CLAIMS

What is claimed is:

1. A recapturable left atrial appendage (LAA) exclusion clip system, comprising:

an LAA exclusion clip comprising:

a first clip strut; and

a second clip strut, at least one of the first and second clip struts having a connector interface comprising a first portion of a lock; and

a delivery device comprising:

a handle comprising a jaw control and a lock control;

an end effector connected to the handle and comprising:

a clevis; and

first and second jaws:

connected to the clevis; and

operatively connected to the jaw control to actively articulate at least one of the first and second jaws with respect to the other, at least one of the first and second jaws having a connector comprising a second portion of the lock operatively connected to the lock control to removably lock with the first portion of the lock, the second portion of the lock being moveable relative to each of the first and second jaws; and

the first and second portions of the lock, the second portion of the lock being moveable relative to each of the first and second jaws having a locked state and being configured:

to unlock the locked state upon actuation of the lock control; and

after having been released, to automatically re-enter the locked state as the first and second portions of the lock are moved back together.

2. The system according to claim 1, wherein:

the connector interface comprises a first internal connector interface and a second internal connector interface;

the first clip strut comprises a first proximal end defining the first internal connector interface;

the second clip strut comprises a second proximal end defining the second internal connector interface;

the connector comprises:

a first internal connector shaped to connect within the first internal connector interface; and

a second internal connector shaped to connect within the second internal connector interface;

the first jaw comprises the first internal connector;

the second jaw comprises the second internal connector; and

one of the first and second internal connectors is longer than the other one of the first and second internal connectors.

3. The system according to claim 2, wherein:

the first internal connector is shaped to connect within either of the first and second internal connector interfaces; and

the second internal connector is shaped to connect within either of the first and the second internal connector interfaces.

4. The system according to claim 1, wherein the at least one of the first and second clip struts has a proximal end defining the connector interface as a hole comprising a lock orifice as the first portion of the lock.

5. The system according to claim 1, wherein one of:

the first clip strut comprises a first proximal end defining a first internal connector interface as a hole, the first portion of the lock being connected to the hole; and

the second clip strut comprises a second proximal end defining a second internal connector interface as a hole, the first portion of the lock being connected to the hole.

6. The system according to claim 1, wherein:

the first clip strut comprises a first proximal end defining a first internal connector interface as a first hole, the first portion of the lock being connected to the first hole;

the second clip strut comprises a second proximal end defining a second internal connector interface as a second hole, the first portion of the lock being connected to the second hole;

the first jaw comprises the connector as a first internal connector:

comprising the second portion of the lock; and

shaped to connect within the first internal connector interface; and

the second jaw comprises the connector as a second internal connector:

comprising the second portion of the lock; and

shaped to connect within the second internal connector interface.

7. The system according to claim 6, wherein the first and second internal connectors have different lengths and are each pivotally connected to the clevis such that, while a longer one of the first and second internal connectors is at least partially inserted within one of the first and second internal connector interfaces, motion of the handle allows a user to passively align a shorter one of the first and second internal connectors into the other one of the first and second internal connector interfaces.

8. The system according to claim 6, wherein the second portion of the lock of each of the first and second internal connectors is:

operatively connected to the lock control; and

configured to unlock with the respective first portion of the lock when the lock control is actuated.

9. The system according to claim 1, wherein:

the connector interface is an internal connector interface;

the connector is an internal connector comprising the second portion of the lock;

at least one of the first and second clip struts comprises a proximal end defining the internal connector interface as a hole, the first portion of the lock being connected to the hole; and

at least one of the first and second jaws:

comprises the internal connector; and

is shaped to connect within the internal connector interface.

10. The system according to claim 1, wherein:

the first and second jaws are each pivotally connected to the clevis;

the first jaw is operatively connected to the jaw control to actively articulate with respect to the clevis; and

the second jaw is operatively connected to the jaw control to actively articulate with respect to the clevis.

11. The system according to claim 10, wherein a first actuation direction of the jaw control causes the first and second jaws to separate from one another and a second actuation direction of the jaw control causes the first and second jaws to move towards one another.

12. The system according to claim 1, wherein the second portion of the lock is shaped to removably lock with the first portion of the lock.

13. The system according to claim 1, wherein the first and second portions of the lock are configured to automatically enter the locked state as the first and second portions of the lock are moved together.

14. The system according to claim 1, further comprising a shaft connecting the end effector to the handle and wherein:

the jaw control comprises a jaw control cord connected to the at least one of the first and second jaws; and

the lock control comprises at least one lock release cord connected to the second portion of the lock.

15. The system according to claim 1, wherein:

the first clip strut has a first tissue-contacting surface;

the second clip strut has a second tissue-contacting surface opposing the first tissue-contacting surface; and

actuation of the jaw control moves the first tissue-contacting surface and the second tissue-contacting surface selectively towards or away from one another in a strut plane.

16. The system according to claim 1, wherein:

the at least one of the first and second clip struts has a proximal end;

the connector interface extends from the proximal end into the at least one of the first and second clip struts and comprises a lock orifice as the first portion of the lock; and

the connector comprises a cord lock as the second portion of the lock , the cord lock being configured to secure removably to the lock orifice.

17. The system according to claim 1, wherein:

an entirety of the LAA exclusion clip defines a transverse cross-sectional circle having a given outer diameter equal to or less than 10 mm; and

the end effector defines a laterally cross-sectional circle having an outer diameter no greater than the given outer diameter.

18. The system according to claim 1, wherein one of:

the second portion of the lock comprises a pin movable with respect to the jaw;

the second portion of the lock comprises a pawl moveable with respect to the jaw; and

the second portion of the lock comprises a pin and a pawl both moveable with respect to the jaw.

19. The system according to claim 1, wherein the connector is pivotally connected to one of the first and second jaws.

20. The system according to claim 1, wherein the connector is two connectors each pivotally connected respectively to one of the first and second jaws.

21. A recapturable external left atrial appendage (LAA) exclusion clip system, comprising:

an LAA exclusion clip comprising:

a first clip strut; and

a second clip strut, at least one of the first and second clip struts having an internal connector interface comprising a first portion of a lock; and

a delivery device comprising:

a handle comprising a jaw control and a lock control;

an end effector connected to the handle and comprising:

a clevis; and

first and second jaws:

connected to the clevis; and

operatively connected to the jaw control to actively articulate at least one of the first and second jaws with respect to the other, at least one of the first and second jaws having a connector comprising a second portion of the lock operatively connected to the lock control to removably lock with the first portion of the lock, the second portion of the lock being moveable relative to each of the first and second jaws; and

the first and second portions of the lock having a locked state and being configured:

to unlock the locked state upon actuation of the lock control; and

after having been released, to automatically re-enter the locked state without actuation of the lock control as the first and second portions of the lock are moved back together.

22. The system according to claim 21, wherein:

at least one of:

the first clip strut comprises a first proximal end defining the internal connector interface as a hole comprising the first portion of the lock; and

the second clip strut comprises a second proximal end defining the internal connector interface as a hole comprising the first portion of the lock;

at least one of:

the first jaw:

comprises the connector as an internal connector comprising the second portion of the lock; and

is shaped to connect within the internal connector interface; and

the second jaw:

comprises the connector as an internal connector comprising the second portion of the lock; and

is shaped to connect within the internal connector interface.

23. The system according to claim 21, wherein:

the first clip strut comprises a first proximal end defining a first internal connector interface as a hole comprising the first portion of the lock;

the second clip strut comprises a second proximal end defining a second internal connector interface as a hole comprising the first portion of the lock;

the first jaw:

comprises the connector as a first internal connector comprising the second portion of the lock; and

is shaped to connect within the first internal connector interface; and

the second jaw:

comprises the connector as a second internal connector comprising the second portion of the lock; and

is shaped to connect within the second internal connector interface; and

the first and second internal connectors have different lengths and are each pivotally connected to the clevis such that, while a longer one of the first and second internal connectors is at least partially inserted within the one of the first and second internal connector interfaces, motion of the handle allows a user to passively align a shorter one of the first and second internal connectors into the other one of the first and second internal connector interfaces.

24. The system according to claim 21, wherein one of:

the second portion of the lock comprises a pin moveable with respect to the jaw;

the second portion of the lock comprises a pawl moveable with respect to the jaw; and

the second portion of the lock comprises a pin and a pawl both moveable with respect to the jaw.

25. The system according to claim 21, wherein the internal connector interface is a hollow within at least one of the first and second clip struts and the connector is shaped to fit within the internal connector interface.

26. The system according to claim 21, wherein the jaw control and the lock control are independently actuatable.

27. A recapturable external left atrial appendage (LAA) exclusion clip system, comprising:

an LAA exclusion clip comprising:

a first clip strut having a first tissue-contacting surface,

a second clip strut having a second tissue-contacting surface opposing the first tissue-contacting surface,

the first and second clip struts shaped to fit on opposing sides of a LAA, each of the first and second clip struts having an internal connector interface, and at least one of the first and second clip struts comprising a first portion of a lock; and

a bias device movably connecting the first and second clip struts together; and

a delivery device comprising:

a handle comprising:

a hollow shaft defining a lumen;

a lock controller having a clip lock cord passing through the lumen; and

a jaw trigger having an end effector cord passing through the lumen;

an end effector attached to the shaft and comprising:

a clevis; and

first and second internal connectors:

operatively connected to the end effector cord to pivot the first and second internal connectors with respect to the clevis, at least one of the first and second internal connectors having a second portion of the lock operatively connected to the clip lock cord and shaped to removably lock with the first portion of the lock, the second portion of the lock being moveable relative to each of the first and second jaws; and

having different lengths and each pivotally connected to the clevis such that, while a longer one of the first and second internal connectors is at least partially inserted within the one of the first and second internal connector interfaces, motion of the handle allows a user to passively align a shorter one of the first and second internal connectors into the other one of the first and second internal connector interfaces;

the first and second portions of the lock having a locked state and being configured:

to unlock upon actuation of the lock controller when locked together; and

after having been released, to automatically re-enter the locked state without actuation of the lock controller as the first and second portions of the lock are moved back together.

28. The system according to claim 27, wherein:

each of the first and second internal connector interfaces comprise the first portion of the lock; and

each of the first and second internal connectors comprise the second portion of the lock to which the respective first portion of the lock secures removably.