DESCRIPTION

TITLE OF INVENTION: AUTOMATIC LIGATURE-CUTTING LIGATION DEVICE

[0001] The present application claims priority of Chinese patent Application No. 202321699038.3, filed on June 30, 2023, the entire contents of which are hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to the technical field of medical devices, and in particular to an automatic ligature-cutting ligation device.

BACKGROUND

[0003] A left atrial appendage (LAA) is a long and narrow tubular blind chamber. The LAA may have an irregular shape with multiple twists and turns. A size of the LAA may be similar to that of a thumb, and an opening size of the LAA may be in a range from 10 mm to 40 mm. The LAA may include abundant pectinate muscles and muscle trabeculae, such that blood flow in the LAA may be prone to vortex formation and reduced velocity, which may cause the LAA to be a common site for thrombus formation.

[0004] A patient with atrial fibrillation (AF) may have a significantly increased risk of stroke. Studies indicate that 60% of cardiogenic thrombi in patients with rheumatic heart disease complicated with the AF come from the LAA, and 91% of strokes caused by non-valvular AF are caused by thrombi in the LAA. Therefore, removing the LAA may help reduce left atrial thrombus and stroke events.

[0005] At present, clinical treatment methods include oral anticoagulant drugs, radiofrequency ablation, percutaneous left atrial appendage closure, and surgical LAA resection. However, regardless of the method, the clinical effect is not very satisfactory.

[0006] Therefore, a LAA ligation is emerged. Accordingly, matching medical devices may also be developed.

[0007] In an existing LAA ligation device, such as Chinese patent Application No. 202110054297.X, when using LAA ligation device, a pre-formed ligature loop may be typically delivered to a target surgical area by utilizing a delivery tool, and an operator may pull the loop to tighten and complete the ligation by applying external hand force. During the

above operation process, a judgment of whether the ligation is completed or firm mainly depends on a visual judgment and hand feeling of an operating doctor, which is prone to an operational error or deviation.

SUMMARY OF THE DISCLOSURE

[0008] A purpose of the present disclosure is to provide an automatic ligature-cutting ligation device, so as to solve the problem in the related art that it is necessary to rely on the visual judgment and hand sensation of the operating doctor when performing a ligation operation by using an existing LAA ligation device, which is prone to an operational error or deviation.

[0009] To solve the above-mentioned technical problem, the purpose of the present disclosure may be achieved by the following technical solutions provided by some embodiments of the present disclosure. An automatic ligature-cutting ligation device may be provided by some embodiments of the present disclosure. The automatic ligature-cutting ligation device includes: a handle assembly, including a first handle and a second handle detachably connected to each other; a catheter assembly, an end of the catheter assembly being connected to the first handle; a snare, disposed at another end of the catheter assembly, where a slit is defined in an inner surface of the snare; a ligature, penetrating the first handle and the catheter assembly, where an end of the ligature is connected to the second handle, another end of the ligature has a loop capable of contracting in a forward direction and stopping in a reverse direction, and the loop is pre-mounted in the snare; and a ligature-cutting assembly, disposed in the second handle; where in a case where the second handle is separated from the first handle and pulled out in a direction away from the first handle, the ligature is driven to pull out in the direction away from the first handle, and the loop is driven to pull out of the snare from the slit to an inner side enclosed by the snare and contract in the forward direction; and in a case where the second handle is separated from the first handle and pulled out in the direction away from the first handle until a preset pulling force is reached, the ligature-cutting assembly is driven to move and cut the ligature.

[0010] In some embodiments, an end of the first handle close to the second handle is spirally interlocked with an end of the second handle close to the first handle, and in a case where the second handle rotates relative to the first handle, the second handle is capable of being separated from or engaged with the first handle.

[0011] In some embodiments, the ligature-cutting assembly includes: a sliding member, slidably mounted in the second handle and capable of sliding along a direction close to the first handle or away from the first handle, where an end of the ligature is connected to the sliding

member; a connecting rod member, mounted in the second handle, where an end of the connecting rod member is connected to the sliding member; an elastic member, an end of the elastic member being connected to an inner side of the second handle, and another end of the elastic member being connected to the sliding member; and a ligature-cutting blade, connected to another end of the connecting rod member; where in a case where the second handle is pulled out in the direction away from the first handle, the ligature is configured to drive the sliding member to slide in the direction close to the first handle, the elastic member is driven to stretch, and the connecting rod member is simultaneously driven to rotate, such that the ligature-cutting blade is driven to rotate towards the ligature; and in a case where the elastic member is stretched to the preset pulling force, the ligature is cut by the ligature-cutting blade.

[0012] In some embodiments, the connecting rod member includes a first connecting rod and a second connecting rod; an end of the first connecting rod is rotatably connected to the sliding member, and another end of the first connecting rod is rotatably connected to an end of the second connecting rod; and a rod arm of the second connecting rod is rotatably connected to an inner wall of the second handle, and the ligature-cutting blade is disposed at another end of the second connecting rod.

[0013] In some embodiments, the second connecting rod includes a first rod portion and a second rod portion connected to each other; and the first rod portion is connected to the first connecting rod, the second rod portion is connected to the ligature-cutting blade, and the first rod portion and the second rod portion are arranged at an angle.

[0014] In some embodiments, a strip-shaped opening is defined on the second handle, the sliding member is arranged with an extension portion, and the extension portion passes through the strip-shaped opening and protrudes beyond a side wall of the second handle; and the extension portion is connected to another end of the elastic member.

[0015] In some embodiments, the extension portion is capable of sliding in the strip-shaped opening, and a length direction of the strip-shaped opening is a sliding direction of the sliding member.

[0016] In some embodiments, the elastic member includes one of a spiral spring and an elastic pull rope.

[0017] In some embodiments, a ligature-cutting base is disposed in the second handle, the ligature-cutting blade is opposite to the ligature-cutting base, and the ligature is placed on the ligature-cutting base; and a V-shaped notch opposite to the ligature-cutting blade is defined on the ligature-cutting base.

[0018] In some embodiments, the catheter assembly includes a heat-shrinkable sleeve, a

flexible catheter, and a connecting tube; an end of the flexible catheter is connected to an end of the first handle away from the second handle; the heat-shrinkable sleeve is covered on a connection part between the flexible catheter and the end of the first handle away from the second handle; and an end of the connecting tube is connected to another end of the flexible catheter, and another end of the connecting tube is connected to the snare.

[0019] In some embodiments, a bone positioning component inside the snare is fabricated from Nitinol shape-memory alloy wire.

[0020] In some embodiments, the snare is a flexible ring with built-in dual channels, and the loop is embedded in an inner channel of the dual channels.

[0021] In some embodiments, a radiopaque tungsten wire is embedded in the snare, and a radiopaque coil spring is disposed in the connecting tube.

[0022] In some embodiments, the second handle includes a grip portion and an engagement portion, the engagement portion is disposed at an end of the grip portion close to the first handle; and in a plane perpendicular to an axial direction of the second handle, a projection of the engagement portion is located within a projection of the grip portion.

[0023] In some embodiments, a first accommodating chamber is defined on the grip portion, a second accommodating chamber is defined on the engagement portion, the second accommodating chamber is in communication with the first accommodating chamber; a through hole is defined on an end surface of the engagement portion away from the first accommodating chamber, and the ligature-cutting assembly is accommodated in the first accommodating chamber; and the end of the ligature away from the snare is configured to sequentially pass through the through hole and the second accommodating chamber, enter the first accommodating chamber, and be connected to the ligature-cutting assembly.

[0024] An automatic ligature-cutting ligation device may be provided in some embodiments of the present disclosure. The automatic ligature-cutting ligation device may include a first handle, a second handle, a catheter assembly, a snare, a ligature, and a ligature-cutting assembly. An end of the catheter assembly may be connected to the first handle, and the snare may be disposed at another end of the catheter assembly. A slit may be defined in an inner surface of the snare. The ligature may penetrate the first handle and the catheter assembly. An end of the ligature may be connected to the second handle, and another end of the ligature may be a loop capable of contracting in a forward direction and stopping in a reverse direction. The loop may be pre-mounted in the snare. The ligature-cutting assembly may be disposed in the second handle. When the second handle may be separated from the first handle and pulled rearward, the ligature may be driven to pull rearward, and the loop is driven to pull out of the snare from

the slit to an inner side enclosed by the snare and contract in the forward direction. When the ligature is pulled rearward until a preset pulling force is reached, the ligature may be automatically cut by the ligature-cutting assembly. In the automatic ligature-cutting ligation device provided in the embodiments of the present disclosure, the ligation operation may be performed by pulling the second handle rearward, and during the above operation process, the ligature-cutting assembly may automatically cut the ligature at a ligature-cutting node. Therefore, it is not necessary to rely on the visual judgment and hand feeling of the operating doctor, thereby reducing the occurrence of manual operation errors or deviations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] In order to more clearly describe the technical solutions in the embodiments of the present disclosure or the related art, the drawings that need to be used in the description of the embodiments or the related art will be briefly described in the following. Apparently, the drawings in the following description are only some embodiments of the present disclosure. For those skilled in the art, other drawings can be obtained based on these drawings without creative work.

[0026] FIG. 1 is a schematic structural view of an automatic ligature-cutting ligation device according to some embodiments of the present disclosure.

[0027] FIG. 2 is a schematic structural view of a handle assembly in a separated state according to some embodiments of the present disclosure.

[0028] FIG. 3 is an inner schematic structural view of a second handle according to some embodiments of the present disclosure.

[0029] FIG. 4 is an exploded structural schematic view of a front end of the automatic ligature-cutting ligation device according to some embodiments of the present disclosure

[0030] Reference signs in drawings: 1, first handle;

2, second handle; 20, grip portion; 28, engagement portion; 201, first accommodating chamber; 202, second accommodating chamber; 203, first limiting shaft; 204, second limiting shaft; 208, through hole; 209, side wall; 21, sliding member; 210, base portion; 211, extension portion; 2111, first extension portion; 2112, second extension portion; 212, fixing pillar; 22, first connecting rod; 221, connecting shaft; 23, second connecting rod; 231, first rod portion; 232, second rod portion; 233, rotational mounting portion; 234, connecting hole; 24, elastic member; 25, ligature-cutting blade; 26, strip-shaped opening; 27, ligature-cutting base;

3, snare; 31, radiopaque tungsten wire;

4, ligature; 41, loop;

5, heat-shrinkable sleeve;

6, flexible catheter;

7, connection tube; 71, radiopaque coil spring.

DETAILED DESCRIPTION

[0031] The technical solutions in the embodiments of the present disclosure will be clearly and completely described below with reference to the drawings in the embodiments of the present disclosure. It is apparent that the described embodiments are a part of the embodiments of the present disclosure rather, than all the embodiments. All other embodiments obtained by those of ordinary skill in the art without creative efforts based on the embodiments in the present disclosure shall fall within the protection scope of the present disclosure.

[0032] It should be understood that in a case where used in the description and the appended claims, terms “comprise/comprising” and “include/including” indicate the presence of the described features, integers, steps, operations, elements, and/or components, but do not exclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or combinations thereof.

[0033] It should also be understood that terms used herein in the description of the embodiments of the present disclosure is for the purpose of describing particular embodiments only and is not intended to limit the embodiments of the present disclosure. As used in the description of the embodiments of the present disclosure and the appended claims, singular forms “a”, “an” and “the” are intended to include plural forms unless the context clearly indicates otherwise.

[0034] It should be further understood that a term “and/or” used in the description of the present disclosure and the appended claims may be referred to any combinations and all possible combinations of one or more of the listed items and include the combinations.

[0035] As shown in FIGS. 1-4, an automatic ligature-cutting ligation device may be provided by some embodiments of the present disclosure. The automatic ligature-cutting ligation device may include a handle assembly, a catheter assembly, a snare 3, and a ligature 4.

[0036] As shown in FIGS. 1-2, the handle assembly may include a first handle 1 and a second handle 2 detachably connected to each other. An end of the catheter assembly may be connected to the first handle 1, and another end of the catheter assembly may be connected to the snare 3. The second handle 2 may be disposed at a side of the first handle 1 away from the snare 3. A receiving channel may be defined in the snare 3, and a slit may be defined in/at an inner surface of the snare 3. The ligature 4 may penetrate the first handle 1 and the catheter assembly. An

end of the ligature 4 may be connected to the second handle 2. Another end of the ligature 4 may be a loop 41, and the loop 41 may be capable of contracting/tightening in a forward direction and stopping in a reverse direction. The expression of "the loop 41 may be capable of contracting in the forward direction and stopping in the reverse direction" may be understood as: the loop 41 may be a unidirectional contraction loop, i.e., the loop 41 may only contract an inner diameter thereof in the forward direction to reduce a snare area of the loop 41, but the loop 41 cannot expand the inner diameter thereof in the reverse direction, so as to prevent the snare area of the loop 41 from increasing. When using the loop 41, the inner diameter of the loop 41 may only be gradually contracted toward the sleeved target tissue in the forward direction, and the inner diameter of the loop 41 may not be expanded in the reverse direction. Therefore, the loop 41 may be firmly sleeved on the target tissue without separating from the target tissue. The target tissue mentioned in the embodiments of the present disclosure may be referred to a tissue to be ligated, such as an external tissue of inverted LAA. The loop 41 may be pre-mounted in the snare 3.

[0037] When the second handle 2 is separated from the first handle 1 and the second handle 2 may be moved/pulled rearward, i.e., pulled away/move in a direction away from the first handle 1 or away from the snare 3, the ligature 4 may be driven to remove/pull rearward, such that the loop 41 may be driven to removed out/pulled out of the snare 3 from the slit to an inner side enclosed by the snare 3 and contract in the forward direction. The inner side of the snare 3 may be also referred to as a side of internal space enclosed by the snare 3.

[0038] A ligature-cutting assembly may be disposed in the second handle 2. When the second handle 2 is separated from the first handle 1 and pulled rearward until a preset action force, such as a pulling force, is reached, the ligature-cutting assembly may be driven to move and cut the ligature 4.

[0039] An operation process of the automatic ligature-cutting ligation device provided by some embodiments of the present disclosure may be described as follows. An end of the catheter assembly connected to the snare 3 may be delivered into a heart through an outer sheath, and the snare 3 may be sleeved on the external tissue of inverted LAA inside a cardiac cavity. Subsequently, the second handle 2 may be rotated to be separated from the first handle 1, and the second handle 2 may be pulled rearward in the direction away from the snare 3, such that the loop 41 may be pulled out of the snare 3 from the slit to the inner side enclosed by the snare 3, and the loop 41 may be contracted on a tissue to be ligated. As an action force, such as a pulling force, applied on the second handle 2 is increased, the action force applied on the second handle 2 may also reach the preset action force when the tissue ligation is completed.

At this time, the ligature-cutting assembly may move under the pulling force and cut the ligature 4, such that an automatic ligature-cutting operation after a ligation operation may be completed.

[0040] In some embodiments, the pulling force required for completing the ligation operation may be measured, and a ligature-cutting node of the ligature-cutting assembly may be designed. In some embodiments, the pulling force required for completing the ligation may be generally about 30 N. When the ligature-cutting assembly is subjected to an action force of about 30 N, such as a pulling force of about 30 N, the ligature-cutting assembly may be driven to move to a position of the ligature 4, such that it may be possible to enable a blade of the ligature-cutting assembly to collide with the ligature 4 to cut the ligature 4. In this way, by pulling the second handle 2 rearward, it may be possible to complete the tissue ligation, and the ligature 4 may also be cut, such that during the operation process, it may be not necessary to rely on the visual judgment and hand feeling of the operating doctor, and thus it may be possible to reduce the errors or deviations caused by manual operation.

[0041] It should be noted that the preset pulling force of 30 N may be selected according to an actual application scenario in some embodiments of the present disclosure, and a specific value of the preset pulling force may be adaptively adjusted according to different situations.

[0042] In some embodiments, a rear end of the first handle 1 may be spirally interlocked with a front end of the second handle 2. When the second handle 2 rotates relative to the first handle 1, the second handle 2 may be capable of being separated from or engaged with the first handle 1. The wording “a front end” of a component may be referred to an end of the component close to the snare 3. The wording “a rear end” of the component may be referred to an end of the component away from the snare 3. Therefore, during the process of using the automatic ligature-cutting ligation device 100 100, the first handle 1 may be usually closer to the snare 3 than the second handle 2, and thus the first handle 1 may also be called as a front-section handle, and the second handle 2 may be called as a rear-section handle.

[0043] In some embodiments, mutually matching buckle structures may be respectively arranged on an inner wall of the rear end of the first handle 1 and an inner wall of the front end of the second handle 2. By rotating the first handle 1 and the second handle 2 relative to each other, the first handle 1 and the second handle 2 may be relatively locked and fixed to implement the locking in a non-use state. In addition, the first handle 1 and the second handle 2 may also be unlocked from each other and pulled after unlocking to implement the quick operation during use. Therefore, only actions of rotation and pulling may be needed during use, and the operation may be simple and convenient.

[0044] In some embodiments, as shown in FIGS. 2-3, the second handle 2 may include a grip portion 20 and an engagement portion 28 connected to each other. The grip portion 20 may be disposed at the rear end of the second handle 2. The grip portion 20 may be a hollow shell and have a first accommodating chamber 201 configured to accommodate the ligature-cutting assembly. The engagement portion 28 may be disposed at the front end of the second handle 2 (i.e., the end of the second handle 2 close to the snare 3 and disposed at an end of the grip portion 20 close to the first handle 1. In some embodiments, in a plane substantially perpendicular to an extending direction of the second handle 2, a projection of the engagement portion 28 may be located within a projection of the grip portion 20. During assembly, the engagement portion 28 may be received in the first handle 1. The engagement portion 28 may have a second accommodating chamber 202. The second accommodating chamber 202 may be in communication with the first accommodating chamber 201, such that the ligature 4 may pass through the first accommodating chamber 201 and the second accommodating chamber 202. A through hole 208 may be defined on an end surface of the engagement portion 28 away from the first accommodating chamber 201. Therefore, an end of the ligature 4 may enter the second accommodating chamber 202 through the through hole 208, enter the first accommodating chamber 201, and be connected to the ligature-cutting assembly.

[0045] As shown in FIG. 3, in some embodiments, the ligature-cutting assembly may include a sliding member 21, a connecting rod member, an elastic member 24, and a ligature-cutting blade 25. The sliding member 21 may be slidably mounted in the second handle 2 and capable of sliding forward/rearward. That is, the sliding member 21 may be slidably mounted in the first accommodating chamber 201 and capable of sliding in a direction close to the engagement portion 28 or away from the engagement portion 28. An end of the ligature 4 may be connected to the sliding member 21. In some embodiments, the ligature 4 may pass through the through hole 208, enter into the second accommodating chamber 202, enter the first accommodating chamber 201, and be connected to the sliding member 21. The connecting rod member may be mounted in the second handle 2, and disposed at a side of the sliding member 21 close to the snare 3. An end of the connecting rod member away from the snare 3 may be connected to the sliding member 21. The ligature-cutting blade 25 may be disposed at another end of the connecting rod member close to the snare 3. The elastic member 24 may be disposed at the side of the sliding member 21 away from the snare 3. An end of the elastic member 24 away from the snare 3 may be connected to the inner wall of the second handle 2. Another end of the elastic member 24 close to the snare 3 may be connected to the sliding member 21. In other words, in a direction from the first handle 1 to the second handle 2, the ligature-cutting blade

25, the connecting rod member, the sliding member 21, and the elastic member 24 may be sequentially arranged in the first accommodating chamber 201.

[0046] When the second handle 2 is pulled rearward, i.e., pulled in a direction away from the snare 3 or away from the first handle 1, the ligature 4 may be configured to drive the sliding member 21 to slide forward, i.e., to drive the sliding member 21 to slide in a direction close to the first handle 1 or close to the snare 3, and the elastic member 24 may be driven to stretch in the direction close to the first handle 1 or close to the snare 3. The ligature 4 may be configured to simultaneously drive the connecting rod member to rotate, so as to enable the ligature-cutting blade 25 to rotate toward the ligature 4. When the elastic member 24 is stretched to the preset pulling force, the ligature-cutting assembly may move to the ligature-cutting node, such that the ligature-cutting blade 25 may rotate to contact the ligature 4 and cut the ligature 4.

[0047] In some embodiments, when the second handle 2 is pulled rearward 1, i.e., pulled in a direction away from the snare 3 or away from the first handle 1, the ligature 4 may exert/generate a forward pulling force on the sliding member 21, such that the sliding member 21 may be driven to move forward. In this way, the connecting rod member may be driven to rotate through a forward movement of the sliding member 21, such that as the connecting rod member rotates, the ligature-cutting blade 25 may be driven to rotate toward the ligature 4. Therefore, when the pulling force applied on the second handle 2 reaches the preset value, the ligature 4 may be cut by the ligature-cutting blade 25.

[0048] In some embodiments, the elastic member 24 may be a spiral spring, an elastic rope, or other structures with a rebound function.

[0049] As shown in FIG. 3, in some embodiments, the connecting rod member may include a first connecting rod 22 and a second connecting rod 23. An end of the first connecting rod 22 may be rotatably connected to the sliding member 21, and another end of the first connecting rod 22 may be rotatably connected to an end of the second connecting rod 23. A rod arm of the second connecting rod 23 may be rotatably connected to the inner wall of the second handle 2. The ligature-cutting blade 25 may be disposed at another end of the second connecting rod 23, and at this time, the elastic member 24 may be stretched. When the automatic ligature-cutting ligation device is in use, the forward movement of the sliding member 21 may push the first connecting rod 22 and the second connecting rod 23 to rotate, so as to drive the ligature-cutting blade 25 to rotate toward the ligature 4. When the automatic ligature-cutting ligation device is not in use, the elastic member 24 may be capable of keeping the sliding member 21 in the reset state, so as to keep the ligature-cutting blade 25 away from the ligature 4, thereby prevent accidental cutting. As shown in FIG. 3, the first connecting rod 22 may include a connecting

shaft 221 disposed at an end of the first connecting rod 22 close to the second connecting rod 23. The second connecting rod 23 may be rotatably connected to the connecting shaft 221. The second connecting rod 23 may include a first rod portion 231 and a second rod portion 232 connected to each other. The first rod portion 231 may be connected to the first connecting rod 22. The second rod portion 232 may be connected to the ligature-cutting blade 25. The first rod portion 231 and the second rod portion 232 may be arranged at an angle. The second connecting rod 23 may further include a rotational/rotary mounting portion 233 connected to the first rod portion 231 and the second rod portion 232. An end of the second rod portion 232 away from the rotational mounting portion 233 may be rotatably/ pivotally connected to the connecting shaft 221. The rotational mounting portion 233 may be rotatably connected to the inner wall of the second handle 2. The ligature-cutting blade 25 may be disposed at the end of the second rod portion 232 away from the rotational mounting portion 233. In some embodiments, the rotational mounting portion 233 may also be referred to as a rod arm of the second connecting rod 23. The second connecting rod 23 may further include a connecting hole 234 defined at an end of the second rod portion 232 close to the first connecting rod 22. The connecting shaft 221 may be rotatably connected to the connecting hole 234, such that the first connecting rod 22 and the second connecting rod 23 may form a linkage structure. In some embodiments, a first limit shaft 203 and a second limit shaft 204 may be arranged at intervals on the inner wall of the second handle 2. The rotational mounting portion 233 may be sleeved on and rotatably connected to the first limit shaft 203. The end of the elastic member 24 away from the snare 3 may be sleeved on the second limit shaft 204. In some embodiments, the first limit shaft 203 and the second limit shaft 204 may be arrange at intervals substantially along the axial direction of the second handle 2, such that the elastic member 24 and the sliding member 21may move linearly along the axial direction of the second handle 2.

[0050] As shown in FIG. 3, in some embodiments, a strip-shaped opening 26 may be defined on the second handle 2. The strip-shaped opening 26 may be defined on a sidewall 209 of the second handle 2. In the plane substantially parallel to the axial direction of the second handle 2, at least a part of the projection of the sliding member 21 may be located within the strip-shaped opening 26, and the sliding member 21 may be capable of sliding in a direction close to the engagement portion 28 or away from the engagement portion 28. An extension portion 211 may be arranged on the sliding member 21. The extension portion 211 may pass through the strip-shaped opening 26 and may protrude beyond the second handle. Another end of the elastic member 24 close to the snare 3 may be connected to the extension portion 211. As shown in FIG. 3, in some embodiments, the sliding member 21 may further include a base

portion 210. The base portion 210 may be disposed at a side of the extension portion 211 away from the strip-shaped opening 26, and may be accommodated in the first accommodating chamber 201. The extension portion 211 may include a first extension portion 2111 and a second extension portion 2112. The first extension portion 2111 may be disposed at a side of the base portion 210 close to the opening 26. The second extension portion 2112 may extend from the first extension portion 2111 in a direction away from the base portion 210. In a plane perpendicular to the plane where the base portion 210 may be located, that is, in the plane substantially parallel to the axial direction of the second handle 2, a projection of the second extension portion 2112 may be located within a projection of the first extension portion 2111. The end of the elastic member 24 close to the snare 3 may be sleeved on the first extension portion 2111. In some embodiments, the sliding member 21 may further include a fixing pillar 212 disposed on a top surface of the base portion 210. An end of the first connecting rod 22 away from the second connecting rod 23 may be sleeved on and rotatably connected to the fixing pillar 212.

[0051] In some embodiments, a length direction of the strip-shaped opening 26 may be substantially parallel to a sliding direction of the sliding member 21. The extension portion 211 may be disposed in the strip-shaped opening 26, such that it may be possible to limit a sliding path of extension portion 211, thereby limiting a sliding path of the elastic member 24. In this way, on one hand, a sliding stroke of the sliding member 21 may be limited, such that it may be possible to limit the maximum pulling force achievable by pulling the second handle 2 backward, thereby ensuring that excessive force does not occur. On the other hand, the extension portion 211 may protrude beyond the second handle 2, such that it may be possible to allow the operating doctor to visually observe a change in the sliding stroke externally, thereby enabling indirect control of the pulling force magnitude during the ligation process and helping to prevent an operational error.

[0052] As shown in FIG. 3, in some embodiments, a ligature-cutting base 27 may be arranged in the second handle 2 and disposed at a side of the grip portion 20 close to the snare 3, such that it may be possible to ensure that the ligature 4 may be rapidly cut by the ligature-cutting blade 25 under the preset pulling force. The ligature-cutting blade 25 may be opposite to the ligature-cutting base 27. The ligature 4 may be placed on the ligature-cutting base 27. A V-shaped notch/groove may be defined on the ligature-cutting base 27 and opposite to the ligature-cutting blade 25. When it is necessary to cut the ligature, the ligature-cutting blade 25 may be capable of rotating to abut against the V-shaped notch, and the ligature 4 may be subjected to greater tension at the V-shaped notch, such that the ligature 4 may be rapidly cut.

In some embodiments, when the ligature-cutting blade 25 rotates to contact the ligature-cutting base 27, for example, when the ligature-cutting blade 25 rotates to contact a V-shaped notch, a node where the ligature 4 contacts the V-shaped notch may be defined as the ligature-cutting node of the ligature-cutting assembly.

[0053] In some embodiments, the ligature-cutting blade 25 may be a hard ceramic blade, and the blade may be hard and sharp, thereby enabling rapid completion of the cutting process. In this way, it may be possible to reduce the risk of over-tightening the loop 41 and scratching cardiac tissue.

[0054] As shown in FIGS. 1, 2, and 4, in some embodiments, the catheter assembly may include a heat-shrinkable sleeve 5, a flexible catheter 6, and a connecting tube 7. An end of the flexible catheter 6 away from the snare 3 may be connected to the front end of the first handle 1 close to the snare 3. A heat-shrinkable sleeve 5 may be covered on a connection part between the flexible catheter 6 and the front end of the first handle 1 close to the snare 3. An end of the connecting tube 7 may be connected to another end of the flexible catheter 6 close to the snare 3. Another end of the connecting tube 7 may be connected to the snare 3. That is, in the direction from the first handle 1 to the second handle 2, the snare 3, the connecting tube 7, the flexible catheter 6, and first handle 1 may be sequentially connected.

[0055] In some embodiments, the flexible catheter 6 may be made of flexible tubing material, which may offer excellent resistance to kinking, fracture, and plastic deformation, such that the flexible catheter 6 may be suitable for various bending scenarios, thereby significantly improving clinical efficiency. The connecting tube 7 may be a metal component, so as to provide sufficient strength at a front end of the handle assembly, thereby ensuring optimal retraction of the loop 41.

[0056] In some embodiments, the snare 3 may be designed with different diameter specifications according to different requirements. The whole snare 3 may be wrapped by a soft thermoplastic polyurethane (TPU) material, such it may be possible to protect a myocardial tissue and reduce accidental injury. A bone positioning component or a skeleton (i.e., the skeleton ring 32) inside the snare 3 may be made of a nitinol memory alloy wire, so as to meet the usage environment or a channel with a narrow or curved condition.

[0057] In some embodiments, the snare 3 may be a flexible ring with built-in dual channels. The dual channels may be disposed externally and internally, and the loop 41 may be embedded in an inner channel of the dual channels.

[0058] As shown in FIG. 4, in some embodiments, a radiopaque tungsten wire 31 may be embedded in an outer channel of the snare 3, and a radiopaque coil spring 71 may be disposed

in the connection tube 7, so as to enhance imaging clarity and prevent an operational error. In this way, it may be possible to enable a position of the snare 3 to be clearly displayed on an imaging module via the radiopaque tungsten wire 31 and the radiopaque coil spring 71, thereby improving operability.

[0059] As described above, this is the specific embodiments of the present disclosure, but the protection scope of the present disclosure is not limited thereto. Any person skilled in the art may easily think of various equivalent modifications or substitutions within the technical scope disclosed in the present disclosure, and these modifications or substitutions should be covered within the protection scope of the present disclosure. Therefore, the protection scope of the present disclosure should be subject to the protection scope of the claims.

CLAIMS

1. An automatic ligature-cutting ligation device, comprising:

a handle assembly, comprising a first handle and a second handle detachably connected to each other;

a catheter assembly, an end of the catheter assembly being connected to the first handle;

a snare, disposed at another end of the catheter assembly, wherein a slit is defined in an inner surface of the snare;

a ligature, penetrating the first handle and the catheter assembly, wherein an end of the ligature is connected to the second handle, another end of the ligature has a loop capable of contracting in a forward direction and stopping in a reverse direction, and the loop is pre-mounted in the snare; and

a ligature-cutting assembly, disposed in the second handle;

wherein in a case where the second handle is separated from the first handle and pulled out in a direction away from the first handle, the ligature is driven to pull out in the direction away from the first handle, and the loop is driven to pull out of the snare from the slit to an inner side enclosed by the snare and contract in the forward direction; and

in a case where the second handle is separated from the first handle and pulled out in the direction away from the first handle until a preset pulling force is reached, the ligature-cutting assembly is driven to move and cut the ligature.

2. The automatic ligature-cutting ligation device as claimed in claim 1, wherein an end of the first handle close to the second handle is spirally interlocked with an end of the second handle close to the first handle, and in a case where the second handle rotates relative to the first handle, the second handle is capable of being separated from or engaged with the first handle.

3. The automatic ligature-cutting ligation device as claimed in claim 1, wherein the ligature-cutting assembly comprises:

a sliding member, slidably mounted in the second handle and capable of sliding in a direction close to the first handle or away from the first handle, wherein an end of the ligature is connected to the sliding member;

a connecting rod member, mounted in the second handle, wherein an end of the connecting rod member is connected to the sliding member;

an elastic member, an end of the elastic member being connected to an inner side of the

second handle, and another end of the elastic member being connected to the sliding member; and

a ligature-cutting blade, connected to another end of the connecting rod member;

wherein in a case where the second handle is pulled out in the direction away from the first handle, the ligature is configured to drive the sliding member to slide in the direction close to the first handle, the elastic member is driven to stretch, and the connecting rod member is simultaneously driven to rotate, such that the ligature-cutting blade is driven to rotate towards the ligature; and

in a case where the elastic member is stretched to the preset pulling force, the ligature is cut by the ligature-cutting blade.

4. The automatic ligature-cutting ligation device as claimed in claim 3, wherein the connecting rod member comprises a first connecting rod and a second connecting rod;

an end of the first connecting rod is rotatably connected to the sliding member, and another end of the first connecting rod is rotatably connected to an end of the second connecting rod; and

a rod arm of the second connecting rod is rotatably connected to an inner wall of the second handle, and the ligature-cutting blade is disposed at another end of the second connecting rod.

5. The automatic ligature-cutting ligation device as claimed in claim 4, wherein the second connecting rod comprises a first rod portion and a second rod portion connected to each other; and

the first rod portion is connected to the first connecting rod, the second rod portion is connected to the ligature-cutting blade, and the first rod portion and the second rod portion are arranged at an angle.

6. The automatic ligature-cutting ligation device as claimed in claim 3, wherein a strip-shaped opening is defined on the second handle, the sliding member is arranged with an extension portion, and

the extension portion passes through the strip-shaped opening and protrudes beyond a side wall of the second handle, and the extension portion is connected to another end of the elastic member.

7. The automatic ligature-cutting ligation device as claimed in claim 6, wherein the extension portion is capable of sliding in the strip-shaped opening, and a length direction of the strip-shaped opening is a sliding direction of the sliding member.

8. The automatic ligature-cutting ligation device as claimed in claim 3, wherein the elastic member comprises one of a spiral spring and an elastic pull rope.

9. The automatic ligature-cutting ligation device as claimed in claim 3, wherein a ligature-cutting base is disposed in the second handle, the ligature-cutting blade is opposite to the ligature-cutting base, and the ligature is placed on the ligature-cutting base; and

a V-shaped notch opposite to the ligature-cutting blade is defined on the ligature-cutting base.

10. The automatic ligature-cutting ligation device as claimed in claim 1, wherein the catheter assembly comprises a heat-shrinkable sleeve, a flexible catheter, and a connecting tube;

an end of the flexible catheter is connected to an end of the first handle away from the second handle;

the heat-shrinkable sleeve is covered on a connection part between the flexible catheter and the end of the first handle away from the second handle; and

an end of the connecting tube is connected to another end of the flexible catheter, and another end of the connecting tube is connected to the snare.

11. The automatic ligature-cutting ligation device as claimed in claim 1, wherein a bone positioning component inside the snare is fabricated from Nitinol shape-memory alloy wire.

12. The automatic ligature-cutting ligation device as claimed in any one of claims 1-11, wherein the snare is a flexible ring with built-in dual channels, and the loop is embedded in an inner channel of the dual channels.

13. The automatic ligature-cutting ligation device as claimed in claim 10, wherein a radiopaque tungsten wire is embedded in the snare, and a radiopaque coil spring is disposed in the connecting tube.

14. The automatic ligature-cutting ligation device as claimed in claim 1, wherein the

second handle comprises a grip portion and an engagement portion, and the engagement portion is disposed at an end of the grip portion close to the first handle; and

in a plane perpendicular to an axial direction of the second handle, a projection of the engagement portion is located within a projection of the grip portion.

15. The automatic ligature-cutting ligation device as claimed in claim 14, wherein a first accommodating chamber is defined on the grip portion, a second accommodating chamber is defined on the engagement portion, and the second accommodating chamber is in communication with the first accommodating chamber;

a through hole is defined on an end surface of the engagement portion away from the first accommodating chamber, and the ligature-cutting assembly is accommodated in the first accommodating chamber; and

the end of the ligature away from the snare is configured to sequentially pass through the through hole and the second accommodating chamber, enter the first accommodating chamber, and be connected to the ligature-cutting assembly.