CLAIMS

1. A microwave antenna apparatus comprising:

a radiating element configured to perform a treatment, the treatment comprising heating a volume of tissue using microwave radiation emitted from the radiating element;

a cooling structure arranged for flowing a coolant through at least one lumen of the cooling structure during the treatment; and

a controller configured to control the flow of coolant ~~such as~~ to provide a first flow rate of coolant through the at least one lumen during a first period of the treatment, wherein the first flow rate is selected to cause the radiating element to heat a first part of a selected treatment zone, the first part of the selected treatment zone having a selected first shape, and to provide a second, different flow rate of coolant through the at least one lumen during a second, later period of the treatment, wherein the second flow rate is selected to cause the radiating element to heat a second part of the selected treatment zone, the second part of the selected treatment zone having a selected second, different shape.

~~2. An apparatus according to Claim 1, wherein the controller is configured to control the flow of coolant such as to shape the volume of tissue that is heated by the radiating element during the treatment.~~

2~~3~~. An apparatus according to Claim 1 ~~or Claim 2~~, wherein the selected treatment zone comprises~~the controller is configured to control the flow of coolant such as to form in the tissue~~ at least one of a) to d):

a) a spherical treatment zone;

b) a hybrid spherical lachrymiform treatment zone;

c) a partial lachrymiform treatment zone;

d) a partial spherical treatment zone.

3~~4~~. An apparatus according to any preceding claim, wherein the controller is configured to control the flow of coolant such that the first flow rate during the first period is higher than the second flow rate during the second period.

4~~5~~. An apparatus according to Claim 1 or Claim 2~~any of Claims 1 to 3~~, wherein the controller is configured to control the flow of coolant such that the first flow rate during the first period is lower than the second flow rate during the second period.

56. An apparatus according to any preceding claim, wherein the first period is longer than the second period.

67. An apparatus according to any of Claims 1 to 45, wherein the second period is longer than the first period.

78. An apparatus according to any preceding claim, wherein the controller is configured to vary the flow rate continuously over time during the treatment.

89. An apparatus according to any preceding claim, wherein the controller is further configured to alter a power of the radiation emitted from the radiating element during the treatment.

10. An apparatus according to Claim 9, wherein the controller is configured to control the power of the radiation such as to shape the volume of tissue that is heated by the radiating element during the treatment.

911. An apparatus according to any preceding claim, wherein the cooling structure comprises at least one inner lumen positioned radially proximal to the radiating element and at least one outer lumen positioned radially distal to the radiating element, and where either a) or b): -.

12. An apparatus according to Claim 11, wherein a) the controller is configured to control the flow of coolant such that the coolant flows into the at least one inner lumen and returns through the at least one outer lumen;.

13. An apparatus according to Claim 11, wherein b) the controller is configured to control the flow of coolant such that the coolant flows into the at least one outer lumen and returns through the at least one inner lumenouter inner.

1014. An apparatus according to any preceding claim, wherein the cooling structure comprises a plurality of lumens arranged circumferentially around the radiating element.

15. An apparatus according to any of Claims 11 to 14, wherein the controller is configured to select lumens through which the coolant flows in and out such as to shape the volume of tissue that is heated by the radiating element during the treatment.

~~16. An apparatus according to any of Claims 11 to 15, wherein at least one diameter of at least one lumen is selected such as to shape the volume of tissue that is heated by the radiating element during the treatment.~~

11~~17~~. An apparatus according to ~~any of Claims 2 to 16~~ any preceding claimwherein the ~~shape of the volume of tissue that is heated is controlled~~selected treatment zone is selected ~~so as~~ to reduce or eliminate heating of an anatomical structure~~, optionally wherein the anatomical structure comprises at least one natural lumen.~~

~~18. An apparatus according to any of Claims 2 to 17 wherein the shape of the volume of tissue that is heated is controlled~~ and/or the selected treatment zone is selected to reduce tissue shrinkage in the vicinity of the radiating element.

12~~19~~. An apparatus according to any preceding claim, further comprising at least one temperature sensor configured to monitor temperature within the volume of tissue to be heated, ~~.~~

~~20. An apparatus according to Claim 19,~~ wherein the controller is configured to control the flow of coolant in dependence on signals from the at least one temperature sensor, wherein the signals are representative of the monitored temperature~~.~~\

~~21. An apparatus according to Claim 20,~~ optionally wherein the controller is further configured to control in dependence on the signals from the at least one temperature sensor at least one of: a power supplied to the radiating element, a direction of coolant flow, a coolant flow path.

13~~22~~. An apparatus according to any preceding claim, wherein the radiating element is formed from coaxial cable and/or ~~.~~

~~23. An apparatus according to any preceding claim, wherein~~ the radiating element comprises at least one of a slot antenna, a monopole antenna, a dipole antenna, a triaxial antenna.

14~~24~~. An apparatus according to any preceding claims, wherein at least one of a) to d):~~-~~
a) the coolant comprises at least one of a gas coolant, a liquid coolant, air, saline~~;~~ ~~-~~

~~25. An apparatus according to any preceding claim, wherein~~ b) the apparatus is configured to perform microwave ablation of tissue and/or tissue hyperthermia~~;~~.

~~26. An apparatus according to any preceding claim, wherein~~ c) the flowing of the coolant through at least one lumen of the cooling structure is to cool the radiating element and/or to cool a cable supplying power to the radiating element~~;~~.

~~27. An apparatus according to any preceding claim, wherein~~ d) the radiating element and the cooling structure are housed within a common housing.

15~~28~~. A microwave system comprising:

a microwave generator;

a microwave cable apparatus comprising a coaxial cable, wherein an exposed distal portion of an inner conductor of the coaxial cable is longer than an outer conductor of the coaxial cable, the exposed distal portion forming a radiating element, wherein the radiating element is configured to perform a treatment, the treatment comprising heating a volume of tissue using microwave radiation emitted from the radiating element;

a cooling structure arranged for flowing a coolant through at least one lumen of the cooling structure during the treatment; and

a controller configured to control the flow of coolant such as to provide a first flow rate of coolant through the at least one lumen during a first period of the treatment, wherein the first flow rate is selected to cause the radiating element to heat a first part of a selected treatment zone, the first part of the selected treatment zone having a selected first shape, and to provide a second, different flow rate of coolant through the at least one lumen during a second, later period of the treatment, wherein the second flow rate is selected to cause the radiating element to heat a second part of the selected treatment zone, the second part of the selected treatment zone having a selected second, different shape.

~~29. A method comprising:~~

~~performing a treatment comprising heating a volume of tissue using microwave radiation emitted from a radiating element;~~

~~during the treatment, flowing a coolant through at least one lumen of a cooling structure; and~~

~~controlling the flow of coolant such as to provide a first flow rate of coolant through the at least one lumen during a first period of the treatment and to provide a second, different flow rate of coolant through the at least one lumen during a second, later period of the treatment.~~

30. A method according to Claim 29, wherein the controller is configured to control the flow of coolant such as to shape the volume of tissue that is heated by the radiating element during the treatment.

31. A method comprising:

receiving parameters of a radiating element for emission of microwave radiation and a cooling structure comprising at least one lumen;

receiving a desired volume of tissue to be heated by the emission of microwave radiation from the radiating element; and

determining a first flow rate of coolant and second flow rate of coolant to be provided through the at least one lumen to shape a volume of tissue heated by the emission of microwave radiation by the radiating element to match the desired volume of tissue, wherein the determining is in dependence on the parameters of the radiating element and the cooling structure.

32. A method according to Claim 31, further comprising determining at least one of a) to e):

a) a direction of coolant flow through the at least one lumen;

b) a path of coolant flow;

c) a power to be provided to the radiating element;

d) a period of time over which the first flow rate is to be delivered;

e) a period of time over which the second flow rate is to be delivered.

33. A method according to Claim 31 or Claim 32, wherein the determining is further in dependence on at least one temperature measurement for tissue heated by the radiating element.