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CANNULA AND STYLET REVERSER

Abstract

Tissue markers may be implanted percutaneously through a needle into soft tissue to locate a site of a procedure at a later date. A medical implantation device for percutaneously implanting a tissue marker can include a housing extending from a proximal end to a distal end. The device may also include an obturator coupler disposed at the distal end of the housing to couple an obturator to the housing, and a guide track extending from a first track opening disposed at a distal end of the track toward a proximal end of the housing. The device can further include an actuator to be received within the guide track, where the actuator includes a cannula coupler disposed at a distal end of the actuator to couple a cannula to the actuator. The device can also include a latch arm configured to lock a position of the actuator along the guide track.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application claims the benefit of U.S. Provisional Patent Application Ser. No. 63/554,768, filed on Feb. 16, 2024, and entitled "CANNULA AND STYLET REVERSER," which is herein incorporated by reference in its entirety.

BACKGROUND

[0002] Tissue markers or localizers are often implanted within soft tissue, such as breasts, during or after a biopsy or other invasive procedure to allow medical professionals to locate the site of the procedure at a later time. Present methods of implanting tissue markers provide unpredictable marker placement in tissue. Conventional devices currently utilized to implant a marker into soft tissue, include an obturator or stylet that is axially movable through a fixed hollow cannula. Traditionally, the movable obturator is configured to translate within the fixed cannula to contact and push the tissue marker disposed therein through a distal opening of the cannula and into the soft tissue. Such methods lead to unpredictable marker placement, due to the variable local soft tissue forces, blood, and marker features.

[0003] In some disadvantageous instances, presently available implantation devices are incapable of implanting brittle or otherwise fragile medical devices. For example, the force required to push a medical device through the distal opening of the fixed cannula of traditional implantation devices can potentially break delicate medical devices or markers.

[0004] Finally, conventional implantation devices are preloaded with the marking device and operated by a sliding switch that pushes the marking device out of the cannula. There is no capacity for refined deployment of the marking device out of the cannula. As the marking device exits the cannula, the final position of the marking device is dependent on heterogeneous densities in the local tissue environment. A marking device can be deployed from a more traditional introducer (cannula with a sharp stylet), but this requires a practitioner to use two hands to properly implant a medical device, leading to implanting procedures that require multiple practitioners. In many cases, the practitioner implanting the medical device may also require the guidance of an imaging device, such as an ultrasound, to properly implant the medical device in an intended location. In such cases, a single practitioner will simultaneously operate both the implantation device and an imaging device. Present implantation devices that push the marking device out of the cannula do not control for tissue heterogeneity resulting in inaccurate or random positioning of the marking device as it leaves the needle.

[0005] As such, there remains a need for methods and systems to reliably implant medical devices into soft tissue at a predictable location.

SUMMARY OF THE DISCLOSURE

[0006] According to an aspect of the present disclosure, a medical implantation device is provided. The medical implantation device includes a housing, the housing extending from a proximal end to a distal end. The device includes an obturator coupler arranged at the distal end of the housing to couple an obturator to the housing. The device includes a guide track extending along a length from a first track opening at a distal end of the guide track toward a proximal end of the housing. The device includes an actuator to be received within the guide track such that the actuator is translatable along the length of the guide track, the actuator including a cannula coupler arranged at a distal end of the actuator to couple a cannula to the actuator. The device includes a latch arm to lock a position of the actuator along the guide track.

[0007] According to other aspects of the present disclosure, the medical implantation device may include one or more of the following features. The latch arm may be configured to limit translation of the actuator along the length of the guide track. The latch arm may be rotatable about a hinge between a closed position and an open position to selectively permit the actuator to be axially translated relative to the length of the guide track. The actuator may include a first set of teeth. The latch arm may include a second set of teeth configured to mate with the first set of teeth to limit movement of the actuator. The guide track may be shaped to limit rotation of the actuator. The guide track may be integrally formed in the housing. The actuator may include a grip. The obturator coupler may be coaxial with the cannula coupler. When an obturator is coupled to the obturator coupler and a cannula is coupled to the cannula coupler, translation of the actuator towards the proximal end of the housing may cause the obturator to be received within the cannula. The obturator coupler may be integrally formed within the housing. The device may be composed of a light-weight material. The light-weight material may comprise a plastic. The device may be sterilizable and reusable. The cannula coupler may define a washer having a washer slot configured to receive the proximal end of the cannula.

[0008] According to another aspect of the present disclosure, a device for implanting a medical device into a patient is provided. The device includes a housing having a proximal end and a distal end. The device includes an obturator removably coupled to the distal end of the housing. The device includes an actuator slidably coupled to the housing and translatable along the housing parallel to an implantation axis. The device includes a cannula removably coupled to a distal end of the actuator, wherein the cannula is configured to receive the obturator and the medical device, and wherein translation of the actuator causes the cannula to slide over the obturator to release the medical device through a distal opening of the cannula.

[0009] According to other aspects of the present disclosure, the device for implanting a medical device into a patient may include one or more of the following features. The housing may comprise a guide track to receive and retain the actuator. The guide track may be configured to guide translation of the actuator and limit radial movement or rotation of the actuator relative to the implantation axis. The device may further comprise a latch arm configured to lock the actuator and limit axial movement of the actuator relative to the implantation axis. The latch arm may be rotatable about a hinge between a closed position and an open position to selectively permit the actuator to be axially translated relative to the implantation axis. The latch arm may be configured to limit distal movement of the actuator while permitting proximal movement of the actuator. The housing may comprise a housing receiver configured to removably couple a proximal end of the obturator. The housing receiver may comprise an inner volume defined by a first wall and a second wall connected by sidewalls. The obturator may comprise an obturator knob configured to be received and retained by the inner volume of the housing receiver. The obturator knob may be configured to contact the second wall to limit proximal translation of the obturator relative to the housing during operation. The actuator may comprise an actuator receiver configured to removably couple a proximal end of the cannula. The actuator receiver may define a washer having a washer slot configured to receive the proximal end of the cannula. The cannula may comprise a cannula knob configured to be received and retained by the washer slot of the actuator receiver. The medical device may be one of a tissue marker, a localizer, or a radioactive seed. The obturator may be configured to maintain a position of the medical device within the cannula until the actuator is translated to release the medical device through the distal opening of the cannula.

[0010] According to another aspect of the present disclosure, a device for implanting a medical device into a patient is provided. The device includes a housing having a proximal end and a distal end. The device includes an actuator slidably coupled to the housing and translatable along the housing parallel to an implantation axis. The device includes a guide track disposed on the housing and configured to receive and retain the actuator, wherein the guide track is shaped to limit radial movement and rotation of the actuator relative to the implantation axis. The device includes a latch

arm coupled to one of the housing or the actuator, the latch arm being movable between a closed position and an open position, wherein in the closed position, the latch arm engages with the other of the housing or the actuator to limit axial movement of the actuator relative to the implantation axis, and wherein in the open position, the latch arm allows the actuator to translate along the guide track.

[0011] According to other aspects of the present disclosure, the device for implanting a medical device into a patient may include one or more of the following features. The guide track may comprise a pair of rails extending parallel to the implantation axis along a track sidewall of the housing. The latch arm may comprise arm teeth configured to engage with corresponding teeth on the other of the housing or the actuator. The latch arm may be configured to limit distal movement of the actuator while permitting proximal movement of the actuator when in the closed position. The housing may comprise a distal guide opening configured to receive a proximal end of the actuator for assembly of the device. The guide track may comprise a cap opposite a track sidewall, the cap connecting a pair of rails and configured to mitigate radial translation of the actuator relative to the implantation axis. The guide track may comprise a T-shaped cross-section configured to receive a complementary T-shaped portion of the actuator. The latch arm may be biased towards the closed position by a spring mechanism.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. **1** is a perspective view of an implantation device, in accordance with some non-limiting examples of the disclosed subject matter.

[0013] FIG. **2** is a side view of the device of FIG. **1**.

[0014] FIG. **3** is an exploded view of the device of FIG. **1**.

[0015] FIG. **4**A-**4**C are perspective views of the implantation device of FIG. **1** at different extension lengths.

[0016] FIG. **5** is a perspective view of an implantation device, in accordance with some non-limiting examples of the disclosed subject matter.

[0017] FIG. **6** is a front view of the device of FIG. **5**.

[0018] FIG. **7** is a cross-section of the device of FIG. **6**, taken at VI-VI.

[0019] FIG. **8** is a perspective view of the implantation device of FIG. **5** in an extended configuration.

[0020] FIG. **9** is a perspective view of the implantation device of FIG. **5**, including a latch arm in an open position.

[0021] FIG. **10** is a top view of the device of FIG. **5**.

[0022] FIG. **11** is a bottom view of the device of FIG. **5**.

[0023] FIG. **12** is a perspective view of an implantation device, in accordance with some non-limiting examples of the disclosed subject matter.

[0024] FIG. **13** is a perspective view of an implantation device, in accordance with some non-limiting examples of the disclosed subject matter.

[0025] FIG. **14** is a perspective view of an implantation device, in accordance with some non-limiting examples of the disclosed subject matter.

[0026] FIG. **15** is a perspective view of an implantation device having an ergonomic housing, in accordance with some non-limiting examples of the disclosed subject matter.

[0027] FIG. **16** is a side view of an implantation device having an ergonomic housing, in accordance with some non-limiting examples of the disclosed subject matter.

[0028] FIGS. **17**A and **17**B show example configurations of a latch arm for releasably securing an actuator of the implantation device.

[0029] FIGS. **18**A-**18**C show example configurations of an obturator holder and cannula holder, in accordance with some non-limiting examples of the disclosed subject matter.
[0030] FIG. **19** is a method for assembling an insertion device, in accordance with some non-limiting examples of the disclosed subject matter.
[0031] FIG. **20** is a method for inserting a medical device into a patient, in accordance with some non-limiting examples of the disclosed subject matter.
DETAILED DESCRIPTION
[0032] Described herein are systems and methods for precisely implanting a soft tissue marker into a soft tissue of a patient. In accordance with various non-limiting examples, an improved implantation device removes the unpredictability and loss of control of the placement of the marker, as the marker exits a cannula into the tissue of the patient.
[0033] In some non-limiting examples, the implantation device can provide an improved instrument for implanting tissue markers. Additionally or alternately, the implantation device may be configured to implant various other medical devices into patient tissue. As will be described, the implantation device utilizes a fixed obturator, whose distal end contacts and moves a position of a medical device within a cannula. The cannula surrounds the obturator and the medical device and is configured to translate toward a proximal end of the implantation device to release the medical device through a distal cannula opening. The non-limiting example below is provided to illustrate the functionality and methods of use for the improved implantation device. As will be described further below, the improved implantation device can be configured to implant a variety of medical devices into a patient, including but not limited to tissue markers, localizers, radioactive seeds, or any other percutaneously implantable device. It is further noted that the improved implantation device can be used to percutaneously implant medical devices in both human and non-human patients (e.g., dogs, cats, horses, and other animals). The below description is but an example and should not limit the scope of the present disclosure.
[0034] The implantation device includes an obturator, a cannula, a housing, and an actuator. An implantation axis extends through a center of the obturator that is fixedly coupled to a distal end of the housing. The actuator is slidably coupled to the housing, and translatable along the housing parallel to the implantation axis. The obturator and the actuator may be of any length and may therefore be compatible with various lengths of introduces. The cannula is fixedly coupled to a distal end the actuator. During operation, a center of the cannula is aligned with the implantation axis, to allow a lumen of the cannula to receive the obturator. A medical device disposed in the lumen of the cannula can be implanted into a patient by sliding the actuator, and therefore the cannula, relative to the housing (e.g., toward a proximal end of the housing), and causing the obturator to push the medical device along the lumen and through a distal opening of the cannula.
[0035] In some non-limiting examples, the housing includes a guide track, configured to receive and retain the actuator. The guide track can be configured to guide the translation of the actuator, and therefore of the cannula. Furthermore, the guide track may be shaped to limit radial movement or rotation of the actuator, relative to the implantation axis. It is an advantage of the implantation devices described in the present disclosure that limiting the movement of rotation of the actuator prevents or otherwise reduces the implantation axis being offset during a procedure. In this way, inaccurate deployment of the medical device is mitigated because even minor rotations of the actuator, which could otherwise result in compounding errors in the placement of the medical device, are eliminated or otherwise reduced.
[0036] In some non-limiting examples, a latch arm can lock the actuator within the guide track, and limit axial movement of the actuator relative to the implantation axis. The latch arm can be rotatable about a hinge between a closed position and an open position to selectively permit the actuator to be axially translated relative to the implantation axis. In some non-limiting examples, the latch arm can be configured to limit distal movement of the actuator while permitting proximal movement of the actuator.

[0037] In some non-limiting examples, the actuator may include a grip. The grip may allow a user to operate the implantation device with a single hand. For example, the user may move the actuator via the grip using a thumb or other finger of a same hand that is holding the device. The grip may therefore allow an operator to control the implantation of a medical device into a patient with a single hand, ensuring the operator is able to control a secondary device with a free hand.
[0038] In some non-limiting examples, the housing and actuator of the implantation device may be reusable. For example, the housing and actuator may be sterilized using an autoclave or other sterilization methods (e.g., using dry heat, radiation (e.g., exposure to gamma radiation, electron beam radiation, ultraviolet radiation), ethylene oxide (EtO) gas, vaporized hydrogen peroxide, chlorine dioxide gas, vaporized peracetic acid, nitrogen dioxide, or the like), and used for multiple implantation procedures.
[0039] FIG. **1** illustrates a non-limiting example of an implantation device **100** that is configured to implant a medical device **104** (e.g., a tissue marker, localizer, radioactive seed, or other percutaneously implantable device) into a patient. The implantation device **100** may be used by itself or in conjunction with a secondary device (e.g., an imaging device) during an implantation procedure. The implantation device **100** includes a housing **108**, an actuator **112**, an obturator **116**, and a cannula **120**.
[0040] Referring to FIG. **2**, the implantation device **100** may include an implantation axis **124**. During operation an obturator center axis **128** and a cannula center axis **132** may be colinear with the implantation axis **124**. That is, when an obturator **116** and a cannula **120** are arranged within the implantation device, they may be coaxial with each other. Furthermore, in some examples, a housing center axis **136** may be colinear with the implantation axis **124**.
[0041] Referring again to FIG. **1**, the implantation device **100** may include the housing **108** extending from a proximal housing end **140** to a distal housing end **144**. The distal housing end **144** may include a housing receiver **148** configured to receive and retain the obturator **116**. For example, the housing receiver **148** may be configured to removably couple a proximal obturator end **152**. The obturator **116** may be removably coupled from the housing **108**, to allow the housing **108** to be utilized for multiple implantation procedures. The housing receiver **148** may couple the proximal obturator end **152** via a snap-fit coupling, a threading, friction fit, adhesive, Luer taper, Tuohy Borst adapter, or any other suitable coupling arrangement.
[0042] Referring to FIG. **3**, the housing receiver **148** can include an inner volume **156** that may be defined by a first wall **160** and a second wall **164**, connected by sidewalls **168**. In some configurations, the first wall **160** may define a distal end of the housing receiver **148**. Furthermore, the first wall **160** may define the distal housing end **144**. In some configurations, the second wall **164** may be closer to the proximal housing end **140**, than the first wall **160**. Finally, the first wall **160** may be disposed directly opposite the second wall **164**.
[0043] Still referring to FIG. **3**, the inner volume **156** of the housing receiver **148** can be configured to receive the proximal obturator end **152**. The obturator **116** includes an obturator knob **172** coupled to the proximal obturator end **152**. The obturator knob **172**, may be received and retained by the inner volume **156** of the housing receiver **148**. The obturator knob **172** may contact the second wall **164** to limit proximal translation of the obturator **116** relative to the housing **108** during operation. Furthermore, the obturator knob **172** may contact one or more of the sidewalls **168** to limit radial rotation and translation of the obturator **116** relative to the implantation axis **124** during operation.
[0044] The obturator **116** may extend from the obturator knob **172**, through an obturator slot **176** formed in the first wall **160**. The obturator slot **176** may be U-shaped, including an obturator opening **180** that receives the obturator **116**. The obturator slot **176** may define a smaller diameter than the obturator knob **172** to limit distal translation of the obturator **116** relative to the housing **108** during operation. In some non-limiting examples, the obturator slot **176** may taper toward the obturator opening **180**, to provide a snap-fit connection to couple the obturator **116**.

[0045] Still referring to FIG. **3**, one of the sidewalls **168** defining the inner volume **156** may be a removable sidewall **184**. In some non-limiting examples, the removable sidewall **184** may be configured to close the obturator opening **180** of the obturator slot **176**. In such examples, the removable sidewall **184** may therefore ensure that the obturator **116** cannot exit the obturator slot **176** during operation.
[0046] Referring to FIG. **2**, the actuator **112** of the implantation device **100** may be configured to translate axially relative to the implantation axis **124**. In some non-limiting examples, the cannula **120** may be removably coupled to a distal actuator end **188**, to allow the actuator **112** to translate the cannula **120** along the implantation axis **124**.
[0047] Referring again to FIG. **3**, the actuator **112** can include an actuator receiver **192** disposed at the distal actuator end **188**. The actuator receiver **192** may define a washer **196** having a washer slot **200**. The washer slot **200** may be U-shaped, including a cannula opening **204** to receive a proximal cannula end **208**.
[0048] Referring again to FIG. **1**, the cannula **120** includes a cannula knob **212** coupled to the proximal cannula end **208**. As illustrated in FIG. **2**, the cannula knob **212**, may be received and retained by the washer slot **200** of the actuator receiver **192**. In some non-limiting examples, the cannula knob **212** may include a recessed channel. The washer slot **200** may couple the recessed channel to mitigate translation of the cannula **120** relative to the actuator **112** during operation.
[0049] In some non-limiting examples, a diameter of the washer slot **200** may taper toward the cannula opening **204**, to provide a snap-fit connection between the actuator **112** and the cannula knob **212**. Furthermore, in some non-limiting examples, the cannula opening **204** may be closable by a tab **218** that extends across the cannula opening **204**.
[0050] Referring to FIGS. **4**A-**4**C, during operation the actuator **112**, and therefore the cannula **120**, may be translated relative to the housing **108**. The housing **108** may include a guide track **266** configured to guide the translation of the actuator **112**. The guide track **266** may include a distal guide opening **220**. As illustrated in FIG. **4**A, the distal guide opening **220** may be configured to receive a proximal actuator end **224** to assemble the housing **108** and the actuator **112**. The actuator **112** may then be slid within the guide track **266** toward the proximal housing end **140**.
[0051] The guide track **266** may extend from a track sidewall **228** (e.g., one of the sidewalls **168** of the housing **108**), and may be defined by a pair of rails **232**. The pair of rails **232** may extend parallel to the implantation axis **124** along the track sidewall **228**. The guide track **266** may be configured to receive an actuator bar **236**, that extends from the actuator receiver **192**. The actuator bar **236** may slide between the pair of rails **232**, to guide axial translation of the actuator **112** relative to the implantation axis **124**. In some non-limiting examples, the guide track **266** may include a cap **240**, opposite the track sidewall **228**, connecting the pair of rails **232**. The cap **240** may mitigate radial translation or rotation of the actuator **112**, relative to the implantation axis **124**, during operation. In some non-limiting examples, the guide track **266** may include fewer or more rails.
[0052] Still referring to FIGS. **4**A-**4**C, the implantation device **100** is utilized to implant the medical device **104** in a tissue of a patient. The medical device **104** may be received, retained, and transported by a lumen **244** of the cannula **120** that extends from a proximal lumen opening **248** to a distal lumen opening **252**. During operation as the cannula **120** is translated by the actuator **112** along the implantation axis **124** toward the proximal housing end **140**, the proximal lumen opening **248** receives a distal obturator end **256**. As the cannula **120** continues to be translated toward the proximal housing end **140**, the distal obturator end **256** may contact the medical device **104** disposed within the lumen **244** to maintain a position of the medical device **104**, until the proximal translation of the cannula **120** causes the release of the medical device **104** through the distal lumen opening **252**. During insertion of the cannula **120** into a patient (not shown), the cannula **120** may pierce the patient tissue (not shown) and form a cannula pocket (not shown) in the patient tissue. During implantation of the medical device **104** into the patient (not shown), the proximal

translation of the cannula **120** may release the medical device **104** into the resulting cannula pocket (not shown). In such embodiments, the operator of the implantation device **100** can be positive that the medical device **104** will be retained by the resulting cannula pocket in the patient tissue, leading to more accurate and more precise placement of the medical device **104** during implantation.

[0053] In some embodiments, once an implantation procedure is finished, the implantation device **100** may be disassembled. As described above, each of actuator **112**, obturator **116**, and cannula **120** can be removed from the housing **108**. The individual components of the implantation device **100** can selectively be disposed, or cleaned for another implantation procedure. For example, the actuator **112** and the housing **108** can be sterilized using an autoclave or other sterilization technique, before being utilized for another implantation procedure.

[0054] In some non-limiting examples, a locking mechanism may aid the securement of an actuator to a housing. For example, FIGS. **5-11** illustrate another embodiment of an implantation device **500** including an alternate actuator locking mechanism. The implantation device **500** may generally include similar features as the implantation device **500**, including but not limited to a medical device **504**, housing **508**, an actuator **512**, an obturator **516**, a cannula **520**, and an implantation axis **524**. Furthermore, the implantation device **500** may include similar mechanisms to couple the various components together, including a housing receiver **548**, an obturator slot **576**, an obturator knob **572**, an actuator receiver **592**, a washer slot **600**, a cannula knob **612**, an actuator bar **636**, a guide track **566**, and rails **632**. Thus, discussion of the implantation device **100** above can also generally apply to similar components of the implantation device **500**. However, in some aspects, the implantation devices **100** and **500** may differ. In particular, the implantation device **500** includes an alternate guide track and actuator configuration.

[0055] Referring to FIG. **5**, the actuator **512** may include a grip **660** disposed on the actuator bar **636**. During operation, the grip **660** may extend away from the housing **108**. The grip **660** may allow the actuator to be operated by a single finger (e.g., a thumb or index finger). For example, the grip **660** can aid a user to hold the implantation device **500** and translate the actuator **512** utilizing a single hand.

[0056] Referring to FIGS. **5**, **8**, and **9**, the housing **508** may include a latch arm **664**. The latch arm **664** may rotate on a hinge between a closed position (see FIG. **5**) and an open position (see FIGS. **8** and **9**). In the closed position, the latch arm **664** may extend over the guide track **566** to mitigate axial translation of the actuator **512** relative to the implantation axis **524**. As will be described below, the latch arm **664** may couple the actuator **512** via a snap-fit coupling, a teethed coupling, friction coupling, clamp coupling, or any other suitable coupling arrangement. In the open position, the latch arm **664** may not extend over the guide track **566**, or may not engage the actuator **512**, to allow the actuator **512** to freely slide within the guide track **566**.

[0057] Referring to FIG. **7**, the actuator **512** may include a plurality of actuator teeth **668** disposed on the actuator bar **636**, configured to mitigate axial translation of the actuator **512** relative to the implantation axis during operation. When the actuator **512** is properly seated in the guide track **566**, the actuator teeth **668** may extend away from the housing **508**. As illustrated in FIG. **7**, the latch arm **664** may include a plurality of arm teeth **672** configured to mate with the actuator teeth **668**. In the closed position of the latch arm **664**, the arm teeth **672** may mate with the actuator teeth **668** to mitigate axial translation of the actuator **512** relative to the implantation axis **524**. In some non-limiting examples, the mating of the arm teeth **672** and the actuator teeth **668** may mitigate axial translation of the actuator **512** relative to the implantation axis **524**, in a first direction (e.g., in a distal to proximal direction), while allowing the actuator **512** to freely slide along the guide track **566** in the second direction (e.g., opposite the first direction). In other non-limiting examples, the first direction is instead in a proximal to distal direction.

[0058] Referring to FIG. **10**, the guide track **566** may be shaped to mitigate radial translation or rotation of the actuator **512** during operation. For example, the pair of rails **632** may extend from a track sidewall **628** at an oblique angle to form a guide track **566** that tapers in width (e.g., a

distance between the two closest co-radial points on separate rails **632**), as the pair of rails **632** extend from the track sidewall **628**. The pair of rails **632** may extend toward each other at opposite oblique angles to form a triangular cross-sectional shape of the guide track **566**. In some non-limiting examples, the angled rails **632** may not intersect, forming a gap **676** between the pair of rails **632**. In some non-limiting examples, the gap **676** may account for radial projections disposed on the actuator bar **236**, such as the grip **660** and the actuator teeth **668**.

[0059] Still referring to FIG. **10**, in some non-limiting examples, a width of the gap **676** between the pair of rails **632** may be less than a width of the actuator bar **636** to limit radial translation or removal of the actuator **512** from the guide track **566**. In some non-limiting examples, the guide track **566** and the actuator bar **636** may define similar or identical cross-sectional shapes. The similar cross-sectional shapes of the actuator bar **636** and the guide track **566** may help to mitigate radial translation and rotation of the actuator bar relative to the implantation axis **524** during operation.

[0060] Referring to FIG. **11**, a cannula opening **604** of the actuator receiver **592** and an obturator opening **580** of the housing receiver **548** may be oriented in different directions. As described above, during operation the obturator **516** may be disposed within the cannula **520**. Therefore, radially translating or bending the cannula **520** relative to the implantation axis **524** may radially translate or bend the obturator **516** relative to the implantation axis **524**, and vice versa. Accordingly, the differently oriented cannula opening **604** and obturator opening **580** may help to ensure the obturator **516** and the cannula **520** do not decouple from the cannula opening **604** and obturator opening **580**. For example, the cannula **520** translating or bending toward the cannula opening **604** may contact the housing receiver **548** prior to exiting the cannula opening **604**. Similarly, the obturator **516** translating or bending toward the obturator opening **580** may contact the actuator receiver **592** prior to exiting the obturator opening **580**.

[0061] In some non-limiting examples, an alternate locking mechanism may aid the securement of an actuator to a housing. For example, FIGS. **12** and **13** illustrate another embodiment of an implantation device **1000** including an alternate actuator locking mechanism. The implantation device **1000** may generally include similar features as the implantation device **500**, including but not limited to a housing **1008**, an actuator **1012**, an obturator (not illustrated), a cannula (not illustrated), and an implantation axis **1024**. Furthermore, the implantation device **1000** may include similar mechanisms to couple the various components together, including a housing receiver **1048**, an obturator slot **1076**, an obturator knob (not illustrated), an actuator receiver **1092**, a washer slot (not illustrated), a cannula knob (not illustrated), an actuator bar **1136**, a guide track **1166**, and a latch arm **1164**. Thus, discussion of the implantation device **500** above can also generally apply to similar components of the implantation device **1000**. However, in some aspects, the implantation devices **500** and **1000** may differ. In particular, the implantation device **1000** includes an alternate guide track and actuator configuration.

[0062] Referring to FIG. **12**, the rails **1132** of the guide track **1166** may include rail teeth **1180**. The rail teeth **1180** may extend opposite the housing **1008**, and may be configured to engage and hold the actuator **1012** during operation.

[0063] Still referring to FIG. **12**, the actuator **1012** may include the latch arm **1164** extending from the actuator bar **1136**. The latch arm **1164** may include arm teeth **1184** that are configured to engage the rail teeth **1180** during operation. In some non-limiting examples, the latch arm **1164** may be a resilient member. The arm teeth **1184** of the latch arm **1164** may springily engage the rail teeth **1180** to maintain an axial position of the actuator **1012**. The latch arm **1164** may be resiliently deformable to disengage the arm teeth **1184** from the rail teeth **1180**. The latch arm **1164** may be resiliently deformed using a thumb or other finger, to allow an operator to control the actuator **1012** using a single hand, ensuring an operator is able to control a second device with their free hand.

[0064] Referring to FIG. **13**, the latch arm **1164** may instead be rotated about a hinge **1188** to engage and disengage the arm teeth **1184** from the rail teeth **1180**.

[0065] In some non-limiting examples, an alternate locking mechanism may aid the securement of an actuator to a housing guide track. For example, FIGS. **14** illustrate another embodiment of an implantation device **1500** including an alternate actuator locking mechanism. The implantation device **1500** may generally include similar features as the implantation device **1000**, including but not limited to a housing **1508**, an actuator **1512**, an obturator (not illustrated), a cannula (not illustrated), and an implantation axis **1524**. Furthermore, the implantation device **1500** may include similar mechanisms to couple the various components together, including a housing receiver **1548**, an obturator slot **1576**, an obturator knob (not illustrated), an actuator receiver **1592**, a washer slot (not illustrated), a cannula knob (not illustrated), an actuator bar **1636**, a guide track **1666**, and a latch arm **1664**. Thus, discussion of the implantation device **500** above can also generally apply to similar components of the implantation device **1500**. However, in some aspects, the implantation devices **500** and **1500** may differ. In particular, the implantation device **1500** includes an alternate guide track and actuator configuration.
[0066] Referring to FIG. **14**, the latch arm **1664** may be coupled to the guide track **1666** via a hinge **1692**. The hinge **1692** may include a removable pin **1696** to allow the hinge **1692** and the latch arm **1664** to be removed from the housing **1508**. The latch arm **1664** may be rotatable between an open position and a closed position. The latch arm **1664** may include arm teeth **1684** configured to engage the actuator **1512** in the closed position. The arm teeth **1684** may increase friction between the latch arm **1664** and a surface of the actuator **1512**. In the open position of the latch arm **1664**, the actuator **1512** may be free to slide along the guide track **1666**.
[0067] Referring now to FIGS. **15** and **16**, an example implantation device **1700** according to some embodiments is shown. The implantation device **1700** includes a housing **1708**, an actuator **1712**, an obturator **1716**, and a cannula **1720**. In the illustrated example, the housing **1708** of the implantation device **1700** is ergonomically shaped. As such, the housing **1708** may facilitate the user operating the implantation device **1700** with a single hand. For example, the user may hold the housing **1708** comfortably in their hand based on the shape of the housing **1708**, and may then move the actuator **1712** via a latch arm **1764** using a thumb or other finger of the same hand that is holding the implantation device **1700**. The ergonomic shape of the housing **1708** and the positioning of the latch arm **1764** may therefore allow an operator to control the implantation of a medical device into a patient with a single hand, ensuring the operator is able to control a secondary device with a free hand. The ergonomics of the housing **1708** may take into account not only the shape of the housing **1708**, but also the weight and grippability of the housing **1708**. Advantageously, the ergonomics of the housing **1708** can minimize effects downstream at the cannula needle tip that may otherwise affect accurate placement of the medical device.
[0068] In some cases, the size and shape of the housing **1708** may be designed to accommodate different hand sizes. For instance, different housings **1708** may be constructed with different sizes and/or shapes. As a non-limiting example, one version of the housing **1708** may be sized as a "small" size, one version may be sized as a "medium" size, and one version may be sized as a "large" size. Advantageously, the same obturator and cannula hardware components may be used with different sized housing **1708** because the obturator **1716** and cannula **1720** are removably coupled to the housing **1708**. In this way, a hospital or clinical site may have different housings **1708** available for users with different sized hands, and the same sized obturator and cannula hardware could be used with the different sized housings **1708**. Since the housing **1708** may be made to be reusable, the interchangeability of the same obturator and cannula components with different sized housings **1708** is an advantage of the implantation devices described in the present disclosure.
[0069] The latch arm **1764** can lock the actuator **1712** within the guide track **1766**, and limit axial movement of the actuator **1712** relative to the implantation axis. The latch arm **1764** can be rotatable about a hinge between a closed position and an open position to selectively permit the actuator **1712** to be axially translated relative to the implantation axis, as indicated by arrows **1770**.

In some non-limiting examples, the latch arm **1764** can be configured to limit distal movement of the actuator **1712** while permitting proximal movement of the actuator **1712**.

[0070] In some embodiments, such as those illustrated in FIG. **17**A, the latch arm **1764** may include a hinged design (e.g., a flexible hinge) that engages with the guide track **1766** between the closed position and the open position. In the illustrated example, the rails **1732** of the guide track **1766** may include rail teeth **1780** that are arranged on an inner surface of the rails **1732**. The rail teeth **1780** are configured to engage and hold the actuator **1712** during operation. The latch arm **1764** may include corresponding arm teeth **1784** that are configured to engage the rail teeth **1780** during operation. In some non-limiting examples, the latch arm **1764** may be a resilient member. The arm teeth **1784** of the latch arm **1764** may springily engage the rail teeth **1780** to maintain an axial position of the actuator **1712**. The latch arm **1764** may be resiliently deformable to disengage the arm teeth **1784** from the rail teeth **1780**. The latch arm **1764** may be resiliently deformed using a thumb or other finger, to allow an operator to control the actuator **1712** using a single hand, ensuring an operator is able to control a second device with their free hand. By way of example, depressing the latch arm **1764** will disengage the arm teeth **1784** from the rail teeth **1780**, allowing translation of the actuator **1712** within the guide track **1766**. When pressure from the latch arm **1764** is released the latch arm **1764** will spring back to its initial state based on the resilient construction of the latch arm **1764**. As such, the arm teeth **1784** will again engage the rail teeth **1780** to lock the actuator **1712** into place.

[0071] As illustrated in FIG. **17**B, in an alternative configuration the latch arm **1764** may instead be a hinged member that rotates about a pivot **1786**. The latch arm **1764** may have one or more arm teeth **1784** that are configured to engage corresponding rail teeth **1780** on the guide track **1766**. In the illustrated example, the rail teeth **1780** are on the top, outer surface of the guide track **1766**. A spring **1788** biases the latch arm **1764** in its closed position, such that the arm teeth **1784** are engaged with the rail teeth **1780** to secure the actuator **1712** in a locked position. Depressing the latch arm **1764** disengages the arm teeth **1784** from the rail teeth **1780**, thereby permitting translation of the actuator **1712**. When pressure is released from the latch arm **1764**, the spring **1788** again biases the latch arm **1764** in its closed position, such that the arm teeth **1784** again engage the rail teeth **1784** to lock the actuator **1712** into place. Alternatively, in lieu of the rail teeth **1780** a plurality of actuator teeth may be disposed on the actuator bar and configured to mitigate axial translation of the actuator **1712** relative to the implantation axis during operation.

[0072] Referring now to FIGS. **18**A-**18**C, example constructions of an obturator holder **1748** (e.g., obturator coupler, housing receiver) and cannular holder **1792** (e.g., cannula coupler, actuator receiver) that can be implemented in various configurations of the implantation devices described in the present disclosure. As described above, the obturator holder **1748** is coaxial with the cannula holder **1792**.

[0073] The obturator holder **1748** (e.g., obturator coupler, housing receiver) is configured to receive and retain the obturator **1716** in the housing **1708**. For example, the obturator holder **1748** may be configured to removably couple a proximal obturator end. The obturator **1716** may be removably coupled from the housing **1708** to allow the housing **1708** to be utilized for multiple implantation procedures. In the example illustrated in FIG. **18**A, the obturator holder **1748** enables quick attachment of the obturator **1716** to the housing **1708** via a U-shaped slot **1750** formed in the obturator holder **1748**. Additionally, the example construction illustrated in FIG. **18**A provides for self-positioning of the obturator **1716**. In the examples illustrated in FIGS. **18**B and **18**C, the obturator holder **1748** includes a Luer connector **1752**.

[0074] The cannula holder **1792** (e.g., cannula coupler, actuator receiver) is configured to receive and retain the cannula **1720** in the actuator **1712**. For example, the cannula holder **1792** may be configured to removably couple a proximal cannula end. The cannula **1720** may be removably coupled from the actuator **1712** to allow the actuator **1712** to be utilized for multiple implantation procedures. In the example illustrated in FIGS. **18**A and **18**B, the cannula holder **1792** enables

quick attachment of the cannula **1720** to the actuator **1712** via a U-shaped channel **1794** formed in the cannula holder **1792**. The cannula holder **1792** may be integrally formed with the actuator **1712**. In the example illustrated in FIG. **18**C, the cannula holder **1792** includes a Luer connector **1796**.

[0075] Referring now to FIG. **19**, a method **2000** is illustrated for assembling an implantation device, which may include fewer or more steps than depicted. In some embodiments, the following steps are performed in any order. At a first step **2004**, the method **2000** includes providing a housing, an obturator, a cannula, and an actuator. At a second step **2008**, the method **2000** includes coupling the obturator to a housing receiver at a distal end of the housing. At a third step **2012**, the method **2000** includes coupling the cannula to a cannula receiver at a distal end of the actuator. At a fourth step **2016**, the method **2000** includes sliding a proximal end of the actuator into a guide track of the housing. At a fifth step **2020**, the method **2000** includes receiving the obturator into the cannula. At a sixth step **2024**, the method **2000** includes limiting movement of the actuator utilizing a latch arm disposed on the guide track or on the actuator.

[0076] Referring now to FIG. **20**, a method **2500** is illustrated for utilizing an implantation device, which may include fewer or more steps than depicted. In some embodiments, the following steps are performed in any order. At a first step **2504**, the method **2500** includes providing a medical device, a housing, an obturator, a cannula, and an actuator, the obturator fixedly coupled to the housing, the cannula fixedly coupled to the actuator, and the actuator being slidable along the housing. At a second step **2508**, the method includes **2500** inserting the medical device into the cannula. At a third step **2512**, the method **2500** includes advancing the actuator, and the cannula, toward the housing. At a fourth step **2516**, the method **2500** includes sliding the cannula over the obturator. At a fifth step **2520**, the method **2500** includes inserting the cannula, obturator, and medical device into a tissue of a patient. At a sixth step **2528**, the method **2500** includes releasing the medical device from a distal cannula opening into the patient tissue using the obturator. At a seventh step **2524**, the method **2500** includes removing the cannula and obturator from the patient tissue.

[0077] The implantation device described above can be manufactured from any material. Preferably, the implantation device may be light-weight to reduce user fatigue. For example, the implantation device, or components thereof, can be composed of light-weight plastic, polymers, metals, metal alloys, or other materials. As a non-limiting example, the implantation device, or components thereof, can be composed of polyethylene, polypropylene, polyvinyl chloride (PVC), polyethylene terephthalate (PET), polycarbonate, polyurethane, acrylonitrile butadiene styrene (ABS), polymethyl methacrylate (PMMA), polyoxymethylene (POM) or acetal, polytetrafluoroethylene (PTFE), or the like. In some instances, the implantation device, or components thereof, can be manufactured using additive manufacturing techniques, such as 3D printing. In some other examples, the implantation device, or components thereof, can be composed of other materials, including stainless steel, titanium, metal alloys, ceramics, or the like. When using metals and metal alloys, in some cases light-weight metals and/or metal alloys may be used to maintain a lightweight, ergonomic design for the implantation device.

[0078] It is to be understood that the systems and methods described in the present disclosure are not limited in their application to the details of construction and the arrangement of components set forth in the preceding description or illustrated in the drawings. The disclosed systems and methods are capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of “including,” “comprising,” or “having” and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Unless specified or limited otherwise, the terms “mounted,” “connected,” “supported,” and “coupled” and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings. Further,

“connected” and “coupled” are not restricted to physical or mechanical connections or couplings, and may also include fluid and electrical connections.
[0079] One or more embodiments are described and illustrated in the preceding description and accompanying drawings. These embodiments are not limited to the specific details provided herein and may be modified in various ways. Further, other embodiments may exist that are not expressly described herein. Also, functions described as being performed by multiple components may be consolidated and performed by a single component. Similarly, functions described herein as being performed by one component may be performed by multiple components in a distributed manner. Additionally, a component described as performing particular functionality may also perform additional functionality not expressly described herein. For example, a device or structure that is “configured” in a certain way is configured in at least that way, but may also be configured in ways that are not expressly listed.

Claims

1. A medical implantation device, comprising a housing, the housing extending from a proximal end to a distal end; an obturator coupler arranged at the distal end of the housing to couple an obturator to the housing; a guide track extending along a length from a first track opening at a distal end of the guide track toward a proximal end of the housing; an actuator to be received within the guide track such that the actuator is translatable along the length of the guide track, the actuator including a cannula coupler arranged at a distal end of the actuator to couple a cannula to the actuator; and a latch arm to lock a position of the actuator along the guide track.
2. The medical implantation device of claim 1, wherein the latch arm is configured to limit translation of the actuator along the length of the guide track.
3. The device of claim 2, wherein the latch arm is rotatable about a hinge between a closed position and an open position to selectively permit the actuator to be axially translated relative to the length of the guide track.
4. The medical implantation device of claim 1, wherein the actuator includes a first set of teeth and the latch arm includes a second set of teeth configured to mate with the first set of teeth to limit movement of the actuator.
5. The medical implantation device of claim 1, wherein the guide track is shaped to limit rotation of the actuator.
6. The medical implantation device of claim 1, wherein the guide track is integrally formed in the housing.
7. The medical implantation device of claim 1, wherein the obturator coupler is coaxial with the cannula coupler.
8. The medical implantation device of claim 7, wherein when an obturator is coupled to the obturator coupler and a cannula is coupled to the cannula coupler, translation of the actuator towards the proximal end of the housing causes the obturator to be received within the cannula.
9. The medical implantation device of claim 1, wherein the obturator coupler is integrally formed within the housing.
10. The medical implantation device of claim 1, wherein the device is composed of a light-weight material.
11. The medical implantation device of claim 10, wherein the light-weight material comprises a plastic.
12. The medical implantation device of claim 1, wherein the device is sterilizable and reusable.
13. The medical implantation device of claim 1, wherein the cannula coupler defines a washer having a washer slot configured to receive the proximal end of the cannula.
14. A device for implanting a medical device into a patient, comprising: a housing having a proximal end and a distal end; an actuator slidably coupled to the housing and translatable along

the housing parallel to an implantation axis; a guide track disposed on the housing and configured to receive and retain the actuator, wherein the guide track is shaped to limit radial movement and rotation of the actuator relative to the implantation axis; and a latch arm coupled to one of the housing or the actuator, the latch arm being movable between a closed position and an open position, wherein in the closed position, the latch arm engages with the other of the housing or the actuator to limit axial movement of the actuator relative to the implantation axis, and wherein in the open position, the latch arm allows the actuator to translate along the guide track.

15. The device of claim 14, wherein the guide track comprises a pair of rails extending parallel to the implantation axis along a track sidewall of the housing.

16. The device of claim 14, wherein the latch arm comprises arm teeth configured to engage with corresponding teeth on the other of the housing or the actuator.

17. The device of claim 14, wherein the latch arm is configured to limit distal movement of the actuator while permitting proximal movement of the actuator when in the closed position.

18. The device of claim 14, wherein the guide track comprises a cap opposite a track sidewall, the cap connecting a pair of rails and configured to mitigate radial translation of the actuator relative to the implantation axis.

19. The device of claim 14, wherein the latch arm is biased towards the closed position by a spring.

20. A device for implanting a medical device into a patient, comprising: a housing having a proximal end and a distal end; an obturator removably coupled to the distal end of the housing; an actuator slidably coupled to the housing and translatable along the housing parallel to an implantation axis; and a cannula removably coupled to a distal end of the actuator, wherein the cannula is configured to receive the obturator and the medical device, and wherein translation of the actuator causes the cannula to slide over the obturator to release the medical device through a distal opening of the cannula.