[0006] These and other shortcomings of the prior art are addressed by the present invention, which provides an articulating organ support.

[0007] According to one aspect of the invention, an organ support apparatus includes: an enclosure having a floor, opposed side walls, opposed end walls, and a lid; a first support pad disposed on the floor of the enclosure, the first support pad comprising a plurality of inflatable and flexible chambers; and an inflation apparatus coupled to the chambers and operable to individually inflate or deflate each chamber.

[0008] According to another aspect of the invention, a method for supporting an organ, includes: providing an enclosure adapted to contain an organ; placing the organ on a first support pad disposed on a floor of the enclosure, the first support pad comprising a plurality of inflatable and flexible chambers; and selectively inflating and deflating the chambers to provide a time-varying contact pressure profile with the organ.

[0009] According to yet another aspect of the invention, a method for supporting an organ includes: providing an enclosure adapted to contain an organ, the enclosure having a floor opposite a lid; placing a first support pad against the floor, the first support pad comprising a plurality of inflatable and flexible chambers; placing a second support pad against the lid, the second support pad comprising a plurality of inflatable chambers; placing the organ between the first and second support pads; inflating the chambers to clamp the organ in position between the support pads; and selectively tilting or rotating the enclosure to provide a time-varying contact pressure profile between the first and second support pads and the organ.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The invention may be best understood by reference to the following description taken in conjunction with the accompanying drawing figures in which:

[0011] Figure 1 is a schematic view of ~~a~~ an organ support apparatus constructed according to an aspect of the present invention, coupled to a perfusion system;

[0012] Figure 2 is top view of the organ support apparatus of Figure 1;

shows chambers 52A, 52C, and 52E as being fully inflated while chambers 52B and 52D are deflated. In this configuration the organ K is supported along three spaced-apart lines, and points of relatively higher pressure are present at the locations marked with arrows "P1". At a subsequent time, chambers 52B and 52D may be fully inflated while chambers 52A, 52C, and 52E are deflated. This configuration is shown in Figure 13. The organ K would thus be supported along two spaced-apart lines and points of relatively higher contact pressure are present at the locations marked with arrows "P2". The locations P1 are relieved of pressure, allowing free flow of circulation and absence of mechanical stress. This cycle of alternating inflation and deflation may be repeated as often as necessary so that no one portion of the organ K is subjected to damaging pressure for too long, which could result in localized pressure ischemia. For example, the pressure in any one location may be relieved about 2 or 3 times per minute.

[0035] If the rotation apparatus described above are used, then the enclosure 24 with the organ K may be periodically tilted and/or inverted so that contact pressures on the organ K are shared between its opposite surfaces. For example, the organ K may be tilted and/or inverted with a frequency of about once per minute to about once every 30 minutes. The frequency is subject to the vascular resistance and condition of the organ K or tissue. The tilt and/or inversion may be in addition to or as an alternative to the selective inflation and deflation of the chambers 52A-52E. The imaging device 31, such as a scanning high resolution infrared camera may be employed to take a series of images and build therefrom a mosaic image of the organ K for localized and global comparison. For example, the organ K may be imaged in small blocks, e.g. 20 mm x 20 mm (0.8 in. x 0.8 in.). In the image, ischemic areas will exhibit relatively higher or lower temperatures than the surrounding tissue.

[0036] In response to the detection of such areas, the controller 56 may be programmed to tilt and/or invert the organ enclosure 24, and/or to selectively inflate or deflate the chambers 52A-52E. To facilitate the imaging and control process, the temperature of the fluid circulating through the organ K may be altered (e.g. using the perfusion system 10) slightly up and down from a physiologically suitable temperature for organ characterization and preservation. For example, the fluid temperature change

WHAT IS CLAIMED IS:

1. An organ support apparatus, comprising:

an enclosure adapted to contain an organ,

a first support pad disposed on a floor of the enclosure, the first support pad comprising a plurality of inflatable and flexible chambers; and

an inflation apparatus coupled to the chambers and operable to individually inflate or deflate each chamber.

2. The apparatus of claim 1 wherein the first support pad comprises flexible, fluid-tight top and bottom sheets bonded together along mutual peripheral edges and seams such that unbonded portions of the top and bottom sheets define the chambers.

3. The apparatus of claim 2 wherein the first support pad comprises a plurality of elongated, side-by-side chambers.

4. The apparatus of claim 1 further comprising a second support pad disposed within the enclosure opposite the first support pad, the second support pad comprising a plurality of inflatable chambers.

5. The apparatus of claim 1 wherein the second support pad comprises flexible, fluid-tight top and bottom sheets bonded together along mutual peripheral edges and seams such that unbonded portions of the top and bottom sheets define the chambers.

6. The apparatus of claim 5 wherein the second support pad comprises a plurality of elongated, side-by-side chambers.

7. The apparatus of claim 1wherein the inflation apparatus comprises:

a pump;

a multi-port valve coupled to the pump and to each of the chambers, the valve adapted to selectively couple the pump to a selected one of the chambers; and

an electronic controller operably coupled to the pump and the valve.

8. The apparatus of claim 1 further comprising a rotation apparatus operable to rotate the enclosure about an axis.

9. The apparatus of claim 8 further comprising an imaging device positioned so that the enclosure is within a field of view thereof, the imaging device operably connected to the rotation apparatus.

10. The apparatus of claim 8 wherein the enclosure is mounted for rotation about a pair of shafts and wherein an electric motor is mechanically coupled to at least one of the shafts.

11. The apparatus of claim 1 further comprising an imaging device positioned so that the enclosure is within a field of view thereof, the imaging device operably connected to the inflation apparatus.

12. A method for supporting an organ, comprising:

providing an enclosure adapted to contain an organ;

placing the organ on a first support pad disposed on a floor of the enclosure, the first support pad comprising a plurality of inflatable and flexible chambers; and

selectively inflating and deflating the chambers to provide a time-varying contact pressure profile with the organ.

13. The method of claim 12 wherein the first support pad comprises a plurality of elongated, side-by-side chambers, the method further comprising cyclically inflating and deflating alternate ones of the chambers.

14. The method of claim 12 further comprising periodically rotating the enclosure about an axis so as to invert the organ.

15. The method of claim 12 further comprising placing a second support pad placing between the organ and a lid of the enclosure which is disposed opposite the floor, the second support pad comprising a plurality of inflatable chambers; and selectively inflating and deflating the chambers to provide a varying contact pressure profile with the organ.

16. The method of claim 15 wherein the second support pad comprises a plurality of elongated, side-by-side chambers, the method further comprising cyclically inflating and deflating alternate ones of the chambers of the second support pad.

17. The method of claim 12 further comprising:

using an imaging device, observing the organ within the enclosure and identifying at least one portion of the organ having a temperature different from the surrounding tissue; and

selectively inflating and deflating the chambers so as to relieve the pressure applied to the identified portion.

18. The method of claim 17, wherein the imaging device is used to generate a plurality of images of varying locations of the organ which are then assembled so as to form a mosaic image.

19. The method of claim 17 further comprising:

prior to observing the organ, maintaining the organ at a first temperature; and

changing the temperature of the organ by a selected amount.

20. A method for supporting an organ, comprising:

providing an enclosure adapted to contain an organ, the enclosure having a floor opposite a lid;

placing a first support pad against the floor, the first support pad comprising a plurality of inflatable and flexible chambers;

placing a second support pad against the lid, the second support pad comprising a plurality of inflatable chambers;

placing the organ between the first and second support pads;

inflating the chambers to clamp the organ in position between the support pads; and

selectively tilting or rotating the enclosure to provide a time-varying contact pressure profile between the first and second support pads and the organ.

21. The method of claim 20 further comprising:

using an imaging device, observing the organ within the enclosure and identifying at least one portion of the organ having a temperature different from the surrounding tissue; and

selectively tilting or rotating the enclosure so as to relieve the pressure applied to the identified portion.

CLAIMS

1. An organ support apparatus, comprising:

a housing having a floor, opposed side walls, opposed end walls, and a lid, the housing adapted to completely encompass an organ placed entirely within the housing;

a first support pad disposed on the floor of the housing, the first support pad comprising a plurality of inflatable and flexible chambers; and

an inflation apparatus coupled to the chambers and operable to individually inflate or deflate each chamber.

2. The apparatus of claim 1 wherein the first support pad comprises flexible, fluid-tight top and bottom sheets bonded together along mutual peripheral edges and seams such that unbonded portions of the top and bottom sheets define the chambers.

3. The apparatus of claim 2 wherein the plurality of chambers are elongated, and arranged in a side-by-side configuration.

4. The apparatus of claim 1 further comprising a second support pad disposed within the housing opposite the first support pad, the second support pad comprising a plurality of inflatable chambers.

5. The apparatus of claim 4 wherein the second support pad comprises flexible,

fluid-tight top and bottom sheets bonded together along mutual peripheral edges and seams such that unbonded portions of the top and bottom sheets define the chambers.

6. The apparatus of claim 5 wherein the second support pad comprises a plurality of elongated, side-by-side chambers.

7. The apparatus of claim 1 wherein the inflation apparatus comprises:

a pump;

a multi-port valve coupled to the pump and to each of the chambers, the valve adapted to selectively couple the pump to a selected one of the chambers; and

an electronic controller operably coupled to the pump and the valve.

8. The apparatus of claim 1 further comprising a rotation apparatus operable to rotate the housing about an axis.

9. The apparatus of claim 8 further comprising an imaging device positioned so that the housing is within a field of view thereof, the imaging device operably connected to the rotation apparatus.

10. The apparatus of claim 8 wherein the housing is mounted for rotation about a pair of shafts and wherein an electric motor is mechanically coupled to at least one of the shafts.

11. The apparatus of claim 1 further comprising an imaging device positioned so that the housing is within a field of view thereof, the imaging device operably connected to the inflation apparatus.

12. A method for supporting an organ, comprising:

providing a housing having a floor, opposed side walls, opposed end walls, and a lid, the housing adapted to completely encompass an organ placed entirely within the housing;

placing the organ on a first support pad disposed on a floor of the enclosure, the first support pad comprising a plurality of inflatable and flexible chambers; and

repeatedly inflating and/or deflating one or more of the chambers so as to provide a time-varying contact pressure profile with the organ, the time-varying contact pressure profile selected such that no one portion of the organ is subjected to damaging pressure long enough to cause localized pressure ischemia in that portion.

13. The method of claim 12 wherein the first support pad comprises a plurality of elongated, side-by-side chambers, the method further comprising cyclically inflating and deflating alternate ones of the chambers.

14. The method of claim 12 further comprising periodically rotating the housing about an axis so as to invert the organ.

15. The method of claim 12 further comprising placing a second support pad placing between the organ and a lid of the housing which is disposed opposite the floor, the second support pad comprising a plurality of inflatable chambers; and selectively inflating and deflating the chambers to provide a varying contact pressure profile with the organ.

16. The method of claim 15 wherein the second support pad comprises a plurality of elongated, side-by-side chambers, the method further comprising cyclically inflating and deflating alternate ones of the chambers of the second support pad.

17. The method of claim 12 further comprising:

using an imaging device, observing the organ within the housing and identifying at least one portion of the organ having a temperature different from the surrounding tissue of the organ; and

selectively inflating and deflating the chambers so as to relieve the pressure applied to the identified portion.

18. The method of claim 17, wherein the imaging device is used to generate a plurality of images of varying locations of the organ which are then assembled so as to form a mosaic image.

19. The method of claim 17 further comprising:

prior to observing the organ, maintaining the organ at a first temperature; and

changing the temperature of the organ by a selected amount.

20. A method for supporting an organ, comprising:

providing a housing having a floor, opposed side walls, opposed end walls, and a lid, the housing adapted to completely encompass an organ placed entirely within the housing;

placing a first support pad against the floor, the first support pad comprising a plurality of inflatable and flexible chambers;

placing a second support pad against the lid, the second support pad comprising a plurality of inflatable chambers;

placing the organ between the first and second support pads;

inflating the chambers to clamp the organ in position between the support pads; and

selectively tilting or rotating the housing to provide a time-varying contact pressure profile between the first and second support pads and the organ.

21. The method of claim 20 further comprising:

using an imaging device, observing the organ within the housing and identifying at least one portion of the organ having a temperature different from the surrounding tissue of the organ; and

selectively tilting or rotating the housing so as to relieve the pressure applied to the identified portion.