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(54) **PHACOEMULSIFICATION NEEDLE**

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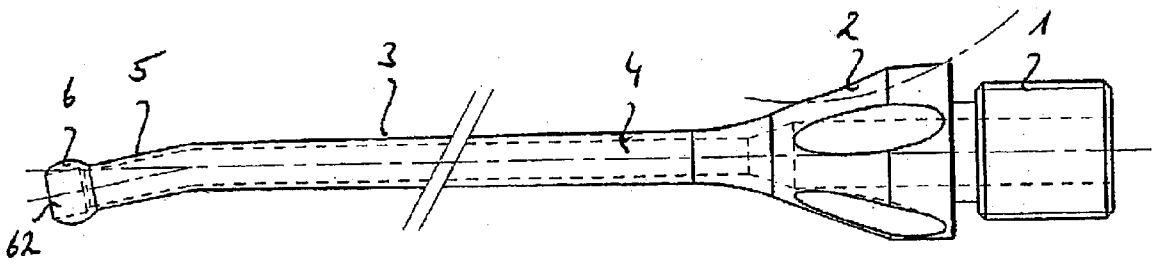
(57) **ABSTRACT**

The phacoemulsification needle according to the invention comprises a shaft, a tip disposed at a distal end of said shaft, the tip having a larger outer diameter than said shaft and an aspiration lumen extending through said shaft and said tip. The tip has an opening communicating with said aspiration lumen, a ball-shaped surface and a flat distal end comprising said opening. This needle can be used for removal of the cataract nucleus as well as for removal of the residual tissue.



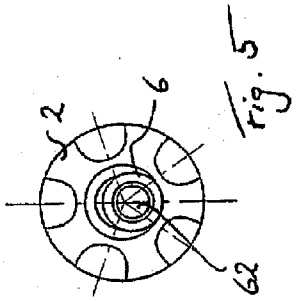


Fig. 5

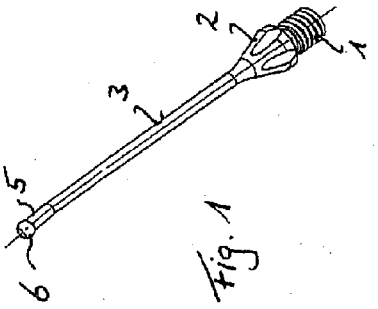


Fig. 1

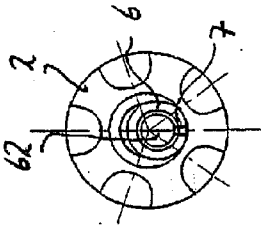


Fig. 6

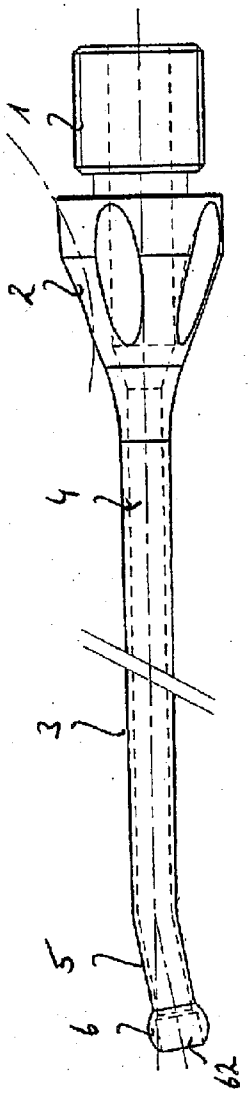


Fig. 2

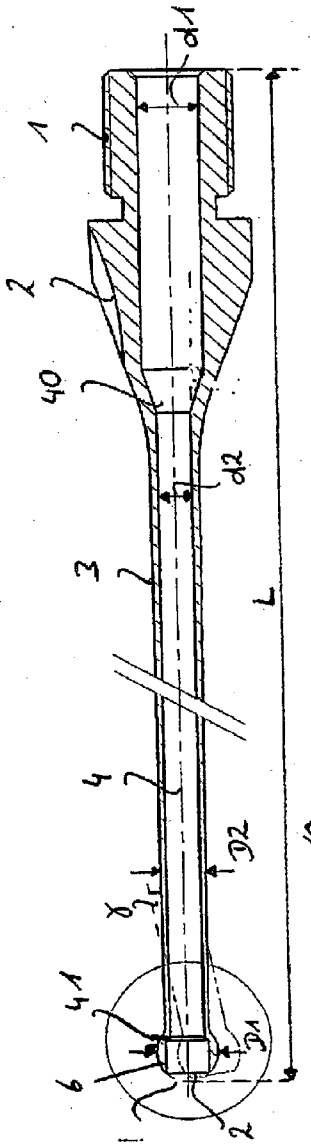


Fig. 3

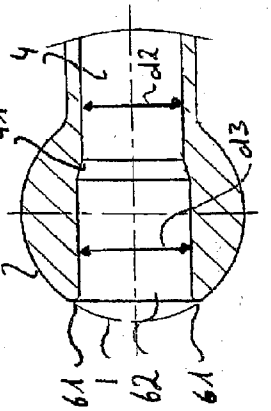


Fig. 4

PHACOEMULSIFICATION NEEDLE

FIELD OF THE INVENTION

[0001] This invention relates to a phacoemulsification needle for an ultrasonic surgical instrument, the needle being designed for promoting cavitation in eye tissue and for the removal of fragmented lens from the eye.

BACKGROUND OF THE INVENTION

[0002] Phacoemulsification has become the preferred form of cataract, i.e. a cloudy eye lens, removal. One of the main advantages of phacoemulsification is, that only a small incision into the cornea or sclera of an eye is needed to remove the cataract. Furthermore, the removal of the cataract can be done very quickly. After the cataract is removed, an intraocular lens is inserted to replace the original lens.

[0003] The phacoemulsification technique uses a hand held microsurgical tool known as phacoemulsifier. This phacoemulsifier comprises a handpiece and a small diameter needle with a tip to be inserted into the small incision of the eye. The needle and therefore the tip are vibrated by an ultrasonic source. It breaks the cataract into small fragments and pieces, which are sucked out through the same tip in a controlled manner. The tip is therefore designed for emulsifying, fragmenting and/or cutting tissue and also comprises a central hollow bore or lumen for the suction or aspiration of the fragments.

[0004] During the procedure, an irrigation solution is introduced to maintain the pressure and to prevent the eye from collapsing. In order to introduce the irrigation solution, the needle is usually covered by a sleeve and the solution flows via the space between this sleeve and the needle. The solution is therefore also used to cool the tip, which is heating up during the phacoemulsification.

[0005] Usually, the needle and often the handpiece must be changed after the removal of the cataract nucleus in order to remove the residual cortex. It takes time to change the handpiece and the continuation of the surgery is disrupted.

[0006] U.S. Pat. No. 5,653,724 discloses a phacoemulsification needle which is angled to provide more comfortable ergonomic angle during phacoelmulsification and lens cortex removal. This angled needle is also considered to produce less heat when emulsifying the lens. Another angled phacoemulsification needle with a concentric sleeve is disclosed in U.S. Pat. No. 5,993,409.

[0007] Different shapes of phacoemulsification needles with slits, a second infusion hole and/or with increased outside diameter at the distal end of the needle body and the needles being surrounded by 4 sleeves are described in U.S. Pat. No. 5,989,209, U.S. Pat. No. 6,591,175, EP-A-1,103, 238, WO 00/74615 and U.S. 2002/0099325.

[0008] Other techniques for cataract removal use laser energy to remove the cataract. A laser/aspiration probe is used for breaking and removing the lens. A separate infusion or irrigation probe. is used for the irrigation solution.

SUMMARY OF THE INVENTION

[0009] It is an object of the invention to provide a phacoemulsification needle which can be used for the removal of the cataract nucleus as well as the residual cortex.

[0010] This object is achieved with a phacoemulsification needle comprising

[0011] a shaft,

[0012] a tip, disposed at a distal end of said shaft, said tip having a larger outer diameter than said shaft and

[0013] an aspiration lumen extending through said shaft and said tip, the tip having an opening communicating with said aspiration lumen,

[0014] wherein said tip has a ball-shaped surface and wherein the tip has a flat distal end comprising said opening.

[0015] With this ball-shaped tip design and the opening arranged at the flat distal end, it is possible to remove both the cataract nucleus and the residual cortex.

[0016] The needle according to the invention can be used with or without an irrigation sleeve.

[0017] In a preferred embodiment, the tip has at its distal end rounded edges. This avoids unwished damage of tissue.

[0018] In a preferred embodiment, the tip comprises a slit extending in longitudinal direction of the needle. When a high vacuum setting is used with the phacoemulsifier, the anterior chamber, formed of a part of the lumen extending in the tip, becomes unstable when occlusion break occurs. In this case, small amount of irrigation fluid will continue to flow through the aspiration lumen. Furthermore, when occlusion surge occurs, the amount of surge can be reduced.

[0019] Further preferred embodiments of the invention are described in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The present invention will be more clearly understood with reference to the following detailed description of preferred embodiments, taken in conjunction with the accompanying drawings, in which

[0021] **FIG. 1** shows a perspective view of a needle according to the invention in a first embodiment;

[0022] **FIG. 2** shows a side view of the needle according to **FIG. 1**;

[0023] **FIG. 3** shows another side view of the needle according to **figure 1**;

[0024] **FIG. 4** shows a magnified part of the needle tip according to **FIG. 3**;

[0025] **FIG. 5** shows a front view of the needle according to **FIG. 1** and

[0026] **FIG. 6** shows a front view of a needle according to a second embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] With reference to **FIGS. 1 and 2**, there is shown a phacoemulsification needle in accordance with the present invention. The needle may be formed from any conventional material as is known in the art for the manufacture of phacoemulsification needles. Usually, it is made of titan.

[0028] The needle comprises, starting with its proximal end and ending with its distal end, a threaded portion **1**, a hub **2**, a shaft **3** and a tip **6** having an opening. The threaded portion **1** and the hub **2** are used to fix the needle on a ultrasonic device of the phacoemulsification handpiece (not shown) in order to couple ultrasonic energy to the needle.

[0029] The needle further comprises, with reference to **FIGS. 3 and 4**, an aspiration lumen **4** extending through the whole longitudinal length of the needle shaft **3** and communicating with the opening of the tip for aspiration of irrigation fluid and therefore for removal of fragments and pieces of the cataract nucleus and residual cortex. Preferably, the lumen **4** comprises a first step **40** in the region of the hub **2** neighboring the shaft **3**. The first diameter d1 of the part of the lumen extending within the hub **2** is therefore larger than the second diameter d2 of the lumen part extending within the shaft **2**. This first step **40** has preferably a conical shape.

[0030] A second step **41**, which has preferably also a conical shape, is located within the tip **6**, wherein the second diameter d2 is smaller than a third diameter d3 of the lumen part extending within the shaft **2**. This diameter d3 corresponds with the diameter of the opening of the tip **6**.

[0031] With exception of the steps **40**, **41**, the lumen **4** preferably has throughout its whole length the same size. In particular the lumen part extending in the tip **6** has a cylindrical shape.

[0032] The shaft **3** is preferably angled. However, it is also possible to have a rectilinear shaft. In the here described embodiment however, the shaft **3** comprises an angled portion **5** neighboring the tip **6**. The aspiration lumen **4** within the tip extends in a rectilinear way.

[0033] The tip **6** as shown in **FIG. 5** as well and which is arranged at the distal end of the shaft **3**, has a larger outer diameter D2 than the outer diameter D1 of the shaft **3**. Furthermore, it has a ball-shaped surface **60** and a flat distal end **62**. In this preferred embodiment, the flat distal end **62** is formed by the opening. However, the opening can also be smaller, so that the end face of the tip **6** is flat. In the here described embodiment however, the end face is formed by rounded blunt edges **61**. The above mentioned second step **41** is preferably located in the tip **6** itself at a distance to the transition of the ball-shaped surface **60** to the surface of the shaft **3**. In **FIG. 4**, a curved line **1** is shown at the distal end of the tip **6**. This line **1** is just an auxiliary line showing that, with exception of the flat distal end, the tip has a completely spherical surface.

[0034] A preferred embodiment of the inventive needle has an outer diameter D2 for the shaft **2** of approximately 1.06 mm, an outer diameter D1 of the tip **6** of approximately 1.6 mm, a first diameter d1 of the lumen **4** of approximately 1.32 mm, a second diameter d2 of approximately 0.72 mm, a third diameter d3 of approximately 0.8 mm, a length L of the tip **5** (extending up to the curved line l) of approximately 1.46 mm and a distance X from the curved line l to the second step **41** of approximately 1.05 mm. The radius of curvature of the rounded edges **61** is approximately 0.15 mm, the angle of the first step **40** approximately 34° and the angle of the second step **41** approximately 30°. The angle γ between shaft **3** and tip **4** lays between 10 and 15°. Here it is approximately 15°. The total length of the needle up to the curved line **1** is approximately 30.15 mm.

[0035] **FIG. 6** shows a second preferred embodiment of the needle according to the invention. The needle is built in the same way as the needle according to the previously described figures. The only difference is, that this tip **6** comprises a slit. **7** extending in longitudinal direction of the needle, which communicates with the aspiration lumen **4**.

[0036] The needle according to the invention can be used for the ultrasonic part of the phacoemulsification procedure, i.e. for the removal of the cataract nucleus, as well as for the irrigation/aspiration part of the procedure, i.e. for the removal of the residual tissue.

List of Reference Numbers

[0037] **1** threaded portion

[0038] **2** hub

[0039] **3** shaft

[0040] **4** lumen

[0041] **40** first step

[0042] **41** second step

[0043] **5** angled portion

[0044] **6** tip

[0045] **60** ball-shaped surface

[0046] **61** rounded edges

[0047] **62** flat distal end

[0048] **7** slit

[0049] d1 first diameter

[0050] d2 second diameter

[0051] d3 third diameter

[0052] D2 outside diameter of the shaft

[0053] D1 outside diameter of the tip

[0054] L length of the tip

[0055] l curved line

[0056] X distance

[0057] γ angle

1. A phacoemulsification needle comprising

a shaft,

a tip, disposed at a distal end of said shaft, said tip having a larger outside diameter than said shaft and

an aspiration lumen extending through said shaft and said tip, the tip having an opening communicating with said aspiration lumen,

wherein said tip has a ball-shaped surface and. wherein the tip has a flat distal end comprising said opening.

2. The needle according to claim 1, wherein said tip has at its distal end rounded edges.

3. The needle according to claim 1, wherein said flat distal end is formed by said opening.

4. The needle according to claim 1, wherein the part of said aspiration lumen extending within the tip is rectilinear.

5. The needle according to claim 1, wherein the needle is angled.

6. The needle according to claim 1, wherein said opening has a larger diameter than the part of the aspiration lumen extending within said shaft.

7. The needle according to claim 1, wherein said aspiration lumen comprises a conical step within the tip.

8. The needle according to claim 1, wherein said opening has a diameter of approximately 0.8 mm.

9. The needle according to claim 2, wherein said edges have a radius of curvature of approximately 0.15 mm.

10. The needle according to claim 1, wherein said tip comprises a slit extending in longitudinal direction of the needle and communicating with said aspiration lumen.

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