Claims

1. An external left atrial appendage (LAA) exclusion clip, comprising:

first and second clip struts separate from one another and each comprising:

a heart-proximate side configured to face an atrium of a heart when the clip struts are implanted on an LAA;

a heart-distal side opposite the heart-proximate side and configured to face away from the atrium when the clip struts are implanted on the LAA;

an LAA tissue-contacting surface;

a bias end;

an open end opposite the bias end;

the first and second clip struts disposed to face the LAA tissue-contacting surfaces towards one another such that:

the bias end of the clip struts together define a bias clip end; and

the open end of the clip struts together define an open clip end opposite the bias clip end;

a bias device comprising:

a first biasing portion:

connecting the first clip strut to the second clip strut;

disposed on an exterior surface of the heart-proximate side of the first and second clip struts; and

crossing over from the first clip strut to the second clip strut along the exterior surface of the heart-proximate side of the first and second clip struts adjacent the bias clip end; and

a second biasing portion:

connecting the first clip strut to the second clip strut;

disposed on an exterior surface of the heart-distal side of the first and second clip struts; and

crossing over from the first clip strut to the second clip strut along the exterior surface of the heart-distal side of the first and second clip struts adjacent the bias clip end.

2. The clip according to claim 1, wherein the first biasing portion is separate from and different from the second biasing portion.

3. The clip according to claims 2, wherein:

the first biasing portion comprises:

a first biasing spring; and

first anchoring portions that connect respectively to the first clip strut and to the second clip strut, the first biasing spring configured to permit movement of the first and second clip struts at least towards and away from one another; and

the second biasing portion comprises:

a second biasing spring; and

second anchoring portions that connect respectively to the first clip strut and to the second clip strut, the second biasing spring configured to permit movement of the first and second clip struts at least towards and away from one another.

4. The clip according to claim 1, wherein the first and second biasing portions are configured to permit yaw movement of the first and second clip struts.

5. The clip according to claim 1, wherein the first and second biasing portions are configured to permit yaw movement of the first clip strut independent of yaw movement of the second clip strut.

6. The clip according to claim 1, wherein:

the first biasing portion connects the first clip strut to the second clip strut to substantially contain movement of the first and second clip struts within a strut plane; and

the second biasing portion connects the first clip strut to the second clip strut to substantially contain movement of the first and second clip struts within the strut plane.

7. The clip according to claim 1, wherein:

the first biasing portion is connected to:

an intermediate position of the first clip strut between the bias and open ends of the first clip strut; and

an intermediate position of the second clip strut between the bias and open ends of the second clip strut; and

the second biasing portion is connected to:

an intermediate position of the first clip strut between the bias and open ends of the first clip strut; and

an intermediate position of the second clip strut between the bias and open ends of the second clip strut.

8. The clip according to claim 1, wherein:

the heart-proximate side of the first clip strut transition at an angle to the LAA tissue-contacting surface of the first clip strut; and

the heart-distal side of the first clip strut transitions at an angle to the LAA tissue-contacting surface of the first clip strut;

the heart-proximate side of the second clip strut transitions at an angle to the LAA tissue-contacting surface of the second clip strut; and

the heart-distal side of the second clip strut transitions at an angle to the tissue-contacting surface of the second clip strut;

the first biasing portion comprises:

a first fastening portion that connects to the first and second clip struts; and

a first spring portion configured to remain on or at a distance from the heart-proximate sides as the clip struts move along a strut plane; and

the second biasing portion comprises:

a second fastening portion that connects to the first and second clip struts; and

a second spring portion configured to remain on or at a distance from the heart-distal sides as the clip struts move along the strut plane.

9. The clip according to claim 1, wherein the first and second clip struts and the bias device together form the clip having a maximum outer width that fits within a laparoscopic port having an interior diameter no greater than approximately 30 French.

10. The clip according to claim 1, wherein:

the first and second clip struts have a maximum longitudinal length;

the first biasing portion has a longitudinal length shorter than the maximum longitudinal length; and

the second biasing portion has a longitudinal length shorter than the maximum longitudinal length.

11. The clip according to claim 1, wherein the first and second clip biasing portions are springs comprising at least one of torsion springs, flat springs, and wire springs.

12. The clip according to claim 1, wherein:

the first clip strut has a first longitudinal axis;

the second clip strut has a second longitudinal axis; and

the first and the second biasing portions balance forces such that the first and second clip struts undergo substantially no rotation about the respective first and second longitudinal axes when the first and second clip struts move in a strut plane.

13. The clip according to claim 1, wherein:

the first clip strut has a first longitudinal axis;

the second clip strut has a second longitudinal axis; and

the first and second biasing portions balance forces such that the first and second clip struts have substantially no torque when the first and second clip struts move in a strut plane.

14. The clip according to claim 1, wherein the first and second clip struts are disposed to face the LAA tissue-contacting surfaces towards one another such that:

the bias ends of the clip struts are adjacent; and

the open ends of the clip struts are adjacent.

15. The clip according to claim 1, wherein the first and second clip struts further comprise a surface opposite the LAA tissue-contacting surface.

~~14~~16. A left atrial appendage (LAA) implantation system comprising:

the clip according to claim 1; and

a delivery device:

removably connected to the bias end of the first and second clip struts; and

configured to move the first and second clip struts in a strut plane.

~~15~~17. A left atrial appendage (LAA) implantation system comprising:

the clip according to claim 1; and

a delivery device:

removably connected to the bias end of the first and second clip struts; and

configured to move the first and second clip struts independently in a strut plane.

~~16~~18. A left atrial appendage (LAA) implantation system comprising:

the clip according to claim 1; and

a delivery device;

the bias end of the first clip strut defines a first proximal opening;

the bias end of the second clip strut defines a second proximal opening; and

the delivery device:

is removably connected to the bias end of the first and second clip struts respectively through the first and second proximal openings; and

is configured to move the first and second clip struts in a strut plane.

~~17~~19. A left atrial appendage (LAA) implantation system comprising:

the clip according to claim 1; and

a delivery device;

the bias end of the first clip strut defines a first proximal opening;

the bias end of the second clip strut defines a second proximal opening; and

the delivery device:

is removably connected only to the bias end of the first and second clip struts respectively through the first and second proximal openings; and

is configured to move the first and second clip struts in a strut plane.

~~18~~20. An external left atrial appendage (LAA) exclusion clip, comprising:

first and second clip struts separate from each other and each comprising:

a heart-proximate side configured to face an atrium of a heart when the clip struts are implanted on an LAA;

a heart-distal side opposite the heart-proximate side and configured to face away from the atrium when the clip struts are implanted on the LAA;

an LAA tissue-contacting surface;

a bias end;

an open end opposite the bias end; and

the first and second clip struts disposed to face the LAA tissue-contacting surfaces towards one another such that:

the bias end of the clip struts together define a bias clip end; and

the open end of the clip struts together define an open clip end opposite the bias clip end;

a first bias device:

connecting the first clip strut to the second clip strut; and

having a first biasing portion:

disposed on an exterior surface of the heart-proximate side of the first and second clip struts; and

crossing over from the first clip strut to the second clip strut along the exterior surface of the heart-proximate side of the first and second clip struts adjacent the bias clip end; and

a second bias device:

different from the first bias device;

connecting the first clip strut to the second clip strut; and

having a second biasing portion:

disposed on an exterior surface of the heart-distal side of the first and second clip struts; and

crossing over from the first clip strut to the second clip strut along the exterior surface of the heart-distal side of the first and second clip struts adjacent the bias clip end.

~~19~~21. An external left atrial appendage (LAA) exclusion clip, comprising:

first and second clip struts separate from one another:

each comprising:

a heart-proximate surface configured to face an atrium of a heart when the clip struts are implanted on an LAA;

a heart-distal surface opposite the heart-proximate surface and configured to face away from the atrium when the clip struts are implanted on the LAA;

an LAA tissue-contacting surface;

a bias end; and

an open end opposite the bias end;

being disposed opposite one another to face the LAA tissue-contacting surfaces towards one another such that:

the bias end of the clip struts together define a bias clip end; and

the open end of the clip struts together define an open clip end opposite the bias clip end;

having a strut movement path between the LAA tissue-contacting surfaces, the strut movement path having a first side and a second side opposite the first side; and

a bias device comprising:

a first biasing portion:

connecting the first clip strut to the second clip strut; ~~and~~

~~crossing over from the first clip strut to the second clip strut;~~

disposed on an exterior surface of the heart-proximate surface of the first and second clip struts; and

crossing over from the first clip strut to the second clip strut along the exterior surface of the heart-proximate surface adjacent the bias clip end and adjacent the first side of the strut movement path; and

a second biasing portion:

different from the first biasing portion;

connecting the first clip strut to the second clip strut;

disposed on an exterior surface of the heart-distal surface of the first and second clip struts; and

crossing over from the first clip strut to the second clip strut along the exterior surface of the heart-distal surface adjacent the bias clip end and adjacent the second side of the strut movement path.

~~20~~22. An external left atrial appendage (LAA) exclusion clip, comprising:

first and second clip struts separate from one another:

each comprising:

a heart-proximate surface configured to face an atrium of a heart when the clip struts are implanted on an LAA;

a heart-distal surface opposite the heart-proximate surface and configured to face away from the atrium when the clip struts are implanted on the LAA;

an LAA tissue-contacting surface;

a bias end; and

an open end opposite the bias end;

being disposed opposite one another to face the LAA tissue-contacting surfaces of the clip struts towards one another such that:

the bias end of the clip struts together define a bias clip end; and

the open end of the clip struts together define an open clip end opposite the bias clip end;

defining a volume between the opposing LAA tissue-contacting surfaces, an extent from one of the LAA tissue-contacting surfaces to the other of the LAA tissue-contacting surfaces defining a strut plane having a first side and a second side opposite the first side; and

a bias device comprising:

a first biasing portion:

connecting the first clip strut to the second clip strut;

disposed on an exterior surface of the heart-proximate surface of the first and second clip struts; and

crossing over from the first clip strut to the second clip strut along the exterior surface of the heart-proximate surface adjacent the bias clip end and adjacent the first side of the strut plane; and

a second biasing portion:

different from the first biasing portion;

connecting the first clip strut to the second clip strut;

disposed on an exterior surface of the heart-distal surface of the first and second clip struts; and

crossing over from the first clip strut to the second clip strut along the exterior surface of the heart-distal surface adjacent the bias clip end and adjacent the second side of the strut plane.

~~21. The clip according to claim 1, wherein the first and second clip struts are disposed to face the LAA tissue-contacting surfaces towards one another such that:~~

~~the bias ends of the clip struts are adjacent; and~~

~~the open ends of the clip struts are adjacent.~~

~~22. The clip according to claim 1, wherein the first and second clip struts further comprise a surface opposite the LAA tissue-contacting surface.~~