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United States Patent	12390218
Kind Code	B2
Date of Patent	August 19, 2025
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Clip for eye muscle surgery

Abstract

An extraocular muscle clip (**22**) for correcting strabismus includes upper and lower plates (**24, 26**) which are couplable together to sandwich and grasp extraocular muscle (**42**). A delivery tool (**50**) delivers the clip (**22**) and includes a shaft (**52**) and a muscle hook (**56**) that is slidable underneath the extraocular muscle (**42**) to position the lower plate (**26**) of the clip (**22**) underneath the muscle (**42**). An integrated blade (**60**) of the tool (**50**) cuts the extraocular muscle (**42**) subsequently to grasping of the muscle (**42**) by the upper and lower plates (**24, 26**) of the clip (**22**). One or more sutures (**30**) are coupled to the upper plate (**24**) and/or the lower plate (**26**) of the clip (**22**) and facilitate recoupling of the extraocular muscle (**42**) to a globe of the eye (**40**) following cutting of the extraocular muscle (**42**). Other embodiments are also described.

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Appl. No.: **18/035203**

Filed (or PCT Filed): **November 09, 2021**

PCT No.: **PCT/IL2021/051323**

PCT Pub. No.: **WO2022/101899**

PCT Pub. Date: May 19, 2022

Prior Publication Data

Document Identifier	Publication Date
US 20230414216 A1	Dec. 28, 2023

Related U.S. Application Data

us-provisional-application US 63112675 20201112

Publication Classification

Int. Cl.: **A61F9/007** (20060101); **A61B17/064** (20060101); **A61B17/08** (20060101); **A61B17/10** (20060101); A61B17/00 (20060101); A61B17/06 (20060101); A61B17/3211 (20060101); A61F2/08 (20060101)

U.S. Cl.:

CPC **A61B17/0643** (20130101); **A61B17/0644** (20130101); **A61B17/083** (20130101); **A61B17/10** (20130101); **A61F9/007** (20130101); A61B2017/00004 (20130101); A61B17/06 (20130101); A61B2017/0641 (20130101); A61B2017/32113 (20130101); A61F2002/0894 (20130101)

Field of Classification Search

CPC: A61B (17/083); A61B (17/068); A61B (17/0682); A61B (17/122); A61B (17/128); A61B (17/10); A61B (17/0684); A61B (17/0686); A61F (9/007)

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Background/Summary

CROSS-REFERENCES TO RELATED APPLICATION (1) The present application is the US National Phase of PCT application PCT/IL2021/051323 to Ron, filed Nov. 9, 2021, entitled “Clip for eye muscle surgery,” which published as WO 2022/101899, and which claims priority from U.S. Provisional Patent Application 63/112,675 to Ron, filed Nov. 12, 2020, entitled “Clip for eye muscle surgery,” and which is incorporated herein by reference.

FIELD OF THE INVENTION
(1) The present application relates to a device and procedures performed on an eye of a patient. In particular, the present application relates to methods and devices for extraocular muscle manipulations and correcting strabismus.
BACKGROUND
(2) Strabismus is a condition in which the eyes do not properly align with each other when looking at an object. Strabismus can occur due to extraocular muscle dysfunction, neurological problems, trauma or infections. Types of strabismus include esotropia, where the eyes converge (cross-eyed), exotropia, where the eyes diverge and hypertropia where they are vertically misaligned.
(3) Treatment to straighten the eyes is needed. Strabismus surgery (or extraocular muscle surgery, eye muscle surgery, or eye alignment surgery) is surgery on the extraocular muscles to correct strabismus.
SUMMARY OF THE APPLICATION
(4) This summary is meant to provide some examples and is not intended to be limiting of the scope of the invention in any way. For example, any feature included in an example of this summary is not required by the claims, unless the claims explicitly recite the features. Also, the features, components, steps, concepts, etc. described in examples in this summary and elsewhere in this disclosure can be combined in a variety of ways. Various features and steps as described elsewhere in this disclosure may be included in the examples summarized here.
(5) In some applications of the present invention, devices and methods are described herein for performing strabismus surgery on an eye to correct strabismus of the eye, using an extraocular muscle clip and an elongate delivery tool that comprises (a) a muscle hook that is reversibly coupled to the extraocular muscle clip, and (b) an integrated blade moveable so as to cut the extraocular muscle subsequently to grasping of the extraocular muscle by the extraocular muscle clip.

(6) The extraocular muscle clip typically comprises an upper plate and a lower plate, which are distanced from each other when in a delivery state, and are couplable together to sandwich and grasp an extraocular muscle when in a grasping state. For some applications, the muscle clip comprises a hinge coupling the upper plate and lower plate. Typically, but not necessarily, the muscle clip is dissolvable.
(7) The elongate delivery tool is used to deliver the extraocular muscle clip to the extraocular muscle. The upper plate of the muscle clip is disposed adjacent to a delivery shaft of the delivery tool. For some applications of the present invention, the delivery tool shaft comprises a tube, and the upper plate is disposed within a lumen of the shaft of the delivery tool. The delivery tool comprises a muscle hook which extends at a nonzero angle with respect to the shaft of the delivery tool. The muscle hook is reversibly coupled to the extraocular muscle clip. For some applications, the muscle hook comprises a mount which comprises a coupling that reversibly couples to the delivery tool a portion of the extraocular muscle clip, e.g., the lower plate of the muscle clip. The muscle hook of the delivery tool is slid and placed under the extraocular muscle in order to position the lower plate of the muscle clip under the muscle.
(8) Once the lower plate is positioned underneath the muscle, the upper plate of the muscle clip is coupled together with the lower plate in order to sandwich the muscle between the upper and lower plates and grasp the extraocular muscle. For some applications of the present invention, the delivery tool delivers the upper plate above the extraocular muscle such that the upper plate is movable toward an upper surface of the extraocular muscle and is couplable together with the lower plate. For some applications, the delivery tool comprises an arm reversibly coupled to the upper plate. The arm is configured to facilitate movement of the upper plate and coupling together the upper plate and the lower plate into the grasping state. For some applications of the present invention, the delivery tool does not comprise the arm, and the operating physician pushes closed the upper plate toward the lower plate.
(9) The integrated blade of the delivery tool is moveable with respect to the elongate shaft so as to cut the extraocular muscle subsequently to grasping of the extraocular muscle by the upper and lower plates of the extraocular muscle clip. For some applications of the present invention, during delivery of the muscle clip toward the extraocular muscle and during grasping of the muscle by the clip, the integrated blade is kept in an unengaged position in which the blade is generally in alignment with the shaft of the delivery tool. For some applications of the present invention, the shaft of the delivery tool comprises a tube, and the blade is disposed in part within the lumen of the tube. Once the muscle is grasped by the clip, the integrated blade is moved away from the longitudinal axis of the shaft of the delivery tool and toward the muscle hook in order to sever the extraocular muscle. Typically, the muscle hook functions as a safety mechanism by preventing the integrated blade form moving beyond the muscle hook, thereby preventing inadvertent cutting of the sclera by the blade.
(10) Unlike conventional techniques which typically utilize a separate tool for cutting the extraocular muscle, the delivery tool of an application of the present invention provides a single tool which combines the functions of (1) delivering a muscle clip to the extraocular muscle, (2) facilitating grasping the extraocular muscle with the muscle clip, as well as subsequently (3) disinserting the extraocular muscle by cutting the muscle with the blade that is integrated with the delivery tool. In addition, since the delivery tool of an application of the present invention comprises an integrated blade as well as the muscle hook, the muscle hook of the delivery tool provides a safety which prevents the blade from moving beyond the muscle hook, unlike conventional techniques which use a separate cutting instrument (scissors or a scalpel) to cut the tissue without providing a buffer between the scalpel and the sclera.
(11) Additionally, the delivery tool (in particular, the muscle hook and the integrated blade) and the clip of an application of the present invention provide a system for more rapid and more precise (1) gasping of the extraocular muscle by the clip and (2) cutting of the extraocular muscle by the

integrated blade.
(12) The muscle clip typically comprises one or more sutures coupled to at least one of the upper plate or the lower plate of the muscle clip. For some applications, the one or more sutures are threaded through at least one of the upper plate or the lower plate of the muscle clip. The one or more sutures are configured to facilitate recoupling of the extraocular muscle to the globe of the eye of following cutting of the extraocular muscle by the integrated blade. Unlike conventional techniques which cut the muscle with a blade and then suture the muscle to the globe of the eye, the system of an application of the present invention provides a muscle clip with an integrated suture that is used to recouple the extraocular muscle to the globe of the eye following the cutting. It is hypothesized by the inventor that this is particularly advantageous, because the extraocular muscle is first grasped by the clip and secured by the clip before it is disinserted. Only once the muscle is secured by the muscle clip is it disinserted and then can easily by imbricated due to the presence of the suture that is coupled to the muscle clip.
(13) The clip of an application of the present invention eliminates the need to suture the suture through the extraocular muscle that has been disinserted from the globe. This is advantageous in (1) the hang-back procedure in which the disinserted muscle is sutured directly to the stump from the original insertion or to the sclera in a vicinity of stump (e.g., underneath the stump) from the original insertion, as well as in (2) procedures in which the extraocular muscle is sutured directly to the sclera (e.g., not in a hang-back procedure) and not back through the poles of the stump of the original insertion, or (3) any other ocular surgical procedure that involves manipulation of the extraocular muscle. The clip of an application of the present invention eliminates the need to imbricate the suture through the disinserted extraocular muscle which, whereby each entry and exit of the suture through the disinserted extraocular muscle increases the likelihood of perforating the eye globe and/or causes additional strain on the sclera during the imbricating of the suture through the disinserted extraocular muscle. The clip of an application of the present invention eliminates the need for imbricating the suture through the disinserted extraocular muscle because the clip couples the suture to the disinserted extraocular muscle via the coupling together of the plates of the clip. Additionally, the extraocular muscle clip of an application of the present invention eliminates the need for a removable clamp which is sometimes used during resection procedures.
(14) The clip and the delivery tool of an application of the present invention may be used for any type of strabismus surgery, e.g., recession and/or resection.
(15) There is therefore provided, in accordance with some applications of the present invention, apparatus for use in correcting strabismus of an eye of a patient, the apparatus including: an extraocular muscle clip including an upper plate and a lower plate, which are distanced from each other when in a delivery state of the extraocular muscle clip, and are couplable together to sandwich and grasp an extraocular muscle when in a grasping state of the extraocular muscle clip; an elongate delivery tool configured to deliver the muscle clip when in the delivery state, the elongate delivery tool including: an elongate shaft; and a muscle hook at a distal end of the elongate shaft being slidable underneath the extraocular muscle, the muscle clip being reversibly coupled to the elongate shaft, the lower plate of the muscle clip being reversibly coupled to the muscle hook so as to be slidable underneath the extraocular muscle, the delivery tool being configured to deliver the upper plate above the extraocular muscle such that the upper plate is movable toward an upper surface of the extraocular muscle and couplable together with the lower plate to sandwich and grasp the extraocular muscle; and an integrated blade moveable with respect to the elongate shaft so as to cut the extraocular muscle subsequently to grasping of the extraocular muscle by the upper and lower plates of the extraocular muscle clip; and one or more sutures coupled to at least one of the upper plate or the lower plate of the muscle clip, the one or more sutures being configured to facilitate recoupling of the extraocular muscle to a globe of the eye of following cutting of the extraocular muscle by the integrated blade.
(16) In some applications of the present invention, the elongate shaft includes a tube, and the

integrated blade is slidable at least in part within a lumen of the tube of the delivery tool and exposable from within the lumen of the tube so as to cut the extraocular muscle.
(17) In some applications of the present invention, the muscle clip includes a hinge coupling the upper plate and lower plate.
(18) In some applications of the present invention, the muscle hook is coupled to the elongate shaft, and the muscle hook prevents movement of the blade beyond the muscle hook.
(19) In some applications of the present invention, the extraocular muscle clip is dissolvable.
(20) In some applications of the present invention, the delivery tool includes an arm reversibly coupled to the upper plate, the arm being configured to facilitate movement of the upper plate and coupling together the upper plate and the lower plate into the grasping state.
(21) In some applications of the present invention, the one or more sutures is threaded through at least one of the upper plate or the lower plate of the muscle clip.
(22) There is also provided, in accordance with some applications of the present invention, a method for correcting strabismus of an eye of a patient, the method including: delivering an extraocular muscle clip including an upper plate and a lower plate to an extraocular muscle using an elongate delivery tool including: an elongate shaft reversibly coupled to the extraocular muscle clip, a muscle hook at a distal end of the elongate shaft, the muscle clip being reversibly coupled to the elongate tube in a manner in which the lower plate of the muscle clip is coupled to the muscle hook and is distanced from the upper plate during the delivering; positioning the lower plate underneath the extraocular muscle by sliding the muscle hook underneath the extraocular muscle; subsequently to the positioning: moving the upper plate of the muscle clip to an upper surface of the extraocular muscle; sandwiching the extraocular muscle between the upper and lower plates; and grasping the extraocular muscle between the upper and lower plates by coupling together the upper and lower plates; subsequently to the grasping: distally moving an integrated blade of the delivery tool with respect to the elongate shaft of the elongate delivery tool; and cutting the extraocular muscle with the integrated blade; and subsequently to the cutting, recoupling the extraocular muscle to the eye by suturing to the eye one or more sutures coupled to at least one of the upper plate or the lower plate of the muscle clip and by the suturing, drawing the muscle clip and the extraocular muscle grasped by the muscle clip toward the eye.
(23) The present invention will be more fully understood from the following detailed description of embodiments thereof, taken together with the drawings, in which:

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) FIG. **1** is a schematic illustration of a delivery tool coupled to an extraocular muscle clip being delivered to an extraocular muscle of an eye of a patient, in accordance with some applications of the present invention;
(2) FIG. **2** is a schematic illustration of the delivery tool and its components, in accordance with some applications of the present invention;
(3) FIGS. **3**A-B are schematic illustrations of the extraocular muscle clip coupled to a suture, in accordance with some applications of the present invention;
(4) FIGS. **4**A-B are schematic illustrations of the operation of the mechanism of the integrated blade of the delivery tool, in accordance with some applications of the present invention; and
(5) FIGS. **5**-**9** are schematic illustrations of the steps of the strabismus surgery procedure using the delivery tool and clip described in FIGS. **1**-**4**B, in accordance with some applications of the present invention.
DETAILED DESCRIPTION OF APPLICATIONS
(6) Reference is now made to FIG. **1**, which is a schematic illustration of a system **20** comprising

an extraocular muscle clip **22** reversibly coupled to a muscle hook **56** of an elongate delivery tool **50**, in accordance with some applications of the present invention. Delivery tool **50** comprises an elongate shaft **52** and muscle hook **56** disposed at a distal end of shaft **52** typically at a non-zero angle with respect to shaft **52**. For some applications, hook **56** is fixedly coupled to shaft **52**. Muscle clip **22** is reversibly coupled to elongate shaft **52**. Muscle clip **22** typically comprises an upper coupling element, e.g., an upper plate **24**, and a lower coupling element, e.g., a lower plate **26**, which are moveable toward each other, typically by moving upper plate **24** toward lower plate **26**. Upper and lower plates **24** and **26** are distanced from each other when in a delivery state (as shown in FIG. **1**), and are couplable together (as shown in FIG. **6**) to sandwich and grasp an extraocular muscle **42** when in a grasping state. Delivery tool **50** comprises an integrated blade **60** moveable with respect to elongate shaft **52** so as to cut extraocular muscle **42** subsequently to grasping of extraocular muscle **42** by upper and lower plates **24** and **26** of extraocular muscle clip **22**, such as shown in FIG. **7**.

(7) (It is to be noted that in the context of the specification and the claims, the verb “clip” means grab, clamp, or grasp and does not mean cut.)

(8) Reference is still made to FIG. **1**, and is additionally made to FIG. **3**A-B, which are schematic illustrations of extraocular muscle clip **22** coupled to a suture **30**, in accordance with an application of the present invention. Typically, upper and lower plates **24** and **26** comprise corresponding planar surfaces which provide increased surface area in order to sandwich extraocular muscle **42** therebetween. Upper and lower plates **24** and **26** are shaped so as to define respective rectangles by way of illustration and not limitation. It is to be noted that the upper and lower coupling elements may be provided in any suitable shape. As shown, upper plate **24** is shaped so as to define a plurality of male coupling elements **25**. Each coupling element **25** comprises a pointed distal tip so as to puncture through tissue of muscle **42**, a post coupled to the pointed distal tip and a barb close to the tip so as to facilitate irreversible coupling between upper and lower plates **24** and **26**. Lower plate **26** is shaped so as to define a plurality of corresponding female coupling elements **27**, e.g., openings, which are each shaped so as to receive a respective male coupling element **25**. It is to be noted upper plate **24** may be shaped to define female coupling elements **27** while lower plate **26** may comprise male coupling elements **25** (configuration not shown). Once plate **24** is moved toward plate **26**, male coupling elements **25** puncture tissue of muscle **42**, and then fit within female coupling elements **27** and are locked in place due to the barbs.

(9) For some applications, upper and lower plates **24** and **26** are coupled together by a hinge **28**. It is to be noted that clip **22** may comprise upper and lower plates **24** and **26** independently of hinge **28**. In such applications of the present invention, upper and lower plates **24** and **26** comprise discrete elements which are held in separate from each other when in the delivery state of clip **22** by different elements of delivery tool **50**, and are moveably together by the respective components of tool **50**. For some applications of the present invention, clip **22** does not comprise hinge **28**, rather, delivery tool **50** comprises hinge **28** (e.g., hinge **28** may be coupled to muscle hook **56**) which is used to couple together upper and lower plates **24** and **26**. Once upper and lower plates **24** and **26** are coupled together, hinge **28** is removed from clip **22** by retracting and/or moving tool **50**.

(10) Typically, suture **30** is coupled to either upper or lower plates **24** and **26**. As shown by way of illustration and not limitation, suture **30** is coupled to lower plate **26**. It is to be noted that suture **30** may be coupled to upper plate **24**. As shown, suture **30** is slidable through a lumen **29** defined by lower plate **26** (as shown in FIG. **3**B). For some applications of the present invention, suture **30** is fixedly coupled to plate **26**. Suture **30** typically comprises suture needles **32** at respective ends thereof. For some applications, suture **30** comprises a fabric. For some applications of the present invention, suture **30** is replaced by a wire.

(11) For some applications, extraocular muscle clip **22** and/or suture **30** comprise a dissolvable material.

(12) Reference is again made to FIG. **1**. For some applications, lower plate **26** is disposed within a

housing or a recessed portion provided by muscle hook **56**, as shown. For some applications of the present invention, muscle hook **56** is coupled to or comprises a mount to which lower plate **26** is coupled. During delivery of clip **22** to muscle **42**, plate **24** is held distanced from plate **26** in the delivery state. Muscle hook **56** is slid underneath muscle **42** so as to position lower plate **26** underneath muscle **42** and in between the sclera and the under surface of muscle **42**. During delivery, suture **30** is positioned with respect to tool **50** in a manner in which suture needles **32** coupled to suture **30** are disposed safely and are not exposed as they appear in FIG. **1**. For example, suture needles **32** may be disposed within a lumen of shaft **52**.

(13) Muscle hook **56** may be moved underneath any of the extraocular muscles, e.g., the superior rectus, the inferior rectus, the medial rectus, the lateral rectus, the superior oblique muscle, or the inferior oblique muscle. FIG. **1** shows a state of system **20** in which muscle hook **56** has been positioned underneath muscle **42** of an eye **40** of a patient that has strabismus.

(14) Reference is still made to FIG. **1**, and is additionally made to FIGS. **4**A-B, which are schematic illustrations of the operation of the mechanism of integrated blade **60** of delivery tool **50**, in accordance with an application of the present invention. When tool **50** is in the state in which hook **56** delivers lower plate **26** underneath muscle **42** and upper plate **24** is moved toward lower plate **26** and subsequently coupled thereto, blade **60** is generally in alignment with a longitudinal axis of shaft **52** of delivery tool **50**. For some applications, when tool **50** is in the state in which hook **56** delivers lower plate **26** underneath muscle **42** and upper plate **24** is moved toward lower plate **26** and subsequently coupled thereto, blade **60** is disposed generally in parallel with upper plate **24**. In either application, during movement of hook **56** and lower plate **26** underneath muscle **42**, blade **60** is kept in a position in which it is maintained in a safe position to prevent premature and inadvertent cutting of tissue during delivery of lower plate **26**. Shaft **52** is shaped so as to define a slit or opening at a distal end of shaft **52**. During delivery of lower plate **26**, blade **60** is maintained within the slit, as shown in FIG. **4**A. For some applications, blade **60** is disposed with respect to the slit in a manner in which a terminal, distal end **65** of blade **60** is disposed within a lumen **54** of shaft **52** in a location that is proximal to a proximal end **68** of the slit. That is, for some applications, during delivery of lower plate **26**, blade **60** is maintained at least in part within lumen **54** of shaft **52**. Once plate **26** is positioned, blade **60** is slidable with respect to shaft **52** distally so as to expose distal end **65** from within the slit in order to facilitate movement of a cutting edge **63** of blade **60** toward muscle **42**, as is described hereinbelow.

(15) For some applications of the present invention, blade **60** is disposed entirely and slidable within lumen **54** of shaft **52** during delivery of clip **22** to muscle **42**.

(16) Reference is still made to FIGS. **4**A-B, and is additionally made to FIG. **2**, which is a schematic illustration of delivery tool **50** and its components, in accordance with an application of the present invention. Blade **60** is coupled to a distal end of an elongate control shaft **64** which facilitates movement of blade **60**. A proximal end of control shaft **64** is coupled to a handle portion at the proximal end of delivery tool **50**. For some applications, as shown in FIG. **2**, the handle portion comprises a stationary finger ring **66** and a moveable finger ring **62**. Movement of ring **62** toward ring **66** facilitates distal movement of control shaft **64** so that blade **60** is moved angularly downward, as shown in FIG. **4**B. It is to be noted that tool **50** comprises ring **62** by way of illustration and not limitation. It is to be noted that a trigger may be used instead of ring **62**. For applications in which at least a part of blade **60** is disposed within lumen **54** of shaft **52** during delivery of clip **22**, control shaft **64** facilitates longitudinal distal sliding of blade **60** with respect to shaft **52** prior to facilitating angular downward movement of blade **60**.

(17) Once lower plate **26** of clip **22** is positioned underneath muscle **42**, and clip **22** is closed to capture muscle **42**, as is described hereinbelow, the operating physician moves ring **62** toward ring **66** in order to facilitate movement of integrated blade **60**.

(18) Reference is now made to FIGS. **1**, **2**, and **4**B. FIGS. **1**, **2**, and **4**B illustrate movement of the blade **60** with respect to shaft **52**. The several states shown do not actually occur during use of the

delivery tool **50** during an operating procedure. That is, during the operating procedure, blade **60** is moved only once clip **22** is in the grasping state in which upper plate **24** is coupled to lower plate **26** so as to sandwich muscle **42** between plates **24** and **26** in order to facilitate grasping of muscle **42** by clip **22**, as shown hereinbelow with reference to FIG. **7**. The step-wise procedure of the use of delivery tool **50** and clip **22** is shown in FIGS. **5-9**, described hereinbelow.

(19) As shown in FIGS. **2** and **4**A-B, for some applications, muscle hook **56** is shaped so as to define a groove **61** for receiving cutting edge **63** of blade **60** once blade **60** cuts muscle **42**. For some applications, groove **61** is disposed between lower plate **26** and an edge of hook **56**. Groove **61** prevents movement of blade **60** beyond muscle hook **56** so as to prevent continued cutting of tissue by blade **60**, and thereby groove **61** functions as a safety to prevent inadvertent cutting of the sclera. For some applications, hook **56** does not define a groove, but instead defines a spatial planar surface that is disposed in the angular path of blade **60** such that hook **56** prevents movement of blade **60** beyond muscle hook **56** so as to prevent continued cutting of tissue by blade **60**, and thereby hook **56** functions as a safety to prevent inadvertent cutting of the sclera.

(20) Reference is now made to FIGS. **5-9**, which are schematic illustrations of the steps of a method using system **20** comprising delivery tool **50** and extraocular muscle clip **22** to correct strabismus of the patient, in accordance with some applications of the present invention. As shown in FIG. **5**, muscle hook **56** is positioned underneath extraocular muscle **42** in order to position lower plate **26** of extraocular muscle clip **22** underneath muscle **42**. As described hereinabove, suture needles **32** are shown exposed by way of illustration and not limitation, and needles **32** may be disposed within lumen **54** of tool **50** during delivery. As shown, during delivery of hook **56** underneath muscle **42**, and during the closing of upper plate **24** toward lower plate **26**, blade **60** is maintained in a position in which blade **60** is in general alignment with shaft **52** and disposed generally in parallel with upper plate **24**. As shown, distal end **65** of blade **60** is exposed from within lumen **54** by way of illustration and not limitation. It is to be noted that distal end **65** of blade **60** may be disposed within lumen **54** of shaft **52**, as described hereinabove with reference to FIG. **4**A.

(21) As shown in FIG. **6**, once lower plate **26** is positioned underneath muscle **42**, upper plate **24** is moved toward muscle **42**. That is, delivery tool **50** facilitates delivery of upper plate **24** above extraocular muscle **42** such that upper plate **24** is movable toward an upper surface of extraocular muscle **42** and couplable together with lower plate **26** to sandwich and grasp extraocular muscle **42**. For some applications of the present invention, as shown, upper plate **24** is reversibly coupled to a control shaft **58** via a connector **59** at the upper surface of upper plate **24**. Control shaft **58** is moveable by the operating physician in order to facilitate closing of upper plate **24** with lower plate **26**. As shown, shaft **58** facilitates downward angular movement of plate **24** toward muscle **42** and toward plate **26** disposed underneath muscle **42**. Force is applied to plate **24** so as to facilitate puncturing of muscle tissue by male coupling elements **25** of upper plate **24**. In such a manner, muscle **42** is sandwiched between upper and lower plates **24** and **26**. Further force is applied to plate **24** so that male coupling elements **25** of upper plate **24** mate with female coupling elements **27** of lower plate **26** in a manner in which upper and lower plates **24** and **26** are secured together in order to facilitate grasping of muscle **42** by clip **22**. For some applications of the present invention, male coupling elements **25** are shaped so as to define a barb which facilitates irreversible coupling between elements **25** and **27**.

(22) It is to be noted that delivery tool **50** comprises control shaft **58** by way of illustration and not limitation. For some applications, the operating physician may use his/her fingers to move plate **24** toward plate **26**.

(23) During the transition of upper and lower plates **24** and **26** from the delivery state of clip **22** to the grasping state of clip **22**, blade **60** remains in a position in which it is in general alignment with shaft **52** of tool **50**, as shown in FIG. **60**.

(24) As shown in FIG. **7**, once muscle **42** is grasped by clip **22**, the operating physician facilitates

movement of blade **60** toward the upper surface of muscle **42**. That is, the physician moves moveable finger ring **62** shown in FIG. **2** toward stationary finger ring **66** so as to facilitate distal sliding of blade **60** with respect to shaft **52** and/or angular movement of blade **60** downward with respect to muscle **42**. Movement of ring **62** facilitates movement of shaft **64** so as to push blade **60** angularly distally. Cutting edge **63** of blade **60** is brought into contact with muscle **42** in order to sever muscle **42**. Once muscle **42** is initially severed and disinserted, any suitable strabismus surgery may be performed, e.g., resection or recession.

(25) As described hereinabove, muscle hook **56** and/or groove **61** of hook **56** stop continued movement of blade **60** beyond muscle hook **56** so as to prevent inadvertent cutting of the sclera by blade **60**.

(26) As shown in FIG. **8**, tool **50** is decoupled from clip **22**, and muscle **42**, which is grasped by clip **22**, is then recoupled to eye **40** (e.g., to a globe of the eye). Recoupling of muscle **42** to eye **40** can be performed using the hang-back procedure, the non-hang-back procedure, procedures in which the disinserted muscle coupled to clip **22** is sutured (a) to the sclera in a vicinity of stump **44** (e.g., underneath stump **44**) from the original insertion (as shown), (b) directly to a stump **44** from the original insertion and to the sclera (not shown), (c) to the sclera in any suitable vicinity of the eye (not shown), and/or to any suitable tissue as decided by the operating physician FIG. **8** shows the hang-back procedure in which suture **30** is sutured underneath stump **44** using needles **32** so as to draw the disinserted muscle **42**, grasped by clip **22**, toward eye **40**.

(27) As shown in FIG. **9**, the strabismus of the patient is corrected, and clip **22** remains coupled to muscle **42**. For some applications clip **22** and/or suture **30** is dissolvable, or absorbable.

(28) Reference is now made to FIGS. **1**-**9**. It is to be noted that system **20** including tool **50** and clip **22** may be used to fix strabismus using any suitable procedure, e.g., recession, resection, and/or any other suitable procedure. It is to be noted that system **20** including tool **50** and clip **22** may be used to perform strabismus surgery using a hang-back procedure and/or a non-hang-back procedure. It is to be noted that system **20** including tool **50** and clip **22** may be used may be used to perform any other ocular surgical procedure that involves manipulation of the extraocular muscle.

(29) It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. Rather, the scope of the present invention includes both combinations and subcombinations of the various features described hereinabove, as well as variations and modifications thereof that are not in the prior art, which would occur to persons skilled in the art upon reading the foregoing description.

Claims

1. A method for correcting strabismus of an eye of a patient, the method comprising: delivering an extraocular muscle clip including an upper plate and a lower plate to an extraocular muscle using an elongate delivery tool including: an elongate shaft reversibly coupled to the extraocular muscle clip, a muscle hook at a distal end of the elongate shaft, the muscle clip being reversibly coupled to the elongate shaft in a manner in which the lower plate of the muscle clip is coupled to the muscle hook and is distanced from the upper plate during the delivering; positioning the lower plate underneath the extraocular muscle by sliding the muscle hook underneath the extraocular muscle; subsequently to the positioning: moving the upper plate of the muscle clip to an upper surface of the extraocular muscle; sandwiching the extraocular muscle between the upper and lower plates; and grasping the extraocular muscle between the upper and lower plates by coupling together the upper and lower plates; subsequently to the grasping: distally moving an integrated blade of the delivery tool with respect to the elongate shaft of the elongate delivery tool; and cutting the extraocular muscle with the integrated blade; and subsequently to the cutting, recoupling the extraocular muscle to the eye by suturing to the eye one or more sutures coupled to at least one of the upper plate or the lower plate of the muscle clip and by the suturing, drawing the muscle clip

and the extraocular muscle grasped by the muscle clip toward the eye.

2. The method according to claim 1, wherein the elongate shaft includes a tube, and wherein the method further includes sliding the integrated blade at least in part within a lumen of the tube of the delivery tool and exposing the blade from within the lumen of the tube so that the blade can cut the extraocular muscle.

3. The method according to claim 1, wherein the muscle clip includes a hinge coupling the upper plate and lower plate.

4. The method according to claim 1, wherein the muscle hook is coupled to the elongate shaft, and wherein the muscle hook prevents movement of the blade beyond the muscle hook.

5. The method according to claim 1, wherein the extraocular muscle clip is dissolvable.

6. The method according to claim 1, wherein the delivery tool includes an arm reversibly coupled to the upper plate, and wherein the method comprises moving the arm to move the upper plate in order to couple together the upper plate and the lower plate such that the upper and lower plates assume a grasping state.

7. The method according to claim 1, wherein the one or more sutures are threaded through at least one of the upper plate or the lower plate of the muscle clip.