Systems and Methods for Skin Treatment

RELATED APPLICATIONS

[0001] This application claims priority to and the benefit of U.S. Provisional Patent Application Serial No. 62/756,694, filed November 7, 2018, entitled "Systems and Methods for Skin Treatment," the disclosure of which is incorporated herein by reference in its entirety.

FIELD OF TECHNOLOGY

[0002] The technologies described herein generally relate to systems and methods for treatment of biological tissues.

BACKGROUND

[0003] Many human health issues arise from damage, deterioration, or loss of tissue due to disease, advanced age, and/or injury. These health issues can manifest themselves in a variety of alterations of tissue structure and/or function, including scarring, sclerosis, tightness, and laxity. In aesthetic medicine, elimination of excess tissue and/or skin laxity is an important concern that affects more than 25% of the U.S. population. In a recent survey (September 2015) of 1052 women in the US (ages 35-75), 78% of women surveyed felt that they had sagging skin, and 83% of these women were self-conscious about it. In addition, 86% of women surveyed felt that they had wrinkles.

SUMMARY

[0004] There is a need for improved systems and methods that provide increased effectiveness over currently available minimally-invasive techniques while maintaining convenience, affordability, and accessibility to patients desiring tissue restoration.

[0005] Described herein are technologies, methods, and/or devices for treating skin (e.g., eliminating tissue volume, tightening skin, lifting skin, and/or reducing skin laxity) by selectively excising a plurality of microcores without thermal energy being imparted to surrounding (e.g., non-excised) tissue. The technologies, methods, and/or devices described herein satisfy an unmet need for rapid and safe treatment of skin, including, e.g., faster pretreatment preparation and post-treatment healing times compared to current surgical and thermal treatment methods.

[0006] In an aspect, this disclosure provides an apparatus for producing a cosmetic effect in skin tissue. In some embodiments, the provided apparatus may include a needle hub comprising at least one hollow needle having a distal end for contacting skin and configured to remove a portion of the skin tissue (e.g., a microcore) when the hollow needle is inserted into and withdrawn from the skin

tissue. The apparatus may include a translation and/or actuation mechanism connected to the needle hub to translate and/or actuate the needle hub in one or more directions relative to a surface of the skin tissue. The apparatus may include a spacer to stabilize skin tissue and/or maintain a constant position of the apparatus relative to the surface of the skin tissue.

[0006a] In another aspect, there is provided an apparatus for producing a cosmetic effect in skin tissue, the apparatus comprising: (i) a needle hub comprising at least one hollow needle having a distal end for contacting skin and configured to remove a portion of the skin tissue when the hollow needle is inserted into and withdrawn from the skin tissue, the needle hub comprising: a first lumen having a first end and a second end, wherein the first lumen comprises a lumen of the at least one hollow needle, and wherein the first end of the first lumen is at the distal end of the hollow needle; and a second lumen having a wall, a first end, and a second end, wherein the first lumen is connected to the second lumen such that the second end of the first lumen forms an opening in the wall of the second lumen, and wherein the second end of the second lumen is connected to a fluid conduit such that when low pressure or vacuum is applied to the conduit, low pressure or vacuum is induced in the first lumen and the second lumen, such that fluid is drawn into and through the second lumen through the first end of the second lumen, thereby clearing skin tissue from the first lumen, the apparatus further comprising: (ii) a translation and/or actuation mechanism connected to the needle hub to translate and/or actuate the needle hub in one or more directions relative to a surface of the skin tissue.

[0007] In some embodiments, an apparatus may include a hand piece shell at least partially enclosing the translation and/or actuation mechanism. In some embodiments, a spacer may be attached to the hand piece shell.

[0008] In some embodiments, a needle hub may include a single hollow needle. In some embodiments, a needle hub may include three hollow needles arranged in a row. In some embodiments, a needle hub may include a two dimensional array of needles (e.g., a two-by-two, three-by-two, or three-by-three array).

[0009] In some embodiments, a needle hub may include a first lumen having a first end and a second end. A first lumen may be or may include a lumen of at least one hollow needle and the first end of the first lumen may be at a distal end of the hollow needle.

[0010] In some embodiments, a needle hub may include a second lumen having a wall, a first end, and a second end. A first end of the second lumen may be or may include a fluid intake nozzle. In some embodiments, a first lumen may be connected to a second lumen such that the second end of the first lumen forms an opening in the wall of the second lumen. In some embodiments, each of a first lumen and a second lumen may be substantially straight, and the first lumen may be substantially perpendicular to the second lumen forming a T-junction. In some embodiments, a fluid intake nozzle may be a convergent nozzle.

[0011] In some embodiments, a second end of a second lumen may be connected to a fluid conduit such that when low pressure or (partial) vacuum is applied to the conduit, low pressure or (partial) vacuum is induced in the first lumen and the second lumen, such that fluid is drawn into and through the second lumen through the first end of the second lumen, thereby clearing skin tissue from the first lumen.

[0012] In some embodiments, a provided apparatus may include a translation and/or actuation mechanism including an actuator to displace a needle hub along a z-axis in a direction substantially perpendicular to a surface of skin tissue and substantially parallel to a longitudinal axis of at least one hollow needle. In some embodiments, an actuator may be or include a voice coil. In some embodiments, an apparatus may include a sensing device for detecting a position of a needle hub along a z-axis. In some embodiments, a translation and/or actuation mechanism may include an x/y-stage to translate the needle hub in one or more directions parallel to the surface of the skin. In some embodiments, an apparatus may include a translation and/or actuation mechanism including a rotary stage to rotate the needle hub around the z-axis.

What is claimed is:

1. An apparatus for producing a cosmetic effect in skin tissue, the apparatus comprising:

(i) a needle hub comprising at least one hollow needle having a distal end for contacting skin and configured to remove a portion of the skin tissue (e.g., a microcore) when the hollow needle is inserted into and withdrawn from the skin tissue;

(ii) a translation and/or actuation mechanism connected to the needle hub to translate and/or actuate the needle hub in one or more directions relative to a surface of the skin tissue; and

(iii) a spacer to stabilize and/or maintain a constant position of the apparatus relative to the surface of the skin tissue.

2. The apparatus of claim 1, comprising a hand piece shell at least partially enclosing the translation and/or actuation mechanism.

3. The apparatus of claim 2, wherein the spacer is attached to the hand piece shell.

4. The apparatus of claim 1, wherein the needle hub comprises a single hollow needle.

5. The apparatus of claim 1, wherein the needle hub comprises three hollow needles arranged in a row.

6. The apparatus of claim 1, wherein the needle hub comprises a two dimensional array of needles (e.g., a two-by-two, three-by-two, or three-by-three array).

7. The apparatus of claim 1, wherein the needle hub comprises a first lumen having a first end and a second end, wherein the first lumen comprises a lumen of the at least one hollow needle and wherein the first end of the first lumen is at the distal end of the hollow needle.

8. The apparatus of claim 7, wherein the needle hub comprises a second lumen having a wall, a first end, and a second end, wherein the first end of the second lumen is or comprises a fluid intake nozzle.

9. The apparatus of claim 8, wherein the first lumen is connected to the second lumen such that the second end of the first lumen forms an opening in the wall of the second lumen.

10. The apparatus of claim 9, wherein each of the first lumen and the second lumen are substantially straight, and wherein the first lumen is substantially perpendicular to the second lumen forming a T-junction.

11. The apparatus of claim 7, wherein the fluid intake nozzle is a convergent nozzle.

12. The apparatus of claim 9, wherein the second end of the second lumen is connected to a fluid conduit such that when low pressure or vacuum is applied to the conduit, low pressure or vacuum is induced in the first lumen and the second lumen, such that fluid is drawn into and through the second lumen through the first end of the second lumen, thereby clearing skin tissue from the first lumen.

13. The apparatus of claim 1, wherein the translation and/or actuation mechanism comprises an actuator to displace the needle hub along a z-axis in a direction substantially perpendicular to a surface of the skin tissue and substantially parallel to a longitudinal axis of the at least one hollow needle.

14. The apparatus of claim 13, wherein the actuator is or comprises a voice coil.

15. The apparatus of claim 13, comprising a sensing device for detecting a position of the needle hub along the z-axis.

16. The apparatus of claim 1, wherein the translation and/or actuation mechanism comprises an x/y-stage to translate the needle hub in one or more directions parallel to the surface of the skin.

17. The apparatus of claim 1, wherein the translation and/or actuation mechanism comprises a rotary stage to rotate the needle hub around the z-axis.

18. The apparatus of claim 1, wherein the spacer comprises a device to contact a surface of the skin tissue, and to (a) to maintain a distance and/or position between the apparatus and the skin tissue and/or (b) maintain or increase tension in the skin tissue during treatment compared to the skin tissue not being treated and/or contacted by an apparatus.

19. The apparatus of claim 1, wherein the spacer comprises a frame to contact the surface of the skin tissue, wherein the frame comprises a base, an inner wall, and an outer wall, wherein the base, inner wall, and outer wall form an open channel.

20. The apparatus of claim 19, wherein the channel is configured such that when the frame is placed on the surface of the skin, the surface of the skin, the base, the inner wall, and outer wall form a frame lumen.

21. The apparatus of claim 20, wherein the frame is connected to a fluid conduit such that when low pressure or vacuum is applied to the conduit, low pressure or vacuum is established in the frame lumen, thereby drawing skin tissue toward and/or into the channel.

22. The apparatus of claim 19, wherein the base comprises one or more protrusions.

23. The apparatus of claim 19, wherein the frame is contoured (e.g., wherein the frame is concave).

24. The apparatus of claim 19, wherein the spacer comprises a switch connected to a sensor to detect a position of the apparatus relative to tissue underlying the skin, wherein

(a) when the frame is placed on the surface of the skin and a low pressure or vacuum is applied to the frame, the switch is in a treatment inhibited position, and

(b) when the frame, while the frame is in contact with the surface of the skin after a low pressure or vacuum is applied to the frame, and after the frame is moved in a direction that is substantially perpendicular to and away from the surface of the skin, the switch is in a treatment enabled position;

wherein, when the switch is in the treatment inhibited position, the needle hub is prevented from moving along a z-axis in a direction substantially perpendicular to a surface of the skin tissue and substantially parallel to a longitudinal axis of the at least one hollow needle; and

wherein, when the switch is in the treatment enabled position, the needle hub is moveable along the z-axis.

25. The apparatus of claim 24, wherein the sensor is or comprises a pushrod.

26. A system comprising the apparatus of claim 1, the system comprising a removal system for removing one or more tissue portions from the apparatus.

27. The system of claim 26, wherein the removal system comprises a low pressure source (e.g., a vacuum pump).

28. The system of claim 27, wherein the low pressure source is connected to the needle hub comprising the at least one hollow needle via a first conduit to provide suction in the at least one hollow needle.

29. The system of claim 28, wherein the low pressure source is connected to the spacer via a second conduit to provide suction in the spacer.

30. The apparatus of claim 1, wherein the at least one hollow needle comprises at least a first prong provided at a distal end of the hollow needle for contacting skin, wherein an angle between a lateral side of the first prong and a longitudinal axis of the hollow needle is at least about 20 degrees.

31. The apparatus of claim 30, wherein the at least one hollow needle comprises a second prong at the distal end of the hollow needle.

32. The apparatus of claim 31, wherein the first prong and/or the second prong comprises a flat tip.

33. The apparatus of claim 31, wherein the first prong and/or the second prong comprises an edge.

34. The apparatus of claim 1, wherein an inner diameter of the at least one hollow needle is between about 0.14 mm and 0.84 mm.

35. The apparatus of claim 1, wherein an inner diameter of the at least one hollow needle is between about 0.24 mm and 0.40 mm.

36. The apparatus of claim 1, wherein the at least one hollow needle is configured to extend (i) into the dermal layer, (ii) through the entire dermal layer to the junction of the dermal layer and the subcutaneous fat layer, or (iii) into the subcutaneous fat layer.

37. An apparatus for producing a cosmetic effect in skin tissue, the apparatus comprising:

(i) a needle hub comprising at least one hollow needle having a distal end for contacting skin and configured to remove a portion of the skin tissue when the hollow needle is inserted into and withdrawn from the skin tissue, the needle hub comprising:

a first lumen having a first end and a second end, wherein the first lumen comprises a lumen of the at least one hollow needle, and wherein the first end of the first lumen is at the distal end of the hollow needle; and

a second lumen having a wall, a first end, and a second end, wherein the first lumen is connected to the second lumen such that the second end of the first lumen forms an opening in the wall of the second lumen, and wherein the second end of the second lumen is connected to a fluid conduit such that when low pressure or vacuum is applied to the conduit, low pressure or vacuum is induced in the first lumen and the second lumen, such that fluid is drawn into and through the second lumen through the first end of the second lumen, thereby clearing skin tissue from the first lumen, the apparatus further comprising:

(ii) a translation and/or actuation mechanism connected to the needle hub to translate and/or actuate the needle hub in one or more directions relative to a surface of the skin tissue.

38. The apparatus of claim 37, wherein each of the first lumen and the second lumen are substantially straight, and wherein the first lumen is substantially perpendicular to the second lumen forming a T-junction.