helped minimize the "pluggy" appearance of large grafts in the recipient area and left only a linear scar in the donor area rather than a more-obvious buckshot pattern.

Motivated by a desire to obtain the largest number of grafts via the "micrografting" technique, many patients pushed for wider donor strip removal and were subsequently left with relatively large (2-10 mm) linear scars in the occipital (back) portion of their head. This obvious telltale sign of the surgery provided impetus for the development of follicular unit extraction (FUE). In FUE each individual follicular unit is meticulously punched out from the donor area with a small biopsy punch and transplanted into the recipient area. This differs from the original approach to HRS in that FUE involves the transfer of only individual FUs rather than large (4-5mm) punch grafts. This novel technique eliminated the stigma of a linear scar in the donor area and, when done properly, minimized the appearance of a buckshot pattern in the donor area. However, several disadvantages persisted with the advent of FUE: a high percentage (up to 40%) of hairs are transected (thus, limiting their survival), a moth-eaten scarring pattern often remains from where FUs are extracted, and a considerable number of patients (up to 30%) are not candidates for FUE based on their hair characteristics (e.g. light color or considerable curl) that present undue challenges for the surgeon.

OBJECT

It is an object of the present invention to overcome or ameliorate one or more disadvantages of the prior art. It is a further, or alternate object of the present invention to provide a surgical apparatus and/or an endoscopic surgery kit, and/or to at least provide the public with a useful choice.

SUMMARY

In a general aspect, a surgical apparatus includes an elongated member, a dissection module, and an extraction module. The dissection module is removably attachable to a first end of the elongated member and includes a tissue separating device. The extraction module is removably attachable to the first end of the elongated member and includes a suction port and a tissue removal implement disposed within the suction port.

Embodiments may include one or more of the following. The apparatus accepts the first module or the second module interchangeably. The apparatus includes an

imaging system attached to a second end of the elongated member, the imaging system including a light source for illuminating a target through a hollow passage in the elongated member between the first end and the second end; and a viewing port for receiving an image of the target.

Applying the downward force includes rotating the tissue removal implement. The method includes detecting a position of the tissue removal implement relative to an outer surface of the skin.

The method further includes positioning a barrier device within the cavity. The barrier device is configured to restrict the operation of the tissue removal implement to a region defined by the barrier device. The barrier device is configured to maintain the cavity open. The method further includes determining the region defined by the barrier device on the basis of a characteristic of the patient.

The method includes storing the extracted tissue in a reservoir.

In a further general aspect, a method includes creating a cavity below the skin using a tissue separating device attached to the end of an elongated member. The method further includes, from the cavity, performing a tissue alteration procedure on a selected portion of skin tissue superficial to the cavity using a tissue alteration implement attached to the end of the elongated member without altering an outward appearance of the skin.

Embodiments may include one or more of the following.

The selected portion of skin tissue includes a hair follicle.

The tissue alteration procedure includes at least one of irradiation with a laser, cautery, tissue structural alteration, biochemical alteration, application of heat, application of electric current, or application of enzymes. The tissue alteration procedure includes removal, ablation, or destruction of the selected portion of skin tissue.

In one embodiment a method of removing a hair follicle from a selected portion of skin tissue is provided, the method comprising:

using a tissue separating device attached to an end of an elongated member, creating a cavity below the skin; and

from the cavity, performing a tissue alteration procedure on a selected portion of skin tissue superficial to the cavity using a tissue alteration implement attached to the end of the elongated member without altering an outward appearance of the skin.

An endoscopic approach to hair restoration as described herein has a number of advantages. Post-surgical scarring in the donor area is minimized or eliminated because the follicles are approached from beneath the surface of the skin and subsequent FU

removal leaves an intact stratum corneum. Eliminating the large, linear, full-thickness scalp incisions as well as the subsequent tension placed on wound edges upon donor region closure also makes painful, aching, and sharp neuropathic pain from nerve trauma virtually non-existent. These two advantages contribute to the shortened post-operative recovery time required for HRS patients who undergo endoscopic HRS, or piloscopy.

Visualizing the incorporation of the stem-cell containing components of the follicle necessary for self-renewal (e.g. the bulge within the isthmus, the bulb containing dermal papilla, etc.) ensures that no FU are transected as they are removed from the

The layer of separation is converted by humidified insufflation, external traction, or balloon expansion to an enlarged visual cavity in which an operator of endoscope 1 observes the deep structures (e.g., the bulb 214) of each individual follicular unit (FU) in the surgical donor area 106 prior to excising the intact FU from its native surrounding tissue for subsequent transplantation into the surgical recipient area (e.g., regions 102, 110 and 104 of Fig. 1A). Each FU may contain one or more individual hair follicles and can be defined by visualization from below based on the natural-occurring arrangement of the bulb region. An FU may be classified based on its caliber and the quantity of hairs it contains as a single-haired FU, a fine-single-haired FU, a double-haired FU, a fine double-haired FU, a triple-haired FU, or a follicular family containing four or more intact hair follicles.

Referring to Figs. 5A and 5B, cutting blade 10 is attached to a distal end 500 of endoscope 1 and is manipulated by an operator via a hand-held engagement device (e.g., a trigger) 7 at a proximal end 502 of endoscope 1. Cutting blade 10 is typically about 0.5– 6.0 mm in length. Trigger 7 controls cutting blade 10 to move with a rotating motion, facilitating the cutting and separation of soft subcutaneous adipose tissue. When activated, cutting blade 10 advances dissection by pushing forward and downward in a clockwise fashion away from distal end 500 of endoscope 1. In addition to the forward and downward motion that advances cutting blade 10 during dissection, an operating lever ~~including a tape 11, a driver wheel 12, and a steering wheel 13 attached to cutting~~ blade 10 enables a side-to-side sweeping motion of blade 10, which enlarges the plane of dissection. In some embodiments, tape 11 is formed of multiple strips of tape to facilitate the side-to-side sweeping motion of blade 10. Cutting blade 10 is adjustable by the operator of endoscope 1 based on indications presented by the scalp tissue of the patient and the comfort of the operator. The operator of endoscope 1 can control the amount of tissue penetration achieved by each advancement of the endoscope as well as the motion of the cutting blade 10 in the side-to-side, up-and-down, and forwards-backwards directions.

In some embodiments, cutting blade 10 may be replaced by a blunt-ended blade, an electrocautery device, a dispenser of pressurized gas or liquid, a balloon-like

The layer of separation is converted by humidified insufflation, external traction, or balloon expansion to an enlarged visual cavity in which an operator of endoscope 1 observes the deep structures (e.g., the bulb 214) of each individual follicular unit (FU) in the surgical donor area 106 prior to excising the intact FU from its native surrounding tissue for subsequent transplantation into the surgical recipient area (e.g., regions 102, 110 and 104 of Fig. 1A). Each FU may contain one or more individual hair follicles and can be defined by visualization from below based on the natural-occurring arrangement of the bulb region. An FU may be classified based on its caliber and the quantity of hairs it contains as a single-haired FU, a fine-single-haired FU, a double-haired FU, a fine double-haired FU, a triple-haired FU, or a follicular family containing four or more intact hair follicles.

Referring to Figs. 5A and 5B, cutting blade 10 is attached to a distal end 500 of endoscope 1 and is manipulated by an operator via a hand-held engagement device (e.g., a trigger) 7 at a proximal end 502 of endoscope 1. Cutting blade 10 is typically about 0.5– 6.0 mm in length. Trigger 7 controls cutting blade 10 to move with a rotating motion, facilitating the cutting and separation of soft subcutaneous adipose tissue. When activated, cutting blade 10 advances dissection by pushing forward and downward in a clockwise fashion away from distal end 500 of endoscope 1. In addition to the forward and downward motion that advances cutting blade 10 during dissection, an operating lever including a tape 11, a driver wheel 12, and a steering wheel 130 attached to cutting blade 10 enables a side-to-side sweeping motion of blade 10, which enlarges the plane of dissection. In some embodiments, tape 11 is formed of multiple strips of tape to facilitate the side-to-side sweeping motion of blade 10. Cutting blade 10 is adjustable by the operator of endoscope 1 based on indications presented by the scalp tissue of the patient and the comfort of the operator. The operator of endoscope 1 can control the amount of tissue penetration achieved by each advancement of the endoscope as well as the motion of the cutting blade 10 in the side-to-side, up-and-down, and forwards-backwards directions.

In some embodiments, cutting blade 10 may be replaced by a blunt-ended blade, an electrocautery device, a dispenser of pressurized gas or liquid, a balloon-like

donor area. Prior to the start of the procedure, the patient is given appropriate anti-anxiolytic and analgesic medication to ensure comfort throughout the follicle removal process. In addition, a small dose (e.g., 1-3 mL) of local anesthetic may be used at the port of entry in which the initial incision is made and at which closing sutures are ultimately placed.

In some embodiments, FUs may be removed by an enzymatic and/or laser-based approach from within the visual cavity rather than by the cutting approach described above.

In many cases, the endoscope described above also includes additional features including, but not limited to, saline flush capability, electrocautery capability, staple and/or sutering capability, and a provision for lens cleaning.

Although the devices and methods described above are controlled by an operator, robotic or otherwise automatic control of the endoscope is also within the scope of the disclosure.

In an alternative embodiment, a miniaturized version of the endoscope described above may be used for the removal of body hair, e.g., by ablating or killing the hair follicles below the skin surface using methods such as lasers, cautery, heat, electric current, enzymes, or an extraction device.

Although the above-described surgical technique was depicted with respect to the removal of hair follicles, it is to be understood that the technique is broadly applicable and may be used for other surgical applications. The foregoing description is intended to illustrate and not to limit the scope of the invention, which is defined by the scope of the appended claims. Other embodiments are within the scope of the following claims.

Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like, are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense, that is to say, in the sense of "including, but not limited to".

The reference to any prior art in the specification is not, and should not be taken as, an acknowledgement or any form of suggestion that the prior art forms part of the common general knowledge in any country.

WHAT IS CLAIMED IS:

1. A surgical apparatus, comprising:

an elongated member;

a dissection module removably attachable to a first end of the elongated member, the dissection module including a tissue separating device; and

an extraction module removably attachable to the first end of the elongated member, the extraction module including

a suction port, and

a tissue removal implement disposed within the suction port.

2. The surgical apparatus of claim 1, wherein the apparatus accepts the first module or the second module interchangeably.

3. The surgical apparatus of claim 1, further comprising an imaging system attached to a second end of the elongated member, the imaging system including:

a light source for illuminating a target through a hollow passage in the elongated member between the first end and the second end; and

a viewing port for receiving an image of the target.

4. The surgical apparatus of claim 1, wherein the tissue removal implement is disposed concentrically within the suction port.

5. The surgical apparatus of claim 4, wherein the tissue removal implement is hollow.

6. The surgical apparatus of claim 4, wherein the tissue removal implement is substantially cylindrical.

7. The surgical apparatus of claim 1, wherein the tissue removal implement is configured to separate the target region of tissue from surrounding tissue.

8. The surgical apparatus of claim 1, wherein the tissue removal implement includes a plurality of curved cutting devices disposed around a most superficial border of the tissue removal implement.

9. The surgical apparatus of claim 8, wherein the cutting devices include at least one of sharp blades, blunt blades, arms, levers, chemicals, enzymes, or lasers.

10. The surgical apparatus of claim 1, wherein the tissue removal implement is configured to be operated by an operator.

11. The surgical apparatus of claim 1, wherein the tissue removal implement is configured for automatic operation.

12. The surgical apparatus of claim 1, wherein the tissue removal implement includes a plurality of gripping ledges disposed on an inner surface of the tissue removal implement.

13. The surgical apparatus of claim 1, wherein the target region of tissue includes a hair follicle.

14. The surgical apparatus of claim 1, wherein the suction port is configured to apply suction to a target region of tissue.

15. The surgical apparatus of claim 1, wherein the suction port is oriented at an angle to a longitudinal axis of the elongated member.

16. The surgical apparatus of claim 1, wherein the elongated member includes a control mechanism connectable to the tissue separating device or the tissue removal implement.

17. The surgical apparatus of claim 1, wherein the tissue separating device is configured to move relative to the elongated member.

18. The surgical apparatus of claim 1, wherein the extraction module further comprises a sensor configured to detect a structure of the skin.

19. The surgical apparatus of claim 1, wherein the elongated member is rigid.

20. The surgical apparatus of claim 1, wherein the elongated member is flexible.

21. The surgical apparatus of claim 1, wherein the tissue separating device includes at least one of a sharp blade, a blunt blade, a balloon, an electrocautery device, a device that dispenses a pressurized gas or liquid, an enzymatic or chemical tissue separator, and a laser.

22. The surgical apparatus of claim 1, wherein the suction port is in fluid communication with a reservoir that receives a region of tissue extracted by the tissue removal implement

23. An endoscopic surgery kit comprising:

a dissection device for dissecting a cavity below the skin of a patient, comprising

a first elongated member, and

a tissue separating device attached to a first end of the first elongated member; and

an extraction device for insertion into the cavity, comprising

a second elongated member,

a suction port attached to a first end of the second elongated member, and

a tissue removal implement disposed within the suction port.

24. The endoscopic surgery kit of claim 23, wherein the dissection device further comprises an imaging system positioned at a second end of the first elongated member.

25. The endoscopic surgery kit of claim 24, wherein the imaging system includes:

a light source for illuminating a target located at the first end of the first elongated member through a hollow passage in the first elongated member; and

a viewing port for receiving an image of the target.

26. The endoscopic surgery kit of claim 23, wherein the extraction device further comprises an imaging system positioned at a second end of the second elongated member.

27. The endoscopic surgery kit of claim 23, wherein the tissue removal implement is disposed concentrically within the suction port.

28. The endoscopic surgery kit of claim 23, wherein the suction port is oriented at an angle to a longitudinal axis of the second elongated member.

29. The endoscopic surgery kit of claim 23, further comprising a barrier device configured to be positioned within the cavity and to restrict the operation of the extraction device to a region defined by the barrier device.

30. The endoscopic surgery kit of claim 29, wherein the barrier device is configured to maintain the cavity open.

31. The endoscopic surgery kit of claim 29, wherein the region defined by the barrier device is determined on the basis of a characteristic of the patient.

32. The endoscopic surgery kit of claim 23, further comprising a reservoir in fluid communication with the suction port.

33. A method comprising:

using a tissue separating device attached to an end of an elongated member, creating a cavity below the skin of a patient;

from the cavity, performing the steps of:

applying suction to a selected portion of skin tissue superficial to the cavity via a suction port attached to the end of the elongated member;

isolating the selected portion of skin tissue from surrounding tissue using a tissue removal implement disposed within the suction port; and

applying a downward force to the selected portion of skin tissue using the tissue removal implement to extract the selected portion of skin tissue from the surrounding tissue without altering an outward appearance of the skin.

34. The method of claim 33, wherein the selected portion of skin tissue includes a hair follicle and creating a cavity below the skin includes creating a cavity in a plane below the hair follicles.

35. The method of claim 33, wherein the elongated member is an endoscope.

36. The method of claim 35, further comprising selecting the selected portion of skin tissue on the basis of an image obtained through the endoscope.

37. The method of claim 33, further comprising obtaining an image of the selected portion of skin tissue, the image obtained from within the cavity.

38. The method of claim 33, wherein applying the downward force includes rotating the tissue removal implement.

39. The method of claim 33, further comprising detecting a position of the tissue removal implement relative to an outer surface of the skin.

40. The method of claim 33, further comprising positioning a barrier device within the cavity, the barrier device configured to restrict the operation of the tissue removal implement to a region defined by the barrier device

41. The method of claim 40, wherein the barrier device is configured to maintain the cavity open.

42. The method of claim40, further comprising determining the region defined by the barrier device on the basis of a characteristic of the patient.

43. The method of claim 33, further comprising storing the extracted tissue in a reservoir.

44. A method comprising:

using a tissue separating device attached to an end of an elongated member, creating a cavity below the skin; and

from the cavity, performing a tissue alteration procedure on a selected portion of skin tissue superficial to the cavity using a tissue alteration implement attached to the end of the elongated member without altering an outward appearance of the skin.

45. The method of claim 44, wherein the selected portion of skin tissue includes a hair follicle.

46. The method of claim 44, wherein the tissue alteration procedure includes at least one of irradiation with a laser, tissue structural alteration, biochemical alteration, application of heat, application of electric current, or application of enzymes.

47. The method of claim 44, wherein the tissue destruction procedure includes removal, ablation, or destruction of the selected portion of skin tissue.

WHAT IS CLAIMED IS:

1. A surgical apparatus, comprising:

an elongated member;

a dissection module removably attachable to a first end of the elongated member, the dissection module including a tissue separating device; and

an extraction module removably attachable to the first end of the elongated member, the extraction module including

a suction port, and

a tissue removal implement disposed within the suction port.

2. The surgical apparatus of claim 1, wherein the apparatus accepts the dissection module or the extraction module interchangeably.

3. The surgical apparatus of claim 1 or claim 2, further comprising an imaging system attached to a second end of the elongated member, the imaging system including:

a light source for illuminating a target through a hollow passage in the elongated member between the first end and the second end; and

a viewing port for receiving an image of the target.

4. The surgical apparatus of any one of claims 1 to 3, wherein the tissue removal implement is disposed concentrically within the suction port.

5. The surgical apparatus of any one of claims 1 to 4, wherein the tissue removal implement is hollow.

6. The surgical apparatus of any one of claims 1 to 5, wherein the tissue removal implement is substantially cylindrical.

7. The surgical apparatus of any one of claims 1 to 6, wherein the tissue removal implement is configured to separate a target region of tissue from surrounding tissue.

8. The surgical apparatus of any one of claims 1 to 7, wherein the tissue removal implement includes a plurality of curved cutting devices disposed around a most superficial border of the tissue removal implement.

9. The surgical apparatus of claim 8, wherein the cutting devices include at least one of sharp blades, blunt blades, arms, levers, chemicals, enzymes, or lasers.

10. The surgical apparatus of any one of claims 1 to 9, wherein the tissue removal implement is configured to be operated by an operator.

11. The surgical apparatus of any one of claims 1 to 9, wherein the tissue removal implement is configured for automatic operation.

12. The surgical apparatus of any one of claims 1 to 11, wherein the tissue removal implement includes a plurality of gripping ledges disposed on an inner surface of the tissue removal implement.

13. The surgical apparatus of any one of claims 1 to 12, wherein a target region of tissue includes a hair follicle.

14. The surgical apparatus of any one of claims 1 to 13, wherein the suction port is configured to apply suction to a target region of tissue.

15. The surgical apparatus of any one of claims 1 to 14, wherein the suction port is oriented at an angle to a longitudinal axis of the elongated member.

16. The surgical apparatus of any one of claims 1 to 15, wherein the elongated member includes a control mechanism connectable to the tissue separating device or the tissue removal implement.

17. The surgical apparatus of any one of claims 1 to 16, wherein the tissue separating device is configured to move relative to the elongated member.

18. The surgical apparatus of any one of claims 1 to 17, wherein the extraction module further comprises a sensor configured to detect a structure of the skin.

19. The surgical apparatus of any one of claims 1 to 18, wherein the elongated member is rigid.

20. The surgical apparatus of any one of claims 1 to 18, wherein the elongated member is flexible.

21. The surgical apparatus of any one of claims 1 to 20, wherein the tissue separating device includes at least one of a sharp blade, a blunt blade, a balloon, an electrocautery device, a device that dispenses a pressurized gas or liquid, an enzymatic or chemical tissue separator, and a laser.

22. The surgical apparatus of any one of claims 1 to 21, wherein the suction port is in fluid communication with a reservoir that receives a region of tissue extracted by the tissue removal implement

23. An endoscopic surgery kit comprising:

a dissection device for dissecting a cavity below the skin of a patient, comprising

a first elongated member, and

a tissue separating device attached to a first end of the first elongated member; and

an extraction device for insertion into the cavity, comprising

a second elongated member,

a suction port attached to a first end of the second elongated member, and

a tissue removal implement disposed within the suction port.

24. The endoscopic surgery kit of claim 23, wherein the dissection device further comprises an imaging system positioned at a second end of the first elongated member.

25. The endoscopic surgery kit of claim 24, wherein the imaging system includes:

a light source for illuminating a target located at the first end of the first elongated member through a hollow passage in the first elongated member; and

a viewing port for receiving an image of the target.

26. The endoscopic surgery kit of any one of claims 23 to 25, wherein the extraction device further comprises an imaging system positioned at a second end of the second elongated member.

27. The endoscopic surgery kit of any one of claims 23 to 26, wherein the tissue removal implement is disposed concentrically within the suction port.

28. The endoscopic surgery kit of any one of claims 23 to 27, wherein the suction port is oriented at an angle to a longitudinal axis of the second elongated member.

29. The endoscopic surgery kit of any one of claims 23 to 28, further comprising a barrier device configured to be positioned within the cavity and to restrict the operation of the extraction device to a region defined by the barrier device.

30. The endoscopic surgery kit of claim 29, wherein the barrier device is configured to maintain the cavity open.

31. The endoscopic surgery kit of claim 29 or claim 30, wherein the region defined by the barrier device is determined on the basis of a characteristic of the patient.

32. The endoscopic surgery kit of any one of claims 29 to 31, further comprising a reservoir in fluid communication with the suction port.