[006] When using a method that employs a clip to secure sutures, the clip can be delivered by advancing the clip along the suture lines to the area of interest, and then engaging the clip to the sutures such that the clip secures the sutures in place. With the clip thus secured, the excess sutures can be cut and removed from the patient. However, deployment of several suture clips during a procedure can be very time consuming, difficult to accomplish without error, and prone to inconsistent tensioning from one clip to the next. In light of the foregoing, there is presently a need for improved systems for securing sutures with suture clips.

SUMMARY

[007] Disclosed herein are improved suture clip delivery devices that can be loaded with and deliver several suture clips to respective sutures in succession without reloading the device with additional suture clips. Disclosed devices and methods can be useful for securing heart valve repair devices or valve replacement prostheses in or near the heart, for example. The devices and methods can also be used for various other types of surgical procedures. The devices and methods disclosed herein can eliminate the need for suture knots, thus reducing surgical time and exposure. Further, the disclosed devices and methods can improve the ease of implantation because the clinician need not tie knots in the limited space in and around the target anatomy.

[008] An aspect of the present invention provides a suture clip comprising an annular outer body, one or more resiliently deformable flaps that project radially inwardly from the annular outer body and define a suture engagement aperture for frictionally engaging one or more sutures passing therethrough, and one or more tabs projecting radially outwardly from the annular outer body. The suture clip is generally disk-shaped with the outer body, flaps, and tabs being substantially coplanar when the suture clip in its natural configuration. In various embodiments, the one or more tabs project radially outwardly from the outer perimeter of the annular outer body. In some embodiments, the clip includes two or more radially projecting tabs spaced about the outer perimeter of the annular outer body. The suture clip has a resiliently deformed configuration when mounted on the delivery device, wherein the one or more resiliently deformable flaps are deflected out of a plane defined by the annular outer body and the one or more tabs, such that the suture engagement aperture enlarges sufficiently to receive a mandrel of the device.

[009] Another aspect of the present invention provides a device for successively deploying a plurality of preloaded suture clips onto sutures, comprising a proximal handle portion including an actuation mechanism and a shaft portion including a mandrel loaded with plural suture clips. The mandrel has an inner lumen for receiving sutures, a proximal end

portion coupled to the actuation mechanism, and a distal end portion having a distal opening in communication with the inner lumen. The mandrel defines an axial dimension extending between the distal end portion and the proximal end portion, and a radial dimension perpendicular to the axial dimension. The mandrel is configured to receive at least one suture extending through the distal opening and into the inner lumen. A plurality of annular suture clips are mounted around the distal end portion of the mandrel. The plurality of annular suture clips are generally disk shaped and have a diameter oriented in the radial dimension of the shaft portion and a thickness oriented in the axial dimension of the shaft portion, wherein the thickness is substantially smaller than the diameter.

[010] The actuation mechanism causes the mandrel to move proximally relative to the suture clips, such that a distal-most one of the suture clips slides off of a distal end of the mandrel and onto one or more sutures extending into the distal opening of the mandrel. After the distal-most one of the suture clips is deployed onto one or more sutures, the actuation mechanism causes the mandrel and a remaining portion of the suture clips to move distally relative to the handle portion such that a distal-most one of the remaining portion of the suture clips is ready to be successively deployed.

[011] The shaft portion can also include a retainer positioned at least partially around the mandrel and coupled to the actuation mechanism independently of the mandrel. The retainer is configured to restrict the suture clips from moving proximally relative to the handle portion when the mandrel moves proximally relative to the handle portion. The actuation mechanism causes the retainer to rotate relative to the mandrel and the suture clips. This rotation can cause cutting of the one or more sutures and/or can free the suture clips to move distally along with the mandrel relative to the handle portion.

[012] The retainer can include at least one axially extending slot that includes a plurality of circumferentially extending notches. The radially extending tabs on the suture clips can project into the axially extending slot in the retainer and can be positioned in respective ones of the circumferentially extending notches. The retainer can have a first rotational position wherein the suture clip tabs are positioned in the notches, such that axial motion of the suture clips relative to the retainer is restricted, and the retainer can have a second rotational position wherein the suture clip tabs are not positioned in the notches and the suture clips are allowed to move axially relative to the retainer. In the second position, the clips can move distally along with the mandrel to reset the device after each suture clip deployment.

[013] In some embodiments, the shaft portion includes an electrical heating element positioned at a distal end of the mandrel and the heating element is configured to cut a suture after a suture clip is deployed onto the suture. The heating element can be coupled to a switch in the handle portion that is activated for a short time when the actuator is depressed.

[013a] Yet another aspect of the present invention provides a method for deploying a suture clip onto a suture, comprising causing a free end of a suture to enter into a distal end portion of an inner lumen of a mandrel of a suture clip deployment device, and causing the mandrel to move proximally relative to a plurality of annular suture clips mounted around an outer surface of the mandrel such that a distal-most one of the suture clip slides distally off of a distal end of the mandrel and onto the suture such that the distal-most one of the suture clips resiliently secures to the suture. The plurality of annular suture clips are generally disk shaped and are mounted around the outer surface of the mandrel such that a diameter of each suture clip is oriented perpendicular to the proximal motion of the mandrel and a thickness of each suture clip is aligned with the proximal motion of the mandrel, wherein the thickness is substantially smaller than the diameter.