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Inventor(s)	MARCHINI; Enrico

CAPSULOTOMY DEVICE AND METHOD

Abstract

A capsulotomy device has a tool holder. The tool holder includes a cutting blade at its distal end and is arranged to move in a distal direction in the device to form an operative state of the device where the cutting blade projects out of a distal end of the capsulotomy device. The at least a portion of the tool holder is adapted in the device's operative state to reciprocate in the distal and proximal directions to urge rotation of the cutting blade.

Inventors: **MARCHINI; Enrico (Verona, IT)**

Applicant: **HORUS MEDTECH S.r.l** (Verona, IT)

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Background/Summary

TECHNICAL FIELD

[0001] Embodiments of the invention relate to a capsulotomy device and method, in particular of a type comprising a cutting blade.

BACKGROUND

[0002] Capsulorhexis or Capsulotomy is a procedure that nowadays is typically used for manually removing a portion of the anterior lens capsule during cataract surgery. Once performed, the crystalline lens within the capsule may be removed, leaving the capsule in place acting as a partition between posterior and anterior portions of the eye; preventing, inter alia, the vitreous humor from moving forward. The remaining capsule may then be used for firmly housing e.g. an artificial intraocular lens.

[0003] Incisions made by a surgeon using hand-held cutting needle and forceps is a method traditionally used for forming a generally continuous aperture in the capsule through which the lens may then be removed, however formation of a smooth and continuous hole in the capsule may be formed also by dedicated cutting tools. Such tools may be suited for evenly applying cutting forces upon the capsule during surgery—in order to substantially avoid any unintentional tears in the capsule.

[0004] WO2015166394 describes, for example, a device for producing cuts or perforations on a human or animal eye in order to open the eye lens. The device operates by means of a cutting element that can be inserted into the interior of the eye and a drive device, which is arranged outside of the eye, in order to cause mechanical, in particular oscillatory vibrations or rotation of the cutting element in the interior of the eye.

[0005] DE4012882 in another example describes a surgical instrument for operating on a cataract of the eye that has a hollow handle which receives the blade holder. The blade is made from a flat strip of flexible material which is bent to form a ring and the ring is gripped between a roller inside the ring and two rollers outside the ring. A drive mechanism inside the handle rotates the rollers which cause the ring to rotate so that its edge cuts out the cataract.

[0006] WO2014145919 in yet a further example describes a device for performing an anterior capsulotomy procedure. The device includes a body having proximal and distal end and a cutting element having at least one surgical blade rotatably disposed on a distal end of the body. The cutting element is attached to a pinion including a plurality of gear teeth that intermesh to cause rotation in the pinion.

SUMMARY

[0007] The following embodiments and aspects thereof are described and illustrated in conjunction with systems, tools and methods which are meant to be exemplary and illustrative, not limiting in scope.

[0008] In an embodiment there is provided a capsulotomy device comprising a tool holder, the tool holder comprising a circular cutting blade at its distal end and being arranged to move in a distal direction in the device to form an operative state of the device where the cutting blade projects out of a distal end of the capsulotomy device, wherein at least a portion of the tool holder is adapted in the device's operative state to reciprocate in the distal and proximal directions to urge oscillating rotation of the cutting blade.

[0009] Said reciprocating portion of the tool holder may be in the form of an axially extending rod that may be arranged to connect/mate at its distal axial end to the cutting blade. Thus, by

reciprocating axial movements of the rod, rotational oscillations of the cutting blade may be urged about a central pivot of the cutting blade, where said pivot being preferably formed by portions of the cutting blade itself.
[0010] Such embodiment where rotational oscillations may be formed by a simple mechanism including an axially extending rod—provides a solution for performing cutting actions with a relative simple mechanism that has less parts than otherwise may be required for formation of such a rotational oscillating cutting action.
[0011] In at least certain embodiments, rotational angular actions of oscillation of the cutting blade about its pivot—may be relative slight—possibly in a magnitude of about 170 degrees or less, possibly about 90 degrees or less. That is to say that the cutting blade may be rotated from a given position by about said 170, 90 or less degrees in a first rotational direction about its pivot—before oscillating back towards said given position in an opposing second rotational direction.
[0012] These rotational movements of the cutting blade may be used for cutting a portion of an anterior side of a lens capsule during e.g. cataract surgery.
[0013] In an embodiment, the capsulotomy device may comprise a piston and the tool holder being coupled to the piston at its proximal end, wherein the urging of the tool holder in the distal direction is via the piston.
[0014] The piston may be manually held by a surgeon performing surgery e.g. cataract surgery on a patient's eye, for example for manually inserting a tip region of the device via an incision formed through a cornea of the eye—prior to the device assuming its operative state.
[0015] In various embodiments, the capsulotomy device comprises a driving mechanism, either manually activated or automatically activated, for reciprocating the at least portion of the tool holder in the distal and proximal directions.
[0016] In an embodiment there is provided a cutting blade for a capsulotomy device having a unitary one-piece construction, the cutting blade comprising a circular body and a plurality of spoke members integral with the body and extending each away from different circumferential locations about the body to meet at central region of the cutting blade.
[0017] In addition to the exemplary aspects and embodiments described above, further aspects and embodiments will become apparent by reference to the figures and by study of the following detailed descriptions.

Description

BRIEF DESCRIPTION OF THE FIGURES
[0018] Exemplary embodiments are illustrated in referenced figures. It is intended that the embodiments and figures disclosed herein are to be considered illustrative, rather than restrictive. The invention, however, both as to organization and method of operation, together with objects, features, and advantages thereof, may best be understood by reference to the following detailed description when read with the accompanying figures, in which:
[0019] FIGS. **1**A and **1**B schematically show assembled and exploded views, respectively, of an embodiment of a capsulotomy device in accordance with the present invention;
[0020] FIGS. **2**A and **2**B schematically show a distal position of an embodiment of a capsulotomy device in, respective, unloaded and loaded states of a cutting blade;
[0021] FIG. **3** schematically shows a perspective view of an embodiment of a capsulotomy device in an operative state;
[0022] FIG. **4**A schematically shows possible processing steps that may be taken to form an embodiment of a cutting blade from a cylindrical piece of material;
[0023] FIGS. **4**B and **4**C schematically show exploded and non-exploded perspective bottom views of a distal portion of an embodiment of a capsulotomy device;

[0024] FIGS. **5**A to **5**C schematically show top views of an embodiment of a capsulotomy device in its operative state, during various states of actuation;
[0025] FIGS. **6**A to **6**C schematically show enlarged bottom views of a cutting blade at a distal portion of the capsulotomy device of FIG. **5** during actuation states corresponding to the respective actuation states seen in FIGS. **5**A to **5**C;
[0026] FIGS. **7**A and **7**B schematically show various cutting blade embodiments suitable for use with the various capsulotomy device disclosed;
[0027] FIG. **8** schematically shows an embodiment of a guide for guiding various capsulotomy device embodiments away from their operative states;
[0028] FIGS. **9**A to **9**C schematically show various driving mechanisms possibly used with the various capsulotomy device embodiments disclosed;
[0029] FIGS. **10**A and **10**B schematically show a proximal portion of an embodiment of a capsulotomy device illustrating a catch-mechanism suitable for reversibly locating the various capsulotomy device embodiments disclosed herein in respective operative states; and
[0030] FIG. **11** schematically shows a capsulotomy device embodiment comprising an embodiment of a piston for urging the device towards and away from its operative state.
[0031] It will be appreciated that for simplicity and clarity of illustration, elements shown in the figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements may be exaggerated relative to other elements for clarity. Further, where considered appropriate, reference numerals may be repeated within the figures to indicate like elements.
DETAILED DESCRIPTION
[0032] Attention is first drawn to FIGS. **1**A and **1**B illustrating an embodiment of a capsulotomy device **10** of the present invention in, respective, assembled and exploded states. Capsulotomy device **10** in these views may be seen including the following main members: a base **12**, a blade holder **14**, a piston **16** and a driving mechanism **18**.
[0033] Capsulotomy device **10** may be used for cutting with a cutting blade, held by the blade holder, a portion of an anterior side of a lens capsule during e.g. cataract surgery. Prior to performing such cutting action, the capsulotomy device may be advanced towards the lens capsule by first placing a tip region **121** at a distal portion of the base through an incision (e.g. a 2.2 mm incision providing a corneal access) formed in a cornea of an eye to be treated (eye anatomy, e.g. cornea and lens capsule, not shown).
[0034] It is noted that the directional term ‘distal’ and its opposite term ‘proximal’ (and their derivatives), which are used herein; generally refer to, respective, remoteness or proximity to a person e.g. physician or surgeon, handling various embodiments of capsulotomy devices of the invention in their assembled state(s). In addition, the terms ‘up’ and ‘down’ (and their derivatives) refer to general directions existing in relation to the described embodiments, when held in an orientation suitable for performing a surgical procedure.
[0035] Blade holder **14** in this example may be arranged to include a rod **141**, a tube **142** and a cutting blade **143**. Tube **142** at its distal end may be arranged to have a downwardly projecting pivot **1421** (see pivot **1421** e.g. in FIG. **4**B). The cutting blade **143** in turn may be arranged to be pivotally coupled to pivot **1421**. Rod **141** may be arranged to pass through the tube to extend up to a distal area of the holder where it may couple to the blade (see coupling between rod and blade e.g. in FIG. **6**).
[0036] Piston **16** may include a handle **161** at a proximal region and a shaft **162** that extends away from the handle in a distal direction up to a distal end of the piston. The shaft in this example includes a passage **163** that extends therethrough and opens out of the piston at its distal end. Passage **163** in this example may have a canal-like formation opening radially out of the shaft here in an upward direction, besides at a distal portion **164** of the shaft where the canal-like formation is concealed from above.
[0037] In an assembled state of the capsulotomy device, a proximal portion **144** of tube **142** may be

fixed within the shaft's distal portion **164** leaving the rod **141** at its proximal end projecting into the canal-like portion of passage **163**. Piston **16** may include in addition at the shaft's distal portion **164** an axle **165** that projects in this example radially upwards in the same direction towards which the canal-like portion of passage **163** opens.

[0038] The driving mechanism **18** in this embodiment may have a manually driven rotary-like formation including a driving wheel **181**, a bar **182** and a grip **183**. Driving mechanism **18** in an assembled state of the capsulotomy device may be arranged to have its driving wheel **181** pivotally coupled to axle **165** with its grip **183** slidably located within passage **163** and securely gripping onto the proximal end of rod **141**.

[0039] Bar **182** may be coupled at a general distal side thereof via a link **99** (see 'dashed-circle' marked in FIG. **5** and indicated by numeral **99** in FIG. **5**A) to a relative outer radial portion of the driving wheel and at a general proximal side thereof to grip **183**. Thus, by rotating driving wheel **181** about axle **165**, grip **183** via bar **182** may be arranged to slide back and forth within passage **163** urging the rod **141** that is attached thereto to move back and forth within tube **142** that accordingly remains fixed at its proximal region **144** to the piston's distal region **164**. Such back and forth movements of rod **141** may be arranged to activate rotation of the cutting blade about its pivot as will be described below.

[0040] Base **12** extends along a longitudinal axis X defining also a longitudinal axis of the capsulotomy device in its assembled state. Base **12** may have a loading chamber **122** proximal to its tip region **121**, and a pathway **123** extending therethrough along axis X that passes through loading chamber **122** and tip region **121** to open out of the device at its distal end. In this shown example, pathway **123** may have a proximal duct-like portion that opens upwards. The duct-like portion here extends from a proximal end of the base and up to the loading chamber.

[0041] Formation of an assembled state of the capsulotomy device may be assumed as following. First a sub-assembly may be formed including the fitted together piston **16** and blade holder **14** with driving mechanism **18** coupled to both. This sub-assembly may then be placed with the cutting blade **143** located within loading chamber **122** and portions of shaft **162** and blade holder **14** received and/or located within pathway **123**, here mostly within the duct-like portion of the pathway. Loading chamber **122** may include an upper movable lid that may be removed for placing cutting blade within the loading chamber and then re-attached to close the loading chamber from above.

[0042] For a better view of the loading chamber **122** attention is now drawn to FIGS. **2**A and **2**B. The capsulotomy device prior to being used in a surgical procedure, e.g. when in storage, may be arranged to include its cutting blade within a central open area **1222** of the loading chamber as seen in FIG. **2**A. The loading chamber includes bearing members **1221** located on both lateral sides of open area **1222**.

[0043] In an un-loaded state of the loading chamber, the bearing members **1221** are located in respective retracted positions, permitting formation of the open area **1222** where the cutting blade **143** rests in a free non-distorted and/or compressed state. This un-loaded state can be seen in FIG. **2**A. The cutting blade, typically formed from elastic material such as nitinol, may be urged to assume a generally compressed profile by urging the bearing members **1221** inwards to thereby assume the loaded state generally seen in FIG. **2**B. This loaded state here shown may be defined as providing a so-called 'initial deformation' in the cutting blade, where later further deformation in this shown example may be assumed while the cutting blade is injected downstream out of the loading chamber on route to exit the device at its distal end.

[0044] Each bearing member **1221** in this illustrated example includes a bearing face **1223** facing towards the cutting blade into central open area **1222**; and a pair of resilient arms **1224** on both axial sides of the member. The resilient arms are possibly arranged with angled teeth engaged with respective teeth formed in an outer housing of the loading chamber to form a ratchet-like formation that permits motion of each bearing member in this example only towards the cutting blade.

[0045] The bearing face **1223** of each bearing member as here seen may be arranged to follow a general contour that tapers towards axis X in the distal direction—thus forming in the loaded state a general funnel shape leading towards an exit **1225** from the loading chamber.
[0046] Exit **1225** forms an entry from the loading chamber into a terminal distal portion **1231** of pathway **123** that passes through tip region **121**. Through distal portion **1231** the cutting blade, initially compressed in the loaded state of the loading chamber, passes while undergoing further compression on route to exit the device's tip region and assume an operative state of the capsulotomy device suitable for performing cutting actions. In the operative state when located outside at the distal side of the device—the cutting blade flexes back to its general circular shape.
[0047] Attention is drawn to FIG. **3** illustrating the capsulotomy device in an operative state after the cutting blade has exited the tip region. As seen in the enlarged section at the top of the figure, the cutting blade remains accordingly pivoted to pivot **1421** at the distal end of the tube **142**. Also, as can be seen; in the operative state of the capsulotomy device—the driving wheel **181** may reach a recessed region **124** along base **12** permitting tactile access to the driving wheel for manual manipulation of the driving wheel about axle **165**.
[0048] Attention is additionally drawn to FIGS. **4**B and **4**C providing a perspective bottom view of a distal region of the capsulotomy device. As seen in this view, cutting blade **143** may be arranged to have a circular body **1431** including a cutting edge **1432** extending along a lower counter thereof. Cutting blade **143** in addition may include several spoke members **1433**, here three spoke members, that extend each away from a respective merge M along an upper side of the blade's body **1431**.
[0049] With attention additionally drawn to FIG. **4**A an embodiment of a cutting blade **143** will be discussed. Cutting blade **143** in this embodiment may be formed by first providing a generally cylindrical piece of material (e.g. nitinol) and then cutting away excess material **7** from the material to leave a skeleton of remaining material that includes material for the blade's body **1431** and the blade's spoke members **1433**. Further machining may then be performed e.g. to form the cutting edge at the lower side of body **1431** (etc.) and each spoke member may then undergo several twists, here three twist actions resulting in formation of three twist regions T in each spoke.
[0050] As shown by within the dotted rectangle and the dashed arrow at the right hand side of this figure, each spoke member may undergo cutting to form twist regions therein, here optionally formed by the remaining curved formation of each spoke member after such cutting. As discussed herein, said twist regions may in addition or alternatively be formed in other manners e.g. by bending spoke members.
[0051] With attention drawn back to FIGS. **4**B and **4**C, a first one of the twist regions T.sub.A may be seen located at the merge M where each spoke member merges with the blade's body and two additional twist regions T.sub.B may be located along each spoke member. Each spoke member **1433** may include an aperture at its end most distal of body **1431** and the bending and twisting of each spoke member (away from the position illustrated at the right-hand side of FIG. **4**A) may be such that all apertures align at a central region of the blade's body to form a pivoting aperture P of the blade.
[0052] The twist regions T.sub.B formed along each spoke member may be said to define each a general twist axis extending generally parallel to an axis about which the blade's body **1431** is formed. Thus, provision of the twist regions T.sub.B along such orientations may be adapted to facilitate compression of the cutting blade to a general compressed (possibly elliptical) shape permitting passage of the cutting blade via the terminal distal portion **1231** or when still in the loading chamber.
[0053] Coupling of rod **141** with the cutting blade as seen in FIGS. **4**B and **4**C may be provided as following. One of the spoke members **1433** may be defined as an ‘activation spoke’ provided with a slit S formed therethrough. Rod in turn may be formed at its distal end with a hook-like formation **1411**. Coupling may thus be formed by inter-engaging hook **1411** within slit S—so that urging rod

back and forth may result in oscillating the cutting blade to rotate about its pivot via interaction with the ‘activation spoke’.

[0054] With attention drawn to FIG. **4**C, cutting blade **143** may be seen pivotally coupled at its aperture P to pivot **1421**. To pivot **1421** may additionally be fixed one or more anchoring pins **77**. The anchoring pins **77**, in this example two such pins, may be fitted to a plate **88** that includes a general elliptical profile suited for passage together with the cutting blade via terminal distal portion **1231**.

[0055] In fact—in embodiments including such pin(s) and in particular plate **88**—compression of the cutting blade may be up to plate **88**, which is located within the blade. Provision of such pin(s) may permit so-called anchoring of the cutting blade against the lens capsule during a surgical procedure—so as to assist in performing the cut through the capsule.

[0056] Attention is drawn to FIGS. **5**A to **5**C and to the respective FIGS. **6**A to **6**C to discuss activation of driving mechanism **18** and its effect on the rotational orientation of cutting blade **143** about its pivot. In FIG. **5**A, an initial ‘home’ position of driving wheel **181** about axle **165** is seen. The dotted line provided in FIGS. **5**A to **5**C and maintained to have the same angular positions throughout these figures, passes in FIG. **5**A through the location where link **99** connecting bar **182** to driving wheel **181** is located.

[0057] FIG. **6**A provides a view of cutting blade that corresponds to the ‘home’ position of driving mechanism in FIG. **5**A. Rod **141** in this ‘home’ position may be at a retracted proximal position maintaining the cutting blade in a respective ‘home’ position in which the ‘activation spoke’ coupled to the rod may be generally aligned with or at a relative small angle α (preferably smaller than 20 degrees) to axis X.

[0058] In this ‘home’ position, the spoke members are angularly arranged to permit suitable compression (inter alia via their respective twist regions T.sub.B) for obtaining the required compressed profile needed when distally advancing of the cutting blade through the distal portion **1231** of pathway **123** or while retracting the cutting blade via same distal portion **1231** e.g. after completion of a surgical procedure.

[0059] FIGS. **5**B and **5**C illustrate further rotation of driving wheel, here in a counter clockwise direction as can be seen by transitions in the location of link **99** acting here as a so-called marker indication amount of rotation relative to the dotted line that remains fixed in its angular orientation. The effect that such further rotation may have on the cutting blade can be seen in FIGS. **6**B and **6**C, respectively.

[0060] FIG. **6**B exemplifies that a further incremental rotation of the driving wheel (from the position in FIG. **5**A to that in FIG. **5**B) advances rod **141** slightly further in the distal direction and consequently urges further rotation of the cutting blade. In FIG. **6**C a yet further incremental rotation of the driving wheel (from the position in FIG. **5**B to that in FIG. **5**C) advances rod **141** yet further in the distal direction, thus further urging rotation of the cutting blade. Oscillating the driving wheel back and forth about its axle may thus urge a corresponding oscillation of the cutting blade about its pivot.

[0061] Attention is drawn to FIGS. **7**A and **7**B illustrating in FIG. **7**A an embodiment of the cutting blade generally similar to that already discussed hereinabove and in FIG. **7**B an embodiment of a cutting blade generally similar to the one discussed but with a wider body that includes an arc shaped slit through which the rod can pass on its way to reach and couple with the ‘activation spoke’.

[0062] FIG. **8** provides a view exemplifying one option of a guide **55** suitable for ensuring that the drive wheel may be guided to its ‘home’ position when attempting to retreat the cutting blade back through passageway **1231**. Guide **55** in this example may be in the form of a cover placed proximal to the location where the driving mechanism is positioned when activating rotation at the cutting blade. Guide **55** may be provided with a key way **551** and drive wheel is provided with key **552**.

[0063] Retracting piston in the proximal direction may in this example urge key **552** to engage key

way **551** that consequently guides and urges the driving wheel to rotate and align towards its 'home' position thus also urging the cutting blade towards its 'home' position (seen in FIG. **6**A) suitable for retraction via passageway **1231**.
[0064] Attention is drawn to FIG. **9**A to **9**C illustrating various driving mechanisms suitable for urging rotating and/or oscillation of the cutting blade other than the discussed driving mechanism **18**. FIG. **9**A illustrates an example of a slider **800** arranged for transferring linear movement to rotational reciprocating movement via a crankshaft to the cutting blade e.g. via means of a rod generally similar to rod **141** discussed herein.
[0065] FIG. **9**B illustrates an example of use of a driving mechanism in form of a motor **810** e.g. a DC motor for urging reciprocating movements in a cutting blade here via a crankshaft. FIG. **9**C illustrates an example of use of a driving mechanism in form of a DC motor or solenoid **820** for urging reciprocating movements in a cutting blade here via a slanted disc engaged with a rod such as rod **141**.
[0066] Attention is drawn to FIGS. **10**A and **10**B exemplifying a fixing mechanism **995** possibly used for ensuring that a defined fixed position may be reached during use of various capsulotomy device embodiments—where the capsulotomy device(s) may be in their respective 'operative' position(s) (seen e.g. in FIG. **5**) suitable for performing a surgical cutting procedure.
[0067] In this example, piston **16** may include along its shaft a snap member **999** and a stop **998**. When the piston may be urged in the distal direction (e.g., from the position seen in FIG. **1**A to that in FIG. **3**), snap member **999** may engage a snap arm **997** adapted to snap onto snap member **999** when engaged therewith. This snapping engagement between snap arm **997** and snap member **999** may define a state identifiable by a surgeon using the device that may indicate that the device reached its operative position suitable for performing a cutting action.
[0068] Once a surgical procedure has been completed, and in order to release the snapped state holding the device in its operative position, a surgeon may manipulate a lever **996** fixed e.g. to device's base, which may be adapted to move and bear back against stop **998** in the proximal direction to urge the piston away from the snapped state e.g. to the position seen in FIG. **2** where the cutting blade may be retreated to within the loading chamber or to any other position within and along pathway **123**.
[0069] In at least certain embodiments, fixing mechanism **995** may be arranged to function by fingers of the same hand activating movement of the piston—so that e.g., to activate the lever **996** a surgeon handling the device may not need remove his hand from the location it otherwise would be in during normal use.
[0070] Attention is drawn to FIG. **11** illustrating an embodiment of a capsulotomy device **100** hand-piece that includes an actuated piston **160**. Such hand-piece may be a of a one piece disposable type. Piston **160** in one example may be electrically actuated.
[0071] In a first actuated state, piston **160** may be arranged to urge the device's blade holder **140** in a distal direction so that the device assumes an operative position suitable for performing a cutting operation. In a second actuated state, piston **160** may be arranged to retract the device's blade holder **140** back in a proximal direction so that the device's cutting blade **143** is retracted back towards the device's loading chamber **122**.
[0072] In FIG. **11** capsulotomy device **100** is shown in its retracted state. It is noted that piston **160** may be combined with driving mechanisms (such as those in FIGS. **9**A and **9**B) such that in addition to actuated extension and retraction of the device's blade holder, the reciprocating movements of the device's cutting blade may be also actuated (e.g. electrically actuated).
[0073] Actuation of piston **160** and/or driving mechanisms for urging oscillation may be activated via means such as a foot pedal **180** as illustrated in the figure. A possible control box **280** receiving inputs from the pedal may include electronic components that generate an electric impulse and/or output signal that may in turn be transferred to the hand-piece of the capsulotomy device **100**. Toggles provided at the control box **280** may permit adjustment of the frequency of the oscillation

(power of the impulse) and may permit plugging in or unplugging of different single use hand-pieces and/or different pedals.
[0074] In the description and claims of the present application, each of the verbs, “comprise” “include” and “have”, and conjugates thereof, are used to indicate that the object or objects of the verb are not necessarily a complete listing of members, components, elements or parts of the subject or subjects of the verb.
[0075] Further more, while the present application or technology has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and non-restrictive; the technology is thus not limited to the disclosed embodiments. Variations to the disclosed embodiments can be understood and effected by those skilled in the art and practicing the claimed technology, from a study of the drawings, the technology, and the appended claims.
[0076] In the claims, the word “comprising” does not exclude other elements or steps, and the indefinite article “a” or “an” does not exclude a plurality. A single processor or other unit may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures can not be used to advantage.
[0077] The present technology is also understood to encompass the exact terms, features, numerical values or ranges etc., if in here such terms, features, numerical values or ranges etc. are referred to in connection with terms such as “about, ca., substantially, generally, at least” etc. In other words, “about 3” shall also comprise “3” or “substantially perpendicular” shall also comprise “perpendicular”. Any reference signs in the claims should not be considered as limiting the scope.
[0078] Although the present embodiments have been described to a certain degree of particularity, it should be understood that various alterations and modifications could be made without departing from the scope of the invention as hereinafter claimed.

Claims

1. A cutting blade for a capsulotomy device having a unitary one-piece construction, the cutting blade comprising a circular body and a plurality of spoke members integral with the body and extending each away from different circumferential locations about the body to meet at a central region of the cutting blade.
2. The cutting blade of claim 1 and comprising a pivot at the central region of the cutting blade where all spoke members meet that defines an axis of rotation of the cutting blade.
3. The cutting blade of claim 2, wherein each spoke member is formed with at least one twist region, possibly by twisting spoke members and/or by forming curved regions is spoke members.
4. The cutting blade of claim 3, wherein the at least one twist region permits twisting of the cutting blade about an axis generally parallel to the axis of rotation of the cutting blade.
5. The cutting blade of claim 1, wherein the circular body comprises a circular cutting edge along its circumference.
6. The cutting blade of claim 2, wherein the circular body comprises a circular cutting edge along its circumference.
7. The cutting blade of claim 1, wherein the entire cutting blade is formed of the same material.
8. The cutting blade of claim 2, wherein the entire cutting blade is formed of the same material.
9. A method of forming a cutting blade for a capsulotomy device comprising the steps of: providing a generally cylindrical piece of material, cutting away excess material from the cylindrical piece of material to leave a skeleton comprising a circular body and a plurality of spoke members extending away from the body, and bending the spoke members to merge at a central region of the cutting blade.
10. The method of claim 9, wherein bending comprises twisting each spoke member, preferably

twisting each spoke member at least twice, to form at least one twist region in each spoke member.
11. The method of claim 9, wherein, possibly prior to bending, spoke members are cut to form curved region(s) therein or therealong to form at least one twist region in each spoke member.
12. The method of claim 9, wherein the cutting blade comprises elastic material.
13. The method of claim 12, wherein the material of the cutting blade comprises nitinol.
14. The method of claim 9, wherein the circular body comprises a circular cutting edge along its circumference.
15. The method of claim 12, wherein the circular body comprises a circular cutting edge along its circumference.
16. The method of claim 9, wherein the entire cutting blade is formed of the same materials.
17. The method of claim 12, wherein the entire cutting blade is formed of the same materials.