

provide a convenient way to prevent leakage from insertion site, which can lead to discomfort and loss of medicament. This can prolong treatment as well as increase costs associated with the treatment.

[1011] Thus, a need exists for improved devices and methods, which can assist in determining if the needle is at the correct depth, can facilitate injection of the medicament into ocular tissue, and/or can prevent leakage of ocular fluids and/or medicament from the insertion site.

Summary of the Invention

[1012] The embodiments described herein relate generally to the field of ophthalmic therapies and more particularly to the use of a microneedle for delivery and/or removal of a substance, such as a fluid therapeutic agent into and/or from ocular tissues for treatment of the eye.

[1012a] According to a first aspect of the present invention, there is provided an apparatus, comprising: a housing configured to receive a portion of a medicament container; a hub, the hub coupled to the housing and defining a passageway configured to receive a puncture member therethrough, the hub having a distal end surface, the distal end surface of the hub configured to contact a target surface of a target tissue when a substance is conveyed through the puncture member; and an actuation rod, the actuation rod configured to be coupled to the medicament container, the actuation rod and the puncture member collectively configured such that (1) a distal end portion of the actuation rod moves within the medicament container in response to a force on the actuation rod when a distal end portion of the puncture member is disposed within a first region of the target tissue and the actuation rod is coupled to the medicament container, and (2) movement of the distal end portion of the actuation rod within the medicament container in response to the force on the actuation rod is limited when the distal end portion of the puncture member is disposed within a second region of the target tissue and the actuation rod is coupled to the medicament container, the force having a magnitude less than a threshold value.

[1012b] According to a second aspect of the present invention, there is provided an apparatus, comprising: a housing configured to receive a portion of a medicament container; and a hub coupled to the housing, the hub defining a passageway configured to receive a puncture member therethrough, the hub having a convex distal end surface, the distal end

surface of the hub configured to contact a target surface of a target tissue when a substance is conveyed through the puncture member; and an actuation rod at least partially disposed within the medicament container, the medicament container, the actuation rod, and the puncture member collectively configured such that (1) a distal end portion of the actuation rod moves within the medicament container in response to a force on the actuation rod when a distal end portion of the puncture member is disposed within a first region of the target tissue, and (2) movement of the distal end portion of the actuation rod within the medicament container in response to the force on the actuation rod is limited when the distal end portion of the puncture member is disposed within a second region of the target tissue, the force having a magnitude less than a threshold value.

[1012c] According to a third aspect of the present invention, there is provided an apparatus, comprising: a housing configured to receive a portion of a medicament container; a hub coupled to the housing, the hub defining a passageway configured to receive a puncture member therethrough, the hub having a distal end surface, the distal end surface of the hub configured to contact a target surface of a target tissue when a substance is conveyed through the puncture member; and an actuation rod at least partially disposed within the medicament container, the puncture member fixedly coupled to the hub such that the hub moves with the puncture member when the puncture member is moved relative to the target surface, the medicament container, the actuation rod, and the puncture member collectively configured such that (1) a distal end portion of the actuation rod moves within and relative to the medicament container in response to a force on the actuation rod when a distal end portion of the puncture member is disposed within a first region of the target tissue, and (2) movement of the distal end portion of the actuation rod within and relative to the medicament container in response to the force on the actuation rod is limited when the distal end portion of the puncture member is disposed within a second region of the target tissue, the force having a magnitude less than a threshold value.

[1013] In some embodiments, an apparatus includes a housing configured to be coupled to a medicament container. The medicament container is configured to be coupled to a needle. An injection assembly is disposed within the housing and includes an energy storage member and an actuation rod. A distal end portion of the actuation rod is configured to be disposed within the medicament container. The energy storage member is configured to produce a force on a proximal end portion of the actuation rod. The force is sufficient to move the distal end portion of the actuation rod within the medicament container to convey at

least a portion of a substance from the medicament container via the needle when a distal tip of the needle is disposed within a first region of a target location. Furthermore, the force is insufficient to move the distal end portion of the actuation rod within the medicament container when the distal tip of the needle is disposed within a second region of the target location. In some embodiments, the first region of the target location has a first density and the second region of the target location has a second density, higher than the first density. In some embodiments, the first region of the target location produces a first backpressure and the second region of the target location produces a second backpressure, higher than the first backpressure.

[1014] In some embodiments, an apparatus includes a housing configured to receive a portion of a medicament container, and an adjustment member. A proximal end portion of

member is disposed within the second region of the target tissue and the actuation rod is coupled to the medicament container such that the substance is not conveyed to the second region of the target tissue.

11. An apparatus, comprising:

a housing configured to receive a portion of a medicament container; and
a hub coupled to the housing, the hub defining a passageway configured to receive a puncture member therethrough, the hub having a convex distal end surface, the distal end surface of the hub configured to contact a target surface of a target tissue when a substance is conveyed through the puncture member; and

an actuation rod at least partially disposed within the medicament container,
the medicament container, the actuation rod, and the puncture member collectively
configured such that (1) a distal end portion of the actuation rod moves within the medicament
container in response to a force on the actuation rod when a distal end portion of the puncture
member is disposed within a first region of the target tissue, and (2) movement of the distal end
portion of the actuation rod within the medicament container in response to the force on the
actuation rod is limited when the distal end portion of the puncture member is disposed within a
second region of the target tissue, the force having a magnitude less than a threshold value.

12. The apparatus of claim 11, wherein:

the distal end surface of the hub includes a sealing portion configured to define a substantially fluid-tight seal with the target surface when the distal end surface is in contact with the target surface.

13. The apparatus of claim 11, wherein:

the distal end surface of the hub includes a sealing portion configured to define a substantially fluid-tight seal with the target surface when the distal end surface of the hub is in contact with the target surface, the sealing portion being symmetrical about a centerline of the passageway.

14. The apparatus of claim 11, wherein:

the target tissue is an eye and the target surface is any one of a conjunctiva of the eye or a sclera of the eye.

15. The apparatus of claim 14, wherein:

the distal end surface of the hub is configured to deform any one of (1) the conjunctiva of the eye, (2) the sclera of the eye, (3) a choroid of the eye, or (4) a retina of the eye, when the distal end surface of the hub is in contact with the target surface.

16. The apparatus of claim 11, further comprising:

the puncture member, a centerline of the puncture member being substantially normal to a surface line tangent to the hub.

~~17. The apparatus of claim 11, further comprising:~~

~~an actuation rod at least partially disposed within the medicament container,~~

~~the medicament container, the actuation rod, and the puncture member collectively configured such that (1) a distal end portion of the actuation rod moves within the medicament container in response to a force on the actuation rod when a distal end portion of the puncture member is disposed within a first region of the target tissue, and (2) movement of the distal end portion of the actuation rod within the medicament container in response to the force on the actuation rod is limited when the distal end portion of the puncture member is disposed within a second region of the target tissue, the force having a magnitude less than a threshold value.~~

~~1817. The apparatus of claim ~~1711~~, wherein:~~

~~the threshold value is from about 2 N to about 6 N.~~

~~1918. The apparatus of claim ~~1711~~, wherein:~~

~~the target tissue is an eye, the target surface is any one of a conjunctiva of the eye or a sclera of the eye,~~

~~the first region includes at least one of a suprachoroidal space, a lower portion of the sclera, a choroid of the eye, a subretinal space of the eye, or a retina of the eye,~~

~~the second region is an upper portion of a sclera of the eye.~~

~~2019. The apparatus of claim ~~1711~~, wherein:~~

~~the target tissue is an eye and the target surface is a conjunctiva of the eye,~~

~~the distal end surface of the hub being configured to displace the conjunctiva towards a sclera of the eye in response to the force.~~

~~2120. An apparatus, comprising:~~

~~a housing configured to receive a portion of a medicament container;~~

a hub coupled to the housing, the hub defining a passageway configured to receive a puncture member therethrough, the hub having a distal end surface, the distal end surface of the hub configured to contact a target surface of a target tissue when a substance is conveyed through the puncture member; and

an actuation rod at least partially disposed within the medicament container,

the puncture member fixedly coupled to the hub such that the hub moves with the puncture member when the puncture member is moved relative to the target surface,

the medicament container, the actuation rod, and the puncture member collectively configured such that (1) a distal end portion of the actuation rod moves within and relative to the medicament container in response to a force on the actuation rod when a distal end portion of the puncture member is disposed within a first region of the target tissue, and (2) movement of the distal end portion of the actuation rod within and relative to the medicament container in response to the force on the actuation rod is limited when the distal end portion of the puncture member is disposed within a second region of the target tissue, the force having a magnitude less than a threshold value.

2221. The apparatus of claim 2120, wherein:

the distal end surface of the hub includes a sealing portion configured to define a substantially fluid-tight seal with the target surface when the distal end surface is in contact with the target surface.

2322. The apparatus of claim 2120, wherein:

the distal end surface of the hub includes a sealing portion configured to define a substantially fluid-tight seal with the target surface when the distal end surface of the hub is in contact with the target surface, the sealing portion being symmetrical about a centerline of the passageway.

2423. The apparatus of claim 2120, wherein:

the target tissue is an eye and the target surface is any one of a conjunctiva of the eye or a sclera of the eye.

| 2524. The apparatus of claim 2423, wherein:

the distal end surface of the hub is configured to deform any one of (1) the conjunctiva of the eye, (2) the sclera of the eye, (3) a choroid of the eye, or (4) a retina of the eye, when the distal end surface of the hub is in contact with the target surface.

| 2625. The apparatus of claim 2420, wherein:

a centerline of the puncture member is substantially normal to a surface line tangent to the hub.

~~27.~~ The apparatus of claim ~~21~~, further comprising:

~~an actuation rod at least partially disposed within the medicament container,
the medicament container, the actuation rod, and the puncture member collectively
configured such that (1) a distal end portion of the actuation rod moves within and relative to the
medicament container in response to a force on the actuation rod when a distal end portion of the
puncture member is disposed within a first region of the target tissue, and (2) movement of the
distal end portion of the actuation rod within and relative to the medicament container in
response to the force on the actuation rod is limited when the distal end portion of the puncture
member is disposed within a second region of the target tissue, the force having a magnitude less
than a threshold value.~~

~~28~~26. The apparatus of claim ~~27~~20, wherein:

the threshold value is from about 2 N to about 6 N.

~~29~~27. The apparatus of claim ~~27~~20, wherein:

the target tissue is an eye, the target surface is any one of a conjunctiva of the eye or a sclera of the eye,

the first region includes at least one of a suprachoroidal space, a lower portion of the sclera, a choroid of the eye, a subretinal space of the eye, or a retina of the eye,

the second region is an upper portion of a sclera of the eye.

~~30~~28. The apparatus of claim ~~24~~20, wherein:

at least a portion of the distal end surface of the hub has a hemispherical shape.