighboring layers.

2. A method according to Claim 1, wherein the biological structure is composed of at least one layer.

3. A method according to Claim 2, wherein the layer is composed of at least one cell type.

4. A method according to Claim 3, wherein the layer is a defined morphological structure.

5. A method according to Claim 4, wherein said morphological structure is in a non superficial location of the biological structure.

6. A method according to Claim 4, wherein said morphological structure is at the periphery of the biological structure.

7. A method according to Claim 1, wherein the biological structure is a tissue or parts thereof.

8. A method according to Claim 1 wherein the biological structure is an organ or parts thereof.

9. A method according to Claim 1, wherein the alteration of the bulk of the layer is via increased activity of at least portion of the components of the said layer.

10. A method according to Claim 9, wherein the increased activity is leading to premature apoptosis.

11. A method according to Claim 10, wherein the premature apoptosis occurs instantly.

12. A method according to Claim 1, wherein the alteration of the bulk of the layer is via reduction of the activity of at least portion of the components of the said layer.

13. A method according to Claim 12, wherein the reduction of activity is accompanied by necrosis.

14. A method according to Claim 13, wherein the necrosis occurs instantly.

15. A method according to Claim 1, wherein the alteration of the bulk of the layer is via mechanical destruction or degeneration, of at least portion of the components of the said layer.

16. A method according to Claim 15, wherein the mechanical destruction or degeneration is leading to necrosis.

17. A method according to Claim 16, wherein the necrosis occurs instantly.

18. A method according to Claim 1, wherein non focused ultrasonic beam is used to create layer alteration.

19. A method according to Claim 18, wherein near zone part of the beam is used to create layer alteration.

20. A method according to Claim 19, wherein at least one energy maxima is located in the treated layer.

21. A method according to Claim 18, wherein far zone part of the beam is used to create layer alteration.

22. A method according to Claim 1, wherein focused ultrasonic beam is used to create layer alteration.

23. A method according to Claim 22, wherein layer alteration is created by cavitation.

24. A method according to Claim 22, wherein layer alteration is created by thermal effects.

25. A method according to Claim 24, wherein thermal effect is ablation.

26. A method according to Claim 22, wherein layer alteration is created by pressure effects.

27. A method according to Claim 22, wherein layer alteration is created by shear stresses.

28. A method according to Claim 22, wherein layer alteration is created by shock waves.

29. A method according to Claim 22, wherein focused beam is created by phase array.

30. A method according to Claim 1, wherein the angle of bulk of the ultrasonic waves is not perpendicular to the treated biological structure.

31. A method according to claim 30, wherein the irradiation angle is pretreatment determined to at least partially create surface waves.

32. A method according to Claim 31, wherein determination of the angle is based on the sound velocity in the different irradiated layers, and also on combination of the morphometrical parameters of treated biological structure, mechanical properties of the different components within treated biological structure, and of the properties of the ultrasonic irradiation used.

33. A method according to Claim 32, wherein the duration of the ultrasonic irradiation is split of a second to 10 minutes

34. A method according to claim 33, wherein the preferred duration of the ultrasonic irradiation is split of a second when focused beam is used.

35. A method according to claim 33, wherein the preferred duration of the ultrasonic irradiation is several seconds to tens of seconds when non focused beam is used.

36. A method according to claim 32, wherein the intensity of the radiation is between 0.001 Watt and 1000 Watt.

37. A method according to claim 36, wherein the preferred intensity is of several hundreds Watts when focused beam is used.

38. A method according to claim 36, wherein the preferred intensity is of Watt parts till several Watts when non focused beam is used.

39. A method according to Claim 32, wherein the frequency of the ultrasonic irradiation is between 20 kHz and 50 MHz.

40. A method according to Claim 39, wherein the preferred frequency of the ultrasonic irradiation is several hundreds kHZ till several MHz.

41. A method according to claim 32, wherein the duration of the irradiation is between 0.001 second and 10 minutes

42. A method according to claim 41, wherein the preferred duration is tens of seconds till several minutes when non focused beam is used.

43. A method according to claim 32, wherein the preferred duration of irradiation is second split, till several seconds when focused beam is used.

44. A method according to Claim 1, wherein during the ultrasonic irradiation the surface of the biological structure is cooled.

45. A method according to Claim 44, wherein the cooling is obtained by the application of a cooling agent.

46. A method according to claim 44 wherein the cooling is obtained by conduction and convection of the body fluids.

47. A method according to claim 1, wherein more than one energy source is used to irradiate the biological structure, providing that at least one energy source emit ultrasound at appropriate angle to create at least partially surface waves, and having cumulative effects with another energy source.

48. A method according to claim 47, wherein another energy source is ultrasound source.

49. A method according to claim 47, wherein another energy source is laser.

50. A method according to claim 47, wherein another energy source is microwave.

51. A method according to claim 47, wherein another energy source is radio frequency.

52. A method according to claim 1, wherein irradiation is in a certain direction.

53. A method according to claim 52, having irradiation at plain direction.

54. A method according to claim 52, having radial irradiation.

55. A method according to claim 1, where irradiation is performed from a lower sound velocity zone, to higher sound velocity zone.

56. A method according to claim 55, wherein the lower sound velocity zone is liquid.

57. A method according to claim 56, wherein the liquid is water.

58. A method according to claim 56, wherein the liquid is body fluids.

59. A method according to claim 58, wherein the body fluid is blood.

60. A method according to claim 58, wherein the body fluid is urine.

61. A method according to claim 56, wherein the liquid is same liquid used to cool suface.

62. A method according to claim 1, wherein a transducer capable of emitting shear waves is used to create irradiation at certain angle.

63. A method according to claim 1, wherein waves are irradiated into biological structure, and propagate in parallel to the surface of the structure.

64. A method according to claim 63, wherein waves are longitudinal waves.

65. A method according to claim 1, and composed also of monitoring of location and of effect.

66. A method according to claim 65, wherein monitoring is carried out by ultrasonic means.

67. A method according to claim 66, wherein the ultrasonic mean for monitoring is the same ultrasonic mean for creating the desired alteration.

68. A method for affecting at least portion of a certain component of a certain layer of a biological structure comprising applying to said structure an ultrasonic irradiation from at least one ultrasonic source which produces ultrasonic waves, at least a portion of said waves penetrate the structure and propagate essentially in parallel to the structure surface, thereby causing alteration of certain component of the layer they propagate in, without substantially altering other components of the layer, nor superficial or deeper layers.

69. A device for use in the method of any one of the preceding claims.

70. A device and a system according to claim 69, substantially as hereinbefore described with reference to the drawings.

71. A device according to claim 70 for affecting layer of biological layered structure, comprising at least one ultrasonic emitting element capable of emitting ultrasonic waves for altering activity at desired layer of biological structure, essentially at least a portion of said waves penetrate the structure and propagate in a certain layer at least partially in parallel to the structure surface.

72. A system according to claim 71, comprised of an element capable of emitting ultrasound waves, and the system generally comprises power source, control unit, a signal generator, a signal amplifier, a matching unit, at least one transducer capable of producing at lest partially surface waves.

73. A device according to claim 71, wherein the ultrasonic emitting element is pivotally mounted on a holder, so that the angle between the said ultrasonic emitting element and the surface towards which the ultrasound is emitted can be adjusted.

74. A device according to Claim 71, wherein the ultrasonic emitting element is mounted on the holder though pivotally movable ring.

75. A device according to Claim 71, wherein the ultrasonic emitting element is mounted on the holder through a flexible sleeve.

76. A device according to any of Claim 71, containing also liquid coupling medium.

77. A device according to Claim 76, and containing cooling medium.

78. A device according to Claim 77, wherein the cooling liquid serves also in coupling.

79. A device according to claim 71, composed of at least one mean for irradiating biological structure so to initiate layer affective waves in said biological structure.

80. A device according to claim 79, composed of ultrasonic emitting element having certain shape enabling irradiation at desired angle without further adjustments.

81. A device according to Claim 79, composed of at least one ultrasonic emitting element capable of emitting shear waves.

82. A device according to claim 81, containing also coupling medium of high viscosity.

83. A system according to claim 71, and composed also of guiding means for minimal invasive procedure with device of the invention.

84. A system according to claim 83, wherein the guiding means is catheter.

85. A system according to claim 83, wherein the guiding means is laparoscope.

86. A system according to claim 71, composed also of monitoring element to detect location of ultrasonic emitted waves, and of the effect created.

87. A system according to claim 86, wherein the monitoring element is based on ultrasonic waves.

88. A system according to claim 87, wherein the ultrasonic monitoring aspect is performed using the same ultrasonic emitting element used as affecting element.

89. A device according to claim 71, wherein device is add on to another device.

90. A device according to claim 89, wherein the device subject of this invention is add on to a monitoring device.

91. A device according to claim 89, wherein the device subject of this invention is add on to a therapeutic device, including cosmetic device.

92. A device according to claim 71, and containing also other irradiating source.

93. A device according to claim 90, wherein the other irradiation source is ultrasound.

94. A method and system, as hereinabove described for treating non biological objects.

95. A method according to claim1, wherein the in layer propagating waves are surface waves.

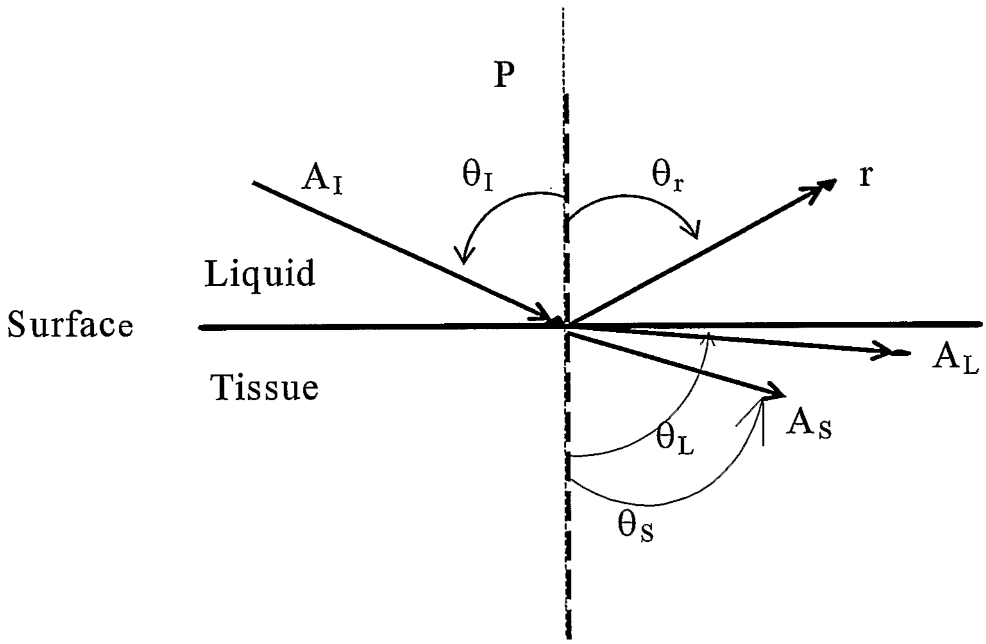
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Figure 1

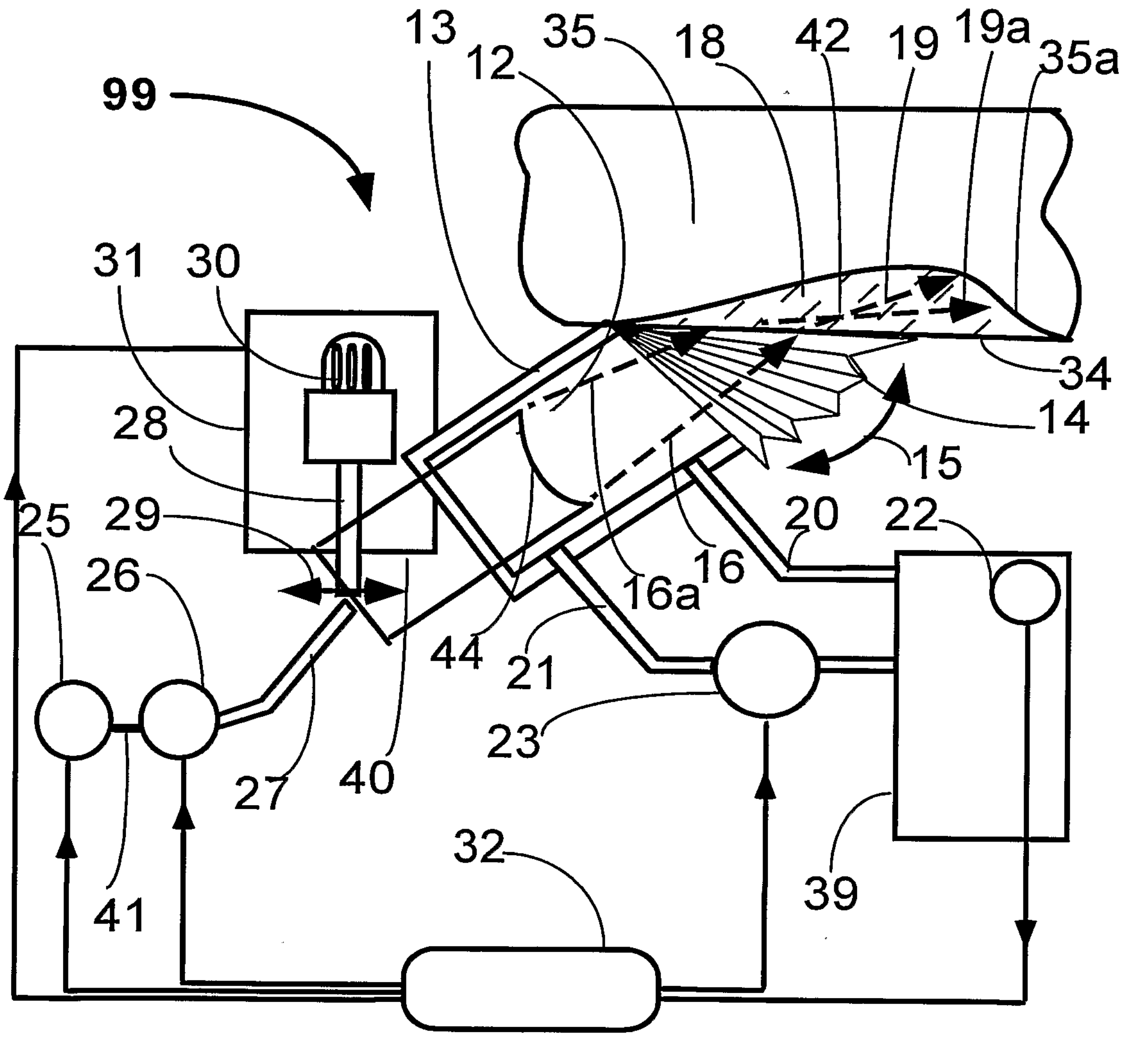
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Figure 2

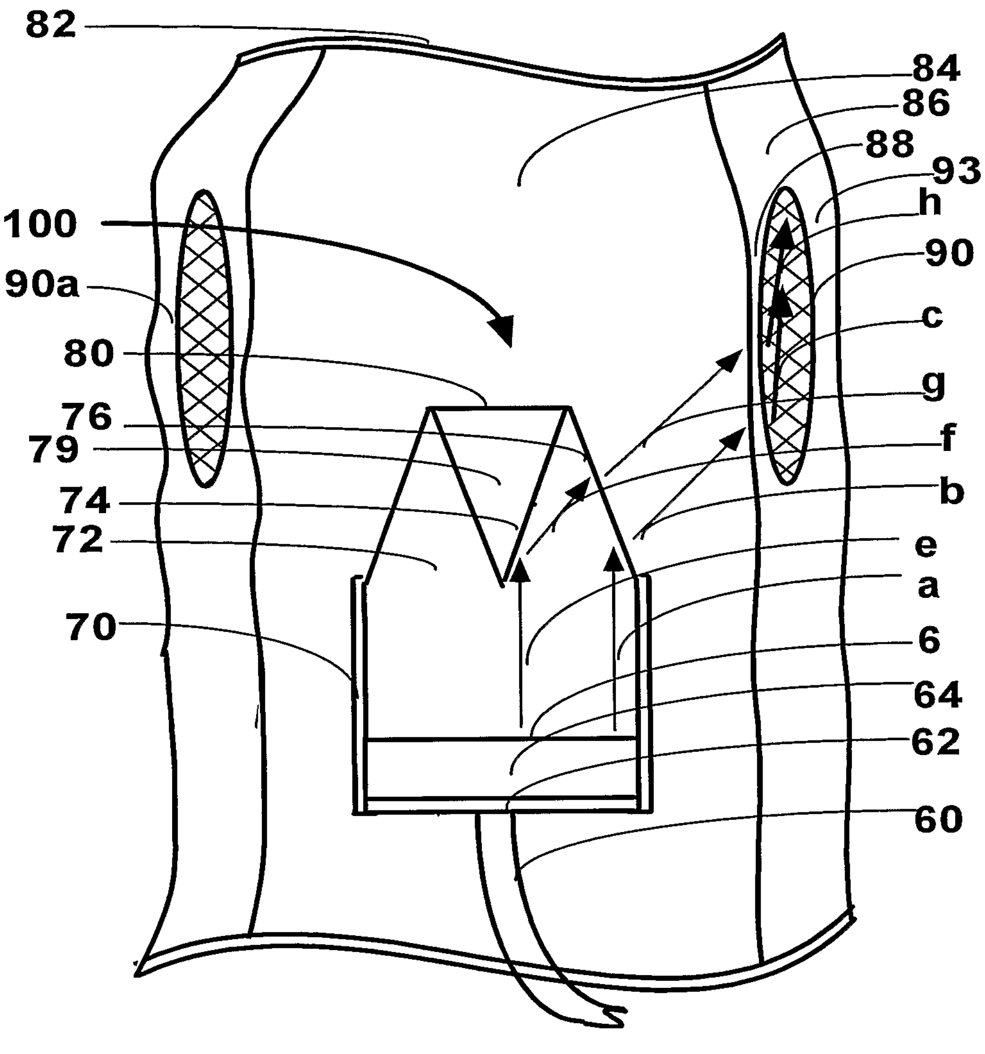

Figure 3

patsnap

专利名称(译)	用于改变组织层活动的方法和设备		
公开(公告)号	EP1539081A2	公开(公告)日	2005-06-15
申请号	EP2003710192	申请日	2003-03-17
[标]申请(专利权)人(译)	约尼IGER		
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当前申请(专利权)人(译)	IGER，约尼		
[标]发明人	IGER YONI		
发明人	IGER, YONI		
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CPC分类号	A61N7/00 A61B2018/00023		
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优先权	148791 2002-03-20 IL		
其他公开文献	EP1539081A4		
外部链接	Espacenet		

摘要(译)

本发明涉及用于改变天然或人造组织和器官的层的活性，以及用于改变所述层内的特定组分的活性的超声方法和装置，同时最小化位于更深处理或外处理层的相邻层的改变。 。它通过在某些角度聚焦或非聚焦照射并且优选通过冷却介质进行，从而至少部分地产生在适当层中传播的表面波，并改变它们的活性，同时使其它层基本上完整。系统还可以监控光束位置和效果。该装置可以构建用于分层组织和器官的表面治疗或微创治疗。它可以单独使用，也可以在化妆品和临床应用中添加到设备上。