METHOD AND APPARATUS FOR FAT REMOVAL

Exemplary embodiments of apparatus and method for fat removal using a plurality of needles to deliver energy to fatty tissue can be provided. For example, the needles can include an optical guide, such as an optical fiber, configured to deliver electromagnetic energy to fatty tissue located near the distal ends of the needles that may be inserted into the tissue to be treated. The electromagnetic energy can irradiate and heat the surrounding fatty tissue to causing thermal damage, and the heated fatty tissue may then be re-absorbed by the body. A plurality of hollow needles can also be provided in proximity to the First needles, such that a portion of the heated fatty tissue can be aspirated through the hollow needles.
METHOD AND APPARATUS FOR FAT REMOVAL

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application relates to and claims priority from U.S. Patent Application Serial No. 61/063,339, filed February 1, 2008, the entire disclosure of which is incorporated herein by reference.

FIELD OF THE PRESENT INVENTION

The present invention is directed to exemplary embodiments of method and apparatus for fat removal. More specifically, the present invention relates to the exemplary embodiments of the method and apparatus whereby an array of needles can be inserted at least partially into skin tissue, whereas at least one of the needles can be used to deliver optical and/or radiofrequency ("RF") energy to heat fatty tissue near tips of the needles, and whereas at least one portion of the heated fatty tissue may optionally be aspirated through a plurality of hollow needles in the array. Such exemplary embodiments of the method and apparatus can be used to damage and/or remove at least one portion of the fatty tissue with more precision and less auxiliary tissue damage than can be achieved with certain conventional liposuction procedures.

BACKGROUND INFORMATION

Liposuction is a well known surgical procedure for surgically removing fatty tissue from selected portions of a patient's body. Liposuction may be used, for example, to contour selected body parts such as the abdomen, buttocks, hips, thighs, etc. Liposuction is also known as suction lipectomy, lipolysis, or body contour surgery.

Conventional liposuction is often performed by inserting a hand-held tubular instrument (e.g., a cannula) through the patient's skin such that the tip of the cannula is in or

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adjacent to fat pockets in a target region of tissue. The cannula is generally moved around to break up the fatty tissue, and pieces of the fatty tissue are then aspirated through openings along the sides or tip of the cannula using vacuum from a syringe or pump. The fatty tissue is then generally deposited in a container provided in-line with the cannula and the vacuum source.

The cannula is typically a tube having an aspirator tip at a distal end. Such conventional cannula can be used to both physically break up the fatty tissue, and to then aspirate the fatty tissue (e.g., together with fluids which may be present) through a central core thereof, and away from the target region.

FIG. 1 is a schematic illustration of a conventional liposuction procedure, in which a cannula 100 is inserted through an incision 120 in the surface of skm tissue 110, such that a tip 130 of the cannula 100 is positioned within a portion of fatty tissue 140 to be removed. During the procedure, the cannula 100 is moved to a different position 150 such that the tip 130 can aspirate a larger volume of the fatty tissue 140 as it passes through the target region. Such movement may be lateral, as shown in FIG. 1, or along the length of the cannula axis (e.g., the cannula 100 can be further inserted or partially withdrawn from the skm tissue 110), or a combination of both types of motion can be performed. Existing fat removal procedures often involve a significant movement of the cannula 100 through the target region(s) containing the fatty tissue 140 to be removed. Such back-and-forth motion of the cannula can also present a risk of perforating the abdominal cavity, large blood vessels, etc. Thus, these techniques can be invasive and disruptive in nature, even when a smaller cannula is used.

Conventional liposuction techniques and apparatus can produce undesirable side effects in a patient undergoing treatment. For example, a neighboring tissue surrounding
and/or interspersed with the fat being removed (such as blood vessels and connective tissue) may be significantly damaged or even partially removed along with the fatty tissue. Conventional liposuction procedures can also lead to other adverse complications, including infection or excessive bleeding. The large cannula used in conventional liposuction procedures may also induce trauma at any points of insertion through the skin, which may also lead to localized scar formation.

Modifications to basic liposuction techniques and apparatus have been described to make liposuction safer, easier to perform, less painful, and/or more effective. For example, certain common liposuction procedures include an injection of an amount of fluid into the target region of tissue containing the fat to be removed. Such fluid may contain lidocaine as a local anesthetic, epinephrine to locally contract blood vessels and reduce bleeding, and/or a saline solution which can help to loosen the fatty tissue and aid in their aspiration through the cannula. The amount of fluid injected into the fatty tissue to be removed may vary depending on the particular technique being performed, the location of the target region being treated, etc.

Laser-assisted liposuction techniques have been developed which use a cannula combined with an optical waveguide connected to a laser source. Energy delivered by the optical waveguide can heat and disrupt fatty tissue, which is then aspirated through the cannula. The heated fatty tissue may also be less viscous, and thereby more easily aspirated than unheated fat. In laser-assisted liposuction, fatty tissue which has been heated and disrupted may optionally be allowed to dissipate and be absorbed by the body itself, rather than being removed by a suction device. Ultrasonic energy can also be applied with a cannula to liquefy and disrupt fatty tissue, which can then be aspirated more easily. However, such techniques can also include significant movement of the cannula through the
fatty tissue to remove it, which may cause undesirable damage to surrounding tissue structures.

Conventional liposuction procedures, including laser assisted liposuction described above, may preferably be performed by skilled and trained practitioners because of the various risks associated with such procedures, including generating unwanted damage to tissue and/or structures located near the fatty tissue. Such safety considerations can limit the number of physicians who may be qualified to safely perform such procedures.

In view of the shortcomings of the above described procedures for liposuction and fat removal, it may be desirable to provide exemplary embodiments of procedures (e.g., methods) and apparatus that can combine safe and effective damage and removal of fatty tissue from the target regions, while reducing and/or minimizing unwanted damage to surrounding tissue. Such exemplary procedures and apparatus may preferably reduce and/or minimize undesirable side effects of the conventional liposuction and/or fat removal procedures and apparatus, such as intra-procedural discomfort, post-procedural discomfort, lengthy healing time, damage of healthy tissue, excessive bleeding, and post-procedural infection.

**SUMMARY OF EXEMPLARY EMBODIMENTS OF THE PRESENT INVENTION**

It is therefore one of the objects of the present invention to provide exemplary embodiments of apparatus and method that can combine safe and effective liposuction treatment with fewer undesirable side effects that are encountered with the conventional liposuction and/or fat removal procedures and apparatus. Another object of the present invention is to provide exemplary embodiments of the apparatus and method that facilitate local disruption and/or removal of the fatty tissue by applying a pattern of localized energy within the fatty tissue using an array of stationary needles. Still another object of the present
invention is to provide exemplary embodiments of the method and apparatus for removal of fatty tissue by using the array of needles to controllably deliver electrical, thermal, optical and/or other electromagnetic energy to predetermined locations within the fatty tissue, and then optionally aspirating such treated fatty tissue through hollow needles in the array.

Certain exemplary hollow needles in the needle array may also be used to inject certain exemplary fluid into the target region of tissue being treated, before and/or during application of energy to the target region. Such exemplary fluid may contain lidocaine or another anesthetic or analgesic, and/or saline solution which may aid in the aspiration of the fatty tissue, and possibly provide other beneficial effects.

According to certain exemplary embodiments of the present invention, the exemplary method and apparatus can be provided for fat removal in which the array of needles can be inserted into a target region of skin, whereas the tips of the needles can be configured and/or structured to penetrate to one or more predetermined depths which are within or in proximity to the fatty tissue. Electromagnetic energy, e.g., optical energy or RF energy, can then be provided through at least some of the needles in the array of needles to create regions of heating and/or thermal damage in the fatty tissue proximal to the needles.

Certain of the exemplary needles which may be used to deliver optical energy can be hollow and/or may contain a light guide or optical fiber. Alternatively or additionally, such exemplary needles may be formed by coating optical fibers or other waveguides with a rigid coating such as, e.g., a metallic coating and/or a diamond film. The exemplary needles may also include a rigid fiber and/or waveguide as a core, which may be coated with a material that can have reflective properties and/or a different refractive index than the core to help direct optical energy to the tip region of the needles. Optical energy and/or other EMR can be provided, e.g., by a laser, a flashlamp, etc.
In further exemplary embodiments of the present invention, optical energy can be provided through the plurality of the needles in the needle array. Optionally, the optical energy may be provided at certain wavelengths that can be absorbed by fatty or lipid-rich tissue, as compared to water. Such optical energy can provide a more effective heating of the fatty tissue proximal to the needle tips, while likely reducing the extent of undesirable heating of non-fatty tissue. For example, optical energy can be provided which can have a wavelength, e.g., between about 900-930 nm, 1190-1220 nm, 1700-1730 nm, and/or 2280-2350 nm. Alternatively, optical energy having other wavelengths that are at least partially absorbed by fatty tissue can be used. In contrast to non-invasive irradiation of fatty tissue by optical energy, the energy applied to fatty tissue in exemplary embodiments of the present invention need not pass through water-rich tissue located above the fatty tissue of interest as described herein.

In certain exemplary embodiments of the present invention, one or more of the exemplary needles in the array can be hollow, and may be used to remove heated fatty tissue by aspiration. Such exemplary hollow needles may be interspersed among the other needles in the array which can be configured and/or structured to deliver electromagnetic or optical energy to the tissue. Alternatively, such hollow needles may be configured as electrodes which can also deliver RF energy to the tissue being treated.

These and other objects, features and advantages of the present invention will become apparent upon reading the following detailed description of embodiments of the present invention, when taken in conjunction with the appended claims.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Further objects, features and advantages of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying
figures showing illustrative embodiments, results and/or features of the exemplary embodiments of the present invention, in which

FIG 1 is a schematic diagram of a cannula being used in a conventional liposuction procedure,

FIG 2 is a schematic illustration of a first exemplary embodiment of an apparatus for removing fatty tissue according to the present invention,

FIG 3 is a schematic illustration of a second exemplary embodiment of the apparatus for removing fatty tissue according to the present invention,

FIG 4a is a schematic illustration of a tip region of a hollow needle, showing an exemplary configuration of openings that may be used for aspirating fatty tissue, according to an exemplary embodiment of the present invention,

FIG 4b is a schematic illustration of a tip region of an optical needle, showing an exemplary configuration of exposed portions of a waveguide that may be used for directing optical energy into the fatty tissue, according to another exemplary embodiment of the present invention,

FIG 5a is a schematic illustration of first exemplary configuration of a needle array that includes both optical needles and hollow needles for heating and aspirating fatty tissue, according to an exemplary embodiment of the present invention,

FIG 5b is a schematic illustration of a second exemplary configuration of a needle array, according to another exemplary embodiment of the present invention, and

FIG 6 is a schematic illustration of a hand-piece or hand-held apparatus that includes an array of optical needles and hollow needles according to a further exemplary embodiment of the present invention.
Throughout the drawings, the same reference numerals and characters, unless otherwise stated, are used to denote like features, elements, components, or portions of the illustrated embodiments. Moreover, while the present invention will now be described in detail with reference to the figures, it is done so in connection with the illustrative embodiments and is not limited by the particular embodiments illustrated in the figures.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Exemplary embodiments of the present invention relate to methods and apparatus for removal of fatty tissue. A first exemplary embodiment of the present invention includes a fat removal apparatus 200, a side view of which is shown in FIG. 2. This exemplary apparatus 200 can be used to direct optical energy to fat and/or fatty (e.g., lipids) tissue 140 to heat the tissue 140 and cause thermal damage thereto, whereby the damaged tissue 140 may be absorbed by the body and/or the heated fat may be metabolized more rapidly, likely leading to a reduced amount of the fatty tissue 140 in the treated area. The phrase 'optical energy' as used herein can include, but is not limited to, electromagnetic energy having wavelengths in the visible spectrum of light, as well as electromagnetic energy having wavelengths in the infrared and/or ultraviolet spectra.

The exemplary apparatus 200 can include a plurality of optical needles 220 attached to a base 210, which may optionally have a form of a plate or be provided as a portion of a housing. An energy source 240 can be configured to provide energy to the fatty tissue 140 via optical guides 245 which extend into and at least partially through the optical needles 220.

An exemplary needle of the optical needles 220 can include a respective optical guide of the optical guides 245 provided through a hollow center of such optical needle 220. The outer portion of the optical needle 220 can be formed of metal or another structurally
rigid material. The optical guide 245 can be, e.g., an optical fiber and/or a waveguide configured and/or structured to propagate optical energy to a distal portion of the respective optical needle 220. Each optical needle 220 can thereby be configured and/or structured to direct the optical energy from energy source 240 through its length and into a target region of the fatty tissue 140 at and/or near the needle tips.

The exemplary optical needle 220 may be provided in a variety of forms. For example, such optical needle 220 can include the optical guide 245 which may be provided in a rigid shell, for example, in a thin hollow tube, as described herein. The material(s) used to form the outer surfaces of such exemplary needles 220 can be selected for their mechanical properties and/or to facilitate the insertion and removal of the exemplary needles 220 from the skin. Such materials can include, but are not limited to, e.g., polymers, glasses, ceramics, diamond or diamond-like films, metals or alloys, etc.

In further exemplary embodiments, the optical needle 220 can also be provided, e.g., as a layer of material which may be deposited or coated on a distal portion of the optical guide 245 to form the optical needle 220. In certain exemplary embodiments, such layer can be formed using a mechanically-rigid and/or stiff material to provide a structural stability to the optical needle 220 when it is inserted into the tissue 110. For example, these exemplary material layers can be formed using polymers, glasses, ceramics, diamond or diamond-like films, metals or alloys, etc. Such exemplary material layers can be provided on the optical guide 245 using one or more conventional deposition or coating techniques such as, e.g., chemical-phase vapor deposition, physical vapor deposition, dip-coating of a solution, a sol-gel reaction, etc. In further exemplary embodiments, the optical needle 240 can include a mechanically-rigid optical guide 245 that may be coated with a layer of material such as, e.g., Teflon®, which can facilitate an insertion of the optical needle 220 into the tissue 110.
If the optical guide 245 is coated with a material layer or surrounded by a shell as described herein to form the optical needle 220, and the distal end of such optical guide 245 is covered with such material or shell, the distal end of this optical guide 245 can then be cut, abraded and/or otherwise treated to expose the distal end of the optical guide 245. For example, such distal end of the optical guide 245 can be cut and/or abraded to form, e.g., a sharp point or another shape which can facilitate a penetration of the distal end of the optical needle 220 thus formed into the skin tissue 110. Such abrading and/or angled shaping of the distal end of the optical needle 220 and the optical guide 245 can facilitate directing of the provided optical energy through the optical guide 245 into the tissue 140 proximal to and/or at the distal portion of the optical needle 220.

In certain exemplary embodiments of the present invention, the optical needles 220 can be inserted into skin tissue to a particular depth, and the energy can be applied directly to the fatty tissue 140 proximal to and/or at the distal portions of the optical needles 220, without irradiating or being absorbed by the skin tissue 110 located above the fatty tissue 140. By using an array of such optical needles 220, a large region of the fatty tissue 140 may be heated and/or thermally damaged after a single insertion of the array of the needles 220, without requiring and/or performing further lateral movement(s) of the optical needles 220 through the skin tissue 110 or the fatty tissue 140. Accordingly, mechanical damage to the surrounding tissue, which can occur during movement of a cannula through tissue in conventional liposuction procedures, may be avoided or reduced.

In still further exemplary embodiments of the present invention, the optical guide 245 can be provided as part of a bundle 247 of such guides such as, e.g., an optical fiber bundle. An end of the bundle 247 can be affixed to a coupler 260, such as an optical coupler. The coupler 260 can be further provided in communication with the energy source 240 using
a waveguide 257. The exemplary apparatus 200 can facilitate connection and separation of 
an optical needle arrangement from the energy source 240, whereas the optical needle 
arrangement can include the fiber bundle 247, together with the needles 220, the substrate 
210, and the optical guides 245.

The energy source 240 can be selected, e.g., based on the desired heating 
characteristics to be applied to the fatty tissue 140. For example, the energy source 240 may 
include, but is not limited to, a diode laser, a diode-pumped solid state laser, an Er:YAG 
laser, a Nd:YAG laser, an argon-ion laser, a He-Ne laser, a carbon dioxide laser, an excimer 
laser, a pulsed dye laser, an intense pulsed light source, a tunable laser, a tungsten lamp, an 
arc lamp, a flashlamp, or a ruby laser. Further exemplary sources of optical energy that may 
be used with exemplary embodiments of the present invention are described, e.g., in U.S. 
Patent No. 6,605,080.

In yet further exemplary embodiments, lasers or filtered sources of optical 
radiation providing electromagnetic energy having wavelengths between about 900-930 nm, 
1190-1220 nm, 1700-1730 nm, and/or 2280-2350 nm, or wavelengths close to these 
length ranges, may be used as or with the energy source 240. The electromagnetic 
energy having such wavelengths has been observed to be preferentially absorbed by fatty 
tissue relative to water-containing tissues or structures as described, e.g., in U.S. Patent Nos. 
6,605,080 and 7,060,061. Thus, using the optical energy having such exemplary wavelengths 
may reduce the amount of heating (and possible thermal damage) of non-fatty tissue 
irradiated by such energy. Alternatively, optical or electromagnetic energy having other 
wavelengths may also be used in certain exemplary embodiments, since such electromagnetic 
energy can be applied, e.g., directly to the local fatty tissue 140 proximal to and/or at the 
distal portions of the optical needles 220, and therefore such energy may not pass through
other water-π ch tissue above this target region where absorption of such energy may be undesirable.

The exemplary apparatus 200 shown in FIG. 2 can also include a control module (or a controller) 242 that can control the amount, duration and/or other characteristics of the energy provided to the optical needles 220 by the energy source 240. The control module 242 can be provided within the same housing as the energy source 240, or it may be separate from the energy source 240. The energy provided to the target areas of the fatty tissue 140 through the optical needles 220 may optionally be continuous and/or pulsed, with pulse and/or continuous wave durations selected based on, e.g., the desired amount of heating to be achieved, the spacing between the optical needles 220, etc.

In further exemplary embodiments, the exemplary apparatus 200 may also include a plurality of hollow needles 270 provided in proximity to the optical needles 220. The hollow needles 270 can have the form of a thin tube with a hollow core that may include an opening near or at the distal end (e.g., the tip) of the hollow needles 270, such that a passageway can extend from the distal portion of the hollow needle 270 to a proximal portion thereof. The hollow needles 270 can be connected to a vacuum source 280 (e.g., a vacuum pump or other low-pressure source) by tubes 275. The fatty tissue 140 that has been heated and/or thermally damaged from the energy supplied by the optical needles 220 can be withdrawn through the hollow needles 270. A container or receptacle may be provided in line with the vacuum source 280, such that heated fatty tissue aspirated through the hollow needles 270 that travels through the tubes 275 may be deposited in the container before reaching the vacuum source 280.

In certain exemplary embodiments of the present invention, the energy source 240 may be a source of RF or other high-frequency electromagnetic energy. For example,
the optical guides 245, bundle 247, coupler 260, and waveguide 257 shown in FIG. 2 can be replaced by electrically conductive elements, such as wires, which can direct the RF energy to the tips of the needles 220 where it can be absorbed into the surrounding tissue 140. The energy source 240 can be configured to operate in a bipolar mode, such that the RF energy can be localized in the tissue between adjacent needles 220 in the array of the needles 220. In this exemplary manner, an elongated region of the fatty tissue 140 between two adjacent or nearby needles 220 in the needle array 220 can be heated and/or thermally damaged using a bipolar mode through an appropriate configuration of the energy source 240. Alternatively, the energy source 240 can be configured to operate in a monopolar mode, such that the RF energy is provided substantially uniformly from the tip region of each needle 220. A variety of thermal heating or damage patterns in the fatty tissue 140 can thus be created using a single array of the needles 220 using the supplied RF energy through an appropriate configuration of the energy source 240.

A second exemplary embodiment of the apparatus in accordance with the present invention is shown in FIG. 3. For example, the optical needles 220 and the hollow needles 270 can be affixed to the substrate 210, similarly to the apparatus 200 shown in FIG. 2. Thus, the energy source 240, vacuum source 280, and connections between the needles 220, 270 and these sources 240, 280 are not shown in FIG. 3. The optical needles 220 and the hollow needles 270 may optionally have different lengths, such that they can extend to different depths within the fatty tissue 140 when the needle array is inserted into the skin 110. This exemplary configuration can facilitate the energy to be delivered at different depths using the optical needles 220, and the fatty tissue 140 to be aspirated from different depths using the hollow needles 270. Thus, a larger depth range of the fatty tissue 140 can be treated by the exemplary apparatus 300 based on a single insertion of the needle array apparatus 300. For
example, in certain exemplary embodiments of the present invention, the hollow needles 270 may generally be slightly longer than the optical needles 220. Such exemplary configuration may facilitate the aspiration of the fatty tissue 140 that is heated below the distal ends of the optical needles 220 by the distal portions of the hollow needles 270.

The exemplary apparatus 300 can further include a spacer plate 310 located between the substrate 210 and the surface of the skin 110 over the area to be treated. The spacer plate 310 can be connected by posts 320, which may have a screw-type configuration or other coupling arrangement which facilitates the distance between the spacer plate 310 and the substrate 210 to be controllably varied. At least some of the needles 220, 270 in the needle array, which are affixed or connected to the substrate 210, can protrude through holes in the spacer plate 310. In this manner, the distance which the needles 220, 270 extend below the surface of the spacer plate 310 can be determined by adjusting the distance between the substrate 210 and the spacer plate 310 to a particular value using the posts 320. The depth to which the needles 220, 270 extend into the skin tissue 110 can be controlled when the needle array is inserted into the skin tissue 110 until the spacer plate 310 contacts the surface of the skin tissue 110. Such spacer plate 310 can be used with various exemplary embodiments of the present invention, and the spacer plate 310 may also provide a mechanical stability to the array of the needles 220, 270.

In an exemplary embodiment of a fat removal procedure according to the present invention, the exemplary apparatus 300 can be inserted into the skin tissue 110 such that the tips of the needles 220, 270 are positioned within the region of the fatty tissue 140 to be removed. Energy (e.g., optical or RF energy, as described herein) can be applied to the fatty tissue 140 using the needles 220. Simultaneously or subsequently, the heated fatty tissue 140 can be aspirated and removed through the hollow needles 270. After an appropriate or
predetermined time, the distance between the spacer plate 310 and the substrate 210 can be changed using posts the 320, such that the tips of the needles 220, 270 which remain in the skin 110 are located at a different depth. The heating and aspiration procedures can be repeated at this new depth. Optionally, the heating and removal of the fatty tissue 140 can be performed at a plurality of depths in this manner using a single insertion of the needle array into the skin 110. To that end, a larger volume of the fatty tissue 140 can be heated and removed without removing and re-inserting the needle array. The needles 220, 270 may remain stationary and not be moved laterally within the skin tissue 110 or fatty tissue 140 during the fat removal procedure, which can reduce an unwanted tissue damage as compared to the conventional fat removal techniques in which a larger cannula is moved through the tissue being treated.

The substrate 210 and/or the spacer plate 310, if provided, can be planar and/or may have a bottom surface that is contoured to follow the shape of the region of tissue being treated. For example, the bottom surface of the substrate 210 or the spacer plate 310 can have a planar, convex, or concave contour. Such contour may be selected based on the area of skin being treated, e.g., to more closely conform to the shape of the skin surface above the target region where the fatty tissue 140 is to be removed. This exemplary configuration can facilitate, for example, the penetration of the needles 220, 270 in the needle array to a uniform depth within the targeted tissue even if the surface of the skin is not planar, e.g., on a chin, cheek, etc. It is possible to provide the needles 220, 270 that are substantially parallel in the needle array to allow for an easier insertion of the needle array into the skin tissue 110.

In another exemplary embodiment of the present invention, the substrate 210 and/or the spacer plate 310, if used, may be cooled using any suitable technique (for example, using embedded conduits containing circulating coolant or a Peltier device). Such cooled
substrate 210 and/or spacer plate 310 can thereby cool the surface of the skin tissue 110 when the needles 220, 270 penetrate the skin tissue to reduce or eliminate pain. The surface region of the skin tissue 110 being treated and/or the needles 220, 270 may also be precooled prior to insertion of the needle array, e.g., using convective or conductive techniques, such as, e.g., a cryospray or soaking in a cold liquid.

In yet another exemplary embodiment of the present invention, one or more vibrating arrangements, such as a piezoelectric transducer or a small motor with an eccentric weight fixed to the shaft, may be mechanically coupled to the substrate 210 that supports the array of needles 220, 270. The vibrations conductively induced in the needles 220, 270 by such exemplary vibrating arrangement can facilitate a piercing of the skin surface by the needle tips and subsequent insertion of the needles 220, 270 into the skin tissue 110. The vibrating arrangement can have an amplitude of vibration in the range of, e.g., about 50-500 µm, and preferably between about 100-200 µm. The frequency of the induced vibrations can be, e.g., between about 10 Hz and about 10 kHz, or preferably between about 500 Hz and about 2 kHz, or more preferably about 1 kHz. The exemplary vibration parameters chosen may depend on the size and material of the needles, the number of needles in the array, and the average spacing, or lateral distance, between the needles. The exemplary vibrating arrangement may further include an optional controller configured to adjusting the amplitude and/or frequency of the vibrations.

The amount of energy directed to a particular needle of the needles 220 can be selected or controlled based on the tissue being treated, the desired amount of thermal damage to be provided, absorption characteristics of the energy, geometric characteristics of the needle array (e.g., needle spacings and optional length differences), etc. The amount of
energy delivered by each optical needle 220 can be selected based on the desired temperature rise and the geometric characteristics of the needle array and spacings therein.

For example, about 2-3 J of energy can raise 1 cubic centimeter of fatty tissue about 1° C. For an exemplary array of needles 220 that are spaced apart, e.g., by about 5 mm, with a height of the portion of fatty tissue 140 to be heated along the longitudinal direction of the needles 220 of about 1 cm, then each needle can be used to heat about 0.25 cm³ of the fatty tissue 140. Accordingly, about 0.5-0.15 J of energy can be used for each degree of temperature rise. Thus, about 5-7 J can be provided through each needle 220 into surrounding tissue to raise the average temperature of the tissue about 10° C. Further, twice as much energy can be provided through each needle 220 to generate an average temperature increase that is approximately twice as large in the nearby fatty tissue 140, etc. If the needles 220 are spaced further apart and/or the energy provided by the needles 220 is directed into nearby tissue 140 along a larger longitudinal distance, larger amounts of energy can be provided to each needle 220 to achieve a similar average temperature rise.

Accordingly, the amount of energy provided through each needle 220 and into surrounding tissue may typically be between about 100 mJ and about 50 J, or more preferably between about 1 J and about 30 J. Other amounts of energy may be used to achieve a desired average temperature rise in nearby fatty tissue 140, based on the spacing and energy dispersion characteristics of the needles 220.

The energy provided to each needle 220 can be provided in a form of a continuous wave (CW) or as a plurality of pulses. The intensity of the CW or pulses, as well as the pulse duration and frequency, can be selected to provide a predetermined or controlled total amount of energy to each optical needle 220 as described herein. For example, energy may be provided to the needles as a continuous wave having a duration, e.g., between about
100 ms and about 10 seconds. Alternatively, energy may be provided to the needles 220 in a form of a plurality of pulses, where each pulse has a duration, e.g., between about 10 µs and about 1 second, or more preferably between about 100 µs and about 100 ms. Pulse frequencies can be between, e.g., about 1 Hz and about 10000 Hz. Other pulse parameters may be used for particular procedures.

The exemplary mechanism by which the fat or fatty tissue 140 can be heated or damaged may vary with the duration of radiation pulses and the temperature to which the fatty tissue 140 is raised. For example, if the fat cell temperature is raised slightly (e.g., by about 10° C or less above normal body temperature of about 37° C, e.g., to between about 42° C and about 47° C), a lethal injury to most of the fat cells may be avoided. This relatively small temperature rise can initiate a biochemical reaction (e.g., lipolysis) in the fatty tissue 140 that may enhance metabolization of fat by the heated fat cells, thereby likely reducing the amount of fat present in the target area over time. Such heating can also reduce the viscosity of the fat, such that a portion of the heated fatty tissue 140 can be more easily aspirated through the hollow needles 270, as described herein.

In further exemplary embodiments, the fat cells in the fatty tissue 140 can be killed and/or destroyed by heating them to higher temperatures, e.g., to about 45-60° C for a sufficient duration of time, using energy provided through the optical needles 220. Such dead fat cells can be absorbed and disposed of by the body, which may reduce the amount of fat present without the aspiration of the heated fatty tissue 140. Alternatively, a portion of the heated fatty tissue 140 can be aspirated through the hollow needles 270. The amount of fat present in the treated volume can be further reduced over time by the absorption process described herein.
In still further exemplary embodiments of the present invention, the fatty tissue 140 can be heated to higher temperatures, e.g., greater than about 60° C, using energy provided through the optical needles 220. At these exemplary higher temperatures, for example, the walls or membranes of the fat cells, which can be formed primarily of lipid-rich material, can be thermally damaged such that they lose their ability to encapsulate the heated liquid lipids contained therein. The heated lipids can then leak from the damaged cells and may then be absorbed by the body. However, the liquid lipids contain free fatty acids which, in sufficient quantity, can be toxic to the human body. Therefore, if a substantial pool of liquid lipids is formed by heating the fatty tissue 140 to higher temperatures, it may be preferable to aspirate some or most of the liquid lipid through the hollow needles 270 as described herein so as to limit or reduce the amount of such lipids that are absorbed into the body.

In the exemplary embodiments according to the present invention described herein, the fatty tissue 140 can be preferably heated to temperatures less than about 70° C to avoid unwanted damage to the collagen bands which hold the skin to the body. Further, such moderate heating of the collagen bands and/or other connective tissue located within or proximal to the fatty tissue 140 can lead to contraction of such connective tissue. Thus, such exemplary heating may provide further aesthetic benefits by causing some shrinkage of the connective tissue, which can help to maintain skin tone and tightness, for example, when the amount of the fat is reduced as described herein.

Certain ones of the needles 220 and/or the needles 270 may further comprise a temperature sensing arrangement such as, e.g., a thermocouple, a thermistor, or a resistance temperature detector. Such temperature sensing arrangements, if present, can be provided in communication with the energy source 240 and/or the control arrangement 242. Signals
provided by the temperature sensing arrangement can be used, e.g., to control or affect characteristics of the energy (e.g., intensity or fluence, pulse rate, pulse duration, etc.) provided by the energy source 240 to the needles 220. For example, signals provided by such exemplary temperature sensing arrangements can be used, e.g., to achieve and/or approximately maintain a particular temperature in the fatty tissue 140 that is heated, and/or to avoid heating such fatty tissue 140 above a predetermined maximum temperature.

In further exemplary embodiments of the present invention, certain of the needles 220 and/or the hollow needles 270 can have a width or diameter of, e.g., less than about 1000 µm, or less than about 800 µm. The exemplary needles 220, 270 having a width or diameter less than about 500 µm, for example, a diameter of about 250 µm, may also be used if they are sufficiently stiff or rigid to allow reliable insertion into skin tissue. For example, thinner optical needles 220 can be provided by coating optical fibers or the like with a rigid coating such as, e.g., a metallic layer or a diamond-like carbon film. The needles wider than about 1000 µm in diameter may also be used in accordance with certain exemplary embodiments of the present invention, but such larger needles may be less preferable because of the possible difficulty in forcing larger needles to penetrate the skin, and because of an increased likelihood of pain and/or scarring when using the larger needles.

A length of the needles 220, 270 extending into the skin can be selected based on the depth of the fatty tissue 140 to be removed from the target region being treated. For example, a subcutaneous fat layer typically begins, e.g., between about 1 mm and about 5 mm below the skin surface. The depth of the subcutaneous fat may be shallower, e.g., in the face and neck areas, and it may be deeper in portions of the body such as the upper arms, stomach, and thighs. An exemplary depth for targeting the fatty tissue 140 in regions such as the abdomen and legs can be about 3 mm or greater, while a depth of about 1-2 mm may be
preferable for removing fat from facial regions. Longer needles 220, 270 may also be used with the spacer plate 310 and posts 320 as shown in FIG. 3 to facilitate the targeting and removal of the fatty tissue 140 over a wider range of depths with a single exemplary apparatus. For example, the plate 310 may be adjusted such that the needles 220, 270 protrude about 1 mm below the lower surface thereof for treating facial regions. When treating areas such as thighs or abdomens, e.g., the plate 310 can be adjusted such that the needles 220, 270 protrude about 3-6 mm or more below the lower surface of the plate 310. In certain exemplary embodiments, it may be desirable to maintain a short length of the hollow needles 270 above the substrate 210 to facilitate aspiration of the fatty tissue 140.

In certain exemplary embodiments of the present invention, the distal portion of the hollow needles 270 may be provided with a plurality of openings 410 as shown in FIG. 4a. The exemplary embodiments of the hollow needles 270 can be provided with a closed sharp tip 420 as illustrated in FIG. 4a, to facilitate insertion of the needle 270 into the skin tissue 110. The openings 410 can be provided around the circumference of the needles 270, and may extend for a distance back from the tip 420. In further exemplary embodiments, an opening 410 may also be provided at the tip 420. Such exemplary openings 410 can facilitate the aspiration of a larger volume of the heated fatty tissue 410 proximal to and/or provided at the needle 270. For example, the openings 410 can be provided over a distance that extends, e.g., between about 1 mm and about 4 mm back from the tip 420. The openings 410 can also be provided over a distance greater than about 4 mm back from the tip 420 for reemoving fatty tissue from thicker layers of subcutaneous fat. Such exemplary configuration of openings 410 can facilitate the aspiration of the fatty tissue 140 from a greater range of depths without moving the needle 270 within the skin tissue 110.
FIG. 4b illustrates an exemplary embodiment of the optical needle 220 that includes a layer of a material 430 provided on the optical guide 245, as described herein. A plurality of regions 440 of the optical guide 245 can be exposed proximal to the tip 460 of the optical needle 220. Such regions 440 can be exposed, e.g., by abrading or otherwise removing a portion of the material 430 overlying the regions 440. A portion 450 of the optical guide 245 located at the tip region may also be exposed, as shown in FIG. 4b. In this exemplary manner, a portion of the optical energy provided at a distal portion of the optical guide 245 can pass through the exposed regions 440, 450 and irradiate a larger volume of the surrounding the tissue proximal to and/or provided at the tip 460. The surface of the optical guide 245 located at the exposed regions 440, 450 can be abraded, grooved, contoured, or otherwise shaped or treated to further direct optical energy provided through the optical guide 245 into the tissue surrounding the optical needle 220. The exemplary configuration of the optical needle 220 shown in FIG. 4b can thus provide a more uniform irradiation of a larger volume of the tissue proximal to the distal end of the needle 220.

The exemplary apparatus 200, 300 shown in FIGS. 2 and 3, respectively, represent side views of the needle arrays. The needles 220, 270 in these exemplary arrays can be provided in a two-dimensional arrangement, where the needles 220, 270 can be, e.g., substantially parallel to each other and/or substantially perpendicular to the surface of the skin region being treated. These exemplary needles 220, 270 may thus be provided in a pattern through the substrate 210 which extends over a finite area of the skin surface (that is, e.g., the substrate extends in a direction into and/or out of the plane of the drawing in these figures).

Frontal views of the exemplary configurations of the optical needles 220 and hollow needles 270 provided on a substrate 210 are illustrated in FIGS. 5a and 5b. In these
exemplary configurations, the needles 220 and 270 are arranged in triangular and square arrays, respectively. The optical needles 220 (shown as solid circles) in these exemplary configurations can be surrounded by hollow needles 270 (shown as open circles). Such exemplary configurations, in which there are more of the hollow needles 270 than the optical needles 220, can facilitate the aspiration of a greater volume of fatty tissue through the hollow needles 270 when the fatty tissue is heated by the optical needles 220. Other exemplary patterns or arrangements of the needles may be used, including non-uniform or irregular patterns, and the relative numbers of the optical needles 220 and the hollow needles 270 can be selected based on the characteristics of the energy supplied to the optical needles 220, the spacings between the needles 220, 270, and the amount of heated fatty tissue to be aspirated. The exemplary substrate 210 shown in FIGS. 5a and 5b are approximately square. However, other substrate shapes may be used including, e.g., round, oval, rectangular, etc. The size and shape of the particular substrate 210 can be selected based on the characteristics of the region of the tissue to be treated.

The exemplary needle arrays may have any geometry appropriate for the desired treatment being performed. The exemplary spacing (e.g., a lateral distance) between the adjacent needles 220, 270 may be less than about 1 cm, or preferably less than about 8 mm. Optionally, the spacing between the adjacent needles 220, 270 in the array may be less than about 5 mm, or less than about 2 mm. The spacing between the needles 220, 270 in the array does not have to be uniform, and can be smaller in areas where a relatively greater amount of fat removal or more precise control of such removal in the target area of the tissue is desired. In certain exemplary embodiments of the present invention, a plurality of the hollow needles 270 may be provided in proximity to a single one of the optical needle 220 within the array,
which can facilitate aspiration of a larger volume of the fatty tissue 140 heated by each of the optical needle 220.

Various numbers of the needles 220, 270 may be used in the exemplary needle arrays. For example, the needle arrays in accordance with the exemplary embodiments of the present invention may include at least about 10 needles, at least about 30 needles, or at least about 50 needles. These exemplary needles can include both the optical needles 220 and the hollow needles 270. Arrays having a larger number of the needles can be used, e.g., to treat a larger volume of tissue with a single insertion of the needle array into the skin, and/or to provide energy and/or aspirate a larger volume of the fatty tissue 140 from the target region being treated. The relative number of the optical needles 220 and the hollow needles 270, as well as their geometric arrangement, can be selected to provide an effective degree and distribution of the heating or thermal damage of the fatty tissue 140 by the optical needles 220, together with an effective amount of the aspiration of the fatty tissue 140 through the hollow needles 270.

In further exemplary embodiments of the present invention, the array of the needles may include pairs of the optical needles 220 which can be provided relatively close to each other and separated from adjacent pairs by larger distances. Such exemplary geometry may be preferable for generating damage in a bipolar mode between such pairs of the needles 220 when the RF energy is used. In any such array geometry, the pattern of damage and resultant tissue reshaping may be controlled with some precision by adjusting the intensity and duration of power transmitted to single needles and/or to certain pairs of needles.

An exemplary hand-piece or hand-held apparatus 600 in accordance with further exemplary embodiments of the present invention is shown in FIG. 6. The exemplary hand-piece or hand-held apparatus 600 includes a plurality of the hollow needles 270 and the
optical needles 220 that include the optical guides 245. The needles 220, 270 are affixed to
the substrate 210. A housing 610 is affixed to the housing 210 to form an enclosed conduit
620 that is in communication with the proximal ends of the hollow needles 270. The housing
610 can include a handle or other shape that facilitates the exemplary hand-piece or hand-
held apparatus 600 to be grasped in a hand, and can further facilitate positioning of the
exemplary hand-piece or hand-held apparatus 600 over the region of skin to be treated. The
housing 610 can also facilitate the manipulation of the exemplary hand-piece or hand-held
apparatus 600 such that the needles 220, 270 may pierce and enter the skin tissue when a
downward pressure is applied to the upper portion of the housing 610. A spacer plate 310
and adjusting mechanism 320 may also be provided with the handpiece apparatus 600, as
shown in FIG. 3, to facilitate a controlled variation of the penetration depths of the needles
220, 270.

A connector 630 can be provided that is also in communication with the enclosed
conduit 620, where the connector 630 is preferably provided at the exterior of the housing
610. The optical guides 245 may also be connected to the optical coupler 260, which can
also be preferably located at an exterior portion of the housing 610. The exemplary hand-
piece or hand-held apparatus 600 can be connected to the energy source 240 using the
coupler 260 as shown in FIG. 2, and can further be connected to the vacuum source 280 using
the connector 630. Thus, the energy can be provided to the optical needles 220 to heat the
fatty tissue 140 as described herein, and heated fatty tissue 140 can be aspirated through the
hollow needles 270 using low pressure provided by the vacuum source 280. The handpiece
apparatus 600 can be provided in a variety of configurations (e.g., different needle lengths
and/or spacings, different substrate sizes, etc.), where each exemplary hand-piece or hand-
held apparatus 600 can be connected to and disconnected from the energy source 240 and the
vacuum source 280. The exemplary hand-piece or hand-held apparatus 600 can be
disposable, or it may be sterilizable and reusable.

In further exemplary embodiments of the present invention, one or more of the
hollow needles 270 in the array may be used to deliver a fluid to the fatty tissue 140 to be
removed. Alternatively, further hollow needles may be provided in the needle array (in
addition to those shown in the exemplary apparatus 200, 300) to deliver the fluid. The fluid
may be delivered to the target region being treated before, during, and/or after application of
energy to the fatty tissue 140 using optical needles 220. The fluid may contain, for example,
a local analgesic such as, e.g., lidocaine 2% solution, saline, and/or other components.

Alternatively or additionally, the fluid may include one or more chromophores such as, e.g.,
indocyanine green (ICG), which may facilitate absorption of energy by the fatty tissue 140.
The fluid components may be selected based on their ability to provide a variety of effects in
the tissue, including lessening of pain and/or bleeding, disruption or lowering of the viscosity
of the fatty tissue 140, increased absorption of optical or other electromagnetic energy in the
target region, facilitation of aspiration of the heated and/or damaged fatty tissue 140, etc.

In certain exemplary embodiments of the present invention, the fat removal may
be achieved by applying energy to the fatty tissue 140 using the exemplary needle arrays
described herein, and without aspirating any of the heated fatty tissue 140. Instead, the
applied energy may thermally damage or disrupt the fatty tissue 140 locally, and the treated
tissue may then be reabsorbed by the body over time, as described herein. In contrast to
certain existing fat removal techniques which may also disrupt fatty tissue by applying
energy thereto using a cannula, the needle arrays of the exemplary methods and apparatus of
the present invention facilitate the application of energy to a controlled volume of fatty tissue
140 without requiring the motion of a cannula through the target region that can lead to
undesirable physical tissue damage. A fluid may also be provided to the target region being
treated before, during, and/or after application of energy to the fatty tissue 140 as described
herein.

Any of the fat damaging and/or removal methods practiced in accordance with
the present invention may be performed in a single treatment, or by multiple treatments
performed either consecutively during one session or at longer intervals over multiple
sessions. Multiple treatments can be performed at a single target region using multiple
insertions of the needle arrays described herein, or over a larger area by inserting a needle
array in several proximal areas of the skin, and performing the fat removal or damage
techniques described herein in each area. Single or multiple treatments of a given region of
tissue can be performed, e.g., to achieve an appropriate amount of thermal damage, heating
and removal of fatty tissue 140, and/or desired cosmetic effects.

The foregoing merely illustrates the principles of the present invention. Various
modifications and alterations to the described embodiments will be apparent to those skilled
in the art in view of the teachings herein. It will thus be appreciated that those skilled in the
art will be able to devise numerous techniques which, although not explicitly described
herein, embody the principles of the present invention and are thus within the spirit and scope
of the present invention.
WHAT IS CLAIMED IS:

1. An apparatus for affecting tissue, comprising:
   a structure;
   a plurality of particular needles coupled to the structure, wherein the particular
   needles are configured to be inserted simultaneously to one or more predetermined depths
   within the tissue, and wherein the particular needles are configured to direct an
   electromagnetic energy into at least one portion of the tissue proximal to at least a portion of
   the needles.

2. The apparatus of claim 1, wherein the electromagnetic energy comprises an optical
   energy.

3. The apparatus of any of claims 1 and/or 2, wherein at least one of the particular
   needles comprises an optical guide provided in a shell and/or a coating of a particular
   material.

4. The apparatus of any of claims 1 and/or 2, wherein at least one of the particular
   needles comprises an optical guide at least partially coated and/or covered with a layer of a
   particular material.

5. The apparatus of any of claims 3 and/or 4, wherein the particular material comprises
   at least one of a metal, a metal alloy, a polymer, a ceramic, Teflon®, diamond, and/or
   diamond-like carbon.

6. The apparatus of any of claims 2-5, wherein the optical guide comprises at least one
   of an optical fiber and/or a waveguide.

7. The apparatus of any of claims 2-6, wherein the optical guide has a plurality of areas
   in the distal portion of at least one of the particular needles that remain uncovered by the
   particular material, such that the electromagnetic energy transmitted by the optical guide is
facilitated to be directed through the plurality of areas and into the tissue proximal to a portion of the at least one of the particular needles.

8. The apparatus of any of claims 1-7, wherein each of the particular needles has substantially the same length.

9. The apparatus of any of claims 1-7, wherein at least two of the particular needles have a different length.

10. The apparatus of any of claims 1-9, wherein at least one length of at least one of the particular needles extending from a lower surface of the structure is at least about 1 mm.

11. The apparatus of any of claims 1-10, wherein at least one length of at least one of the particular needles extending from a lower surface of the structure is between about 1 mm and about 5 mm.

12. The apparatus of any of claims 1-10, wherein at least one length of at least one of the particular needles extending from a lower surface of the structure is greater than about 5 mm.

13. The apparatus of any of claims 1-12, wherein each of the particular needles is substantially parallel to another one of the particular needles.

14. The apparatus of any of claims 3-7, further comprising at least one optical coupler provided in communication with the optical guides associated with the particular needles.

15. The apparatus of claim 14, wherein the at least one optical coupler is configured to be connected to a source of optical energy, such that the optical energy is directable into the optical guides.

16. The apparatus of any of claims 1-15, wherein the structure comprises a substrate, and wherein the apparatus further comprises a movable plate provided in proximity to the substrate such that the particular needles pass through the movable plate, and wherein a distance between the movable plate and the substrate is modifiable such that at least one
length of the particular needles extending from a lower surface of the movable plate is adjustable to a predetermined value.

17. The apparatus of any of claims 1-16, further comprising a plurality of further needles affixed to the structure, wherein each of the further needles comprises at least one opening proximal to a distal portion of the respective one of the further needles and a passageway that extends from the at least one opening to a proximal portion of the respective one of the further needle.

18. The apparatus of claim 17, wherein each of the further needles is substantially parallel to another one of the further needles.

19. The apparatus of any of claims 17 and/or 18, wherein at least one of the further needles comprises a plurality of openings proximal to the distal portion of the at least one of the further needles.

20. The apparatus of any of claims 17-19, wherein the particular needles and the further needles are configured such that at least one of the further needles is proximal to each of the particular needles.

21. The apparatus of any of claims 17-20, wherein a distal end of each of the particular needles and of the further needles has a form of a sharp point to facilitate an insertion of the particular needles and the further needles into the tissue.

22. The apparatus of any of claims 17-21, wherein the proximal portions of the further needles are configured to communicate with a vacuum source such that a portion of the tissue irradiated by the electromagnetic energy provided using the particular needles is facilitated to be aspirated through passageways of the further needles.
23. The apparatus of any of claims 17-22, further comprising a housing affixed to the structure and an enclosure provided in communication with passageways included in the further needles.

24. The apparatus of claim 23, wherein the enclosure is configured to provide a low pressure in the passageways when a vacuum source is provided in communication with the enclosure.

25. The apparatus of any of claims 17-24, further comprising a vacuum source provided in communication with passageways included in the further needles.

26. The apparatus of claim 25, wherein the vacuum source is configured to provide a low pressure in the passageways associated with the further needles, such that a portion of the tissue proximal to the at least one opening proximal to the distal portions of the further needles that is irradiated by the electromagnetic energy provided by the particular needles is configured to be aspirated through the further needles and removed from a surrounding tissue.

27. The apparatus of any of claims 1-26, wherein the electromagnetic energy is provided by an energy source comprising at least one of a diode laser, a diode-pumped solid state laser, an Er:YAG laser, a Nd:YAG laser, an argon-ion laser, a He-Ne laser, a carbon dioxide laser, an excimer laser, a pulsed dye laser, an intense pulsed light source, a tunable laser, a tungsten lamp, an arc lamp, a flashlamp, and/or a ruby laser.

28. The apparatus of any of claims 1-27, wherein the electromagnetic energy comprises energy having a wavelength in at least one of the ranges of about 900-930 nm, about 1190-1220 nm, about 1700-1730 nm, and/or about 2280-2350 nm.

29. The apparatus of any of claims 27 and/or 28, further comprising the energy source configured to generate the electromagnetic energy.
30. The apparatus of any of claims 1-29, wherein a diameter of each of the particular needles is less than about 1000 µm.

31. The apparatus of any of claims 1-29, wherein a diameter of each of the particular needles is less than about 800 µm.

32. The apparatus of any of claims 1-29, wherein a diameter of each of the particular needles is less than about 500 µm.

33. The apparatus of any of claims 1-32, wherein a diameter of each of the further needles is less than about 1000 µm.

34. The apparatus of any of claims 1-32, wherein a diameter of each of the further needles is less than about 800 µm.

35. The apparatus of any of claims 1-32, wherein a diameter of each of the further needles is less than about 500 µm.

36. The apparatus of any of claims 17-26, wherein a lateral distance between adjacent ones of the particular needles and the further needles is less than about 1 cm.

37. The apparatus of any of claims 17-26, wherein a lateral distance between adjacent ones of the particular needles and the further needles is less than about 8 mm.

38. The apparatus of any of claims 1-37, wherein the electromagnetic energy is has characteristics to heat a portion of the tissue proximal to a portion of the particular needles to a temperature between about 42°C and about 47°C.

39. The apparatus of any of claims 27-29, wherein the energy source is configured to control properties of the electromagnetic energy such that the at least one portion of the tissue proximal to a portion of the particular needles is heated to a temperature between about 42°C and about 47°C.
40. The apparatus of any of claims 1-37, wherein the electromagnetic energy has characteristics to heat a portion of the tissue proximal to distal portions of the particular needles to a temperature between about 45° C and about 60° C.

41. The apparatus of any of claims 27-29, wherein the energy source is configured to control properties of the electromagnetic energy such that the at least one portion of the tissue proximal to a portion of the particular needles is heated to a temperature between about 45° C and about 60° C.

42. The apparatus of any of claims 1-37, wherein the electromagnetic energy has characteristics to heat a portion of the tissue proximal to a portion of the particular needles to a temperature between about 60° C and about 70° C.

43. The apparatus of any of claims 27-29, wherein the energy source is configured to control properties of the electromagnetic energy such that the at least one portion of the tissue proximal to a portion of the particular needles is heated to a temperature between about 60° C and about 70° C.

44. The apparatus according to any of claims 1-43, wherein the particular needles are configured to direct an electromagnetic energy into at least one portion of the tissue proximal to a distal portion of the needles.

45. The apparatus according to any of claims 1-44, further comprising at least one temperature sensing arrangement configured to generate signals based on a temperature of a tissue proximal to at least one of the particular needles, wherein at least one characteristic of the energy provided to at least one of the particular needles is at least one of modified or controlled by the signals.

46. A method comprising:
simultaneously inserting a plurality of particular needles into tissue to be treated to position distal portions of the particular needles proximal to at least one portion of a fatty tissue;

directing electromagnetic energy through the particular needles, such that the electromagnetic radiation irradiates at least one portion of the fatty tissue proximal to the distal portions of the particular needles and generates at least one of a heating and/or a thermal damage to the at least one portion of the fatty tissue.

47. The method of claim 46, wherein at least some of the particular needles are affixed to a structure and are substantially parallel to each further one of the particular needles.

48. The method of any of claims 46 and/or 47, wherein the electromagnetic energy has characteristics such that the at least one portion of the fatty tissue proximal to the distal portions of the particular needles is heated to a temperature of between about 42° C and about 47° C.

49. The method of any of claims 46 and/or 47, wherein the electromagnetic energy has characteristics such that the at least one portion of the fatty tissue proximal to the distal portions of the particular needles is heated to a temperature of between about 45° C and about 60° C.

50. The method of any of claims 46 and/or 47, wherein the electromagnetic energy has characteristics such that the at least one portion of the fatty tissue proximal to the distal portions of the particular needles is heated to a temperature of between about 60° C and about 70° C.

51. The method of any of claims 46-50, further comprising providing a plurality of hollow further needles proximal to the particular needles, and aspirating a particular amount of the irradiated fatty tissue through the hollow further needles.
52. The method of claim 51, wherein a diameter of each of the particular needles and of the hollow further needles is less than about 1000 µm.

53. The method of claim 51, wherein a diameter of each of the particular needles and of the hollow further needles is less than about 800 µm.