GLAUCOMA A CLOSER LOOK

WHAT IS GLAUCOMA

The LIGHTLas YAG is used to treat Glaucoma, the leading cause of blindness in North America and Europe, and the second leading cause of blindness worldwide. It is estimated that approximately 65 million people are diagnosed with the disease in 2011, with the prevalence set to grow to 80 million by 2020.

Glaucoma is particularly dangerous because in many cases and its variants, it can progress gradually and go unnoticed for years causing irreversible damage.

Glaucoma (rather a group of conditions) is a disease associated with abnormal pressure inside the eye, which eventually causes damage to the optic nerve and permanent loss of vision. In a normal eye, aqueous fluid is constantly produced in the ciliary body and drained from the eye at a balanced rate.

The green ring outlining the gradual enlarging optic nerve "cup" shows the progression of the disease.

The formation and drainage of aqueous fluid determines the eye’s intraocular pressure, or IOP. Blockage or obstruction of this drainage restricts the balanced flow of aqueous fluid and causes a rise in the IOP.

In all cases, the resulting damage is demise of retinal nerve cells leading to irreversible loss of vision.
WHAT CAUSES GLAUCOMA

Although risk factors for glaucoma include heredity, diet, smoking and age, its actual cause remains often unclear even by today’s technology.

Clear liquid called aqueous humor circulates inside the front portion of the eye. To maintain a healthy level of pressure within the eye, a small amount of this fluid is produced constantly while an equal amount flows out of the eye through a microscopic drainage system. (This liquid is not part of the tears on the outer surface of the eye.)

Because the eye is a closed structure, if the drainage area for the aqueous humor—called the drainage angle—is blocked, the excess fluid cannot flow out of the eye. Fluid pressure within the eye increases, pushing against the optic nerve and causing damage.

WHAT ARE THE DIFFERENT TYPES OF GLAUCOMA

CLOSED (ACUTE) ANGLE GLAUCOMA

Some people have a naturally narrow anterior chamber angle between the iris and trabecular meshwork. This angle can suddenly close, giving rise to acute angle closure glaucoma. Since the fluid cannot exit the eye, pressure inside the eye builds up very rapidly and causes an acute closed-angle attack.

Symptoms may include:

- Blurred vision.
- Severe eye pain.
- Excessive headache.
- Rainbow-coloured halos when looking at bright objects.
- Nausea and vomiting.
This is a true eye emergency as irreversible vision loss may occur fast.

Two-thirds of those with closed-angle glaucoma develop it slowly and without any symptoms prior to an attack.

Closed Angle Glaucoma affects particularly the Asian population, and an immediate Laser treatment is necessary to save the Optic Nerve. This treatment is called Laser Iridotomy.

**PRIMARY (CHRONIC) OPEN-ANGLE GLAUCOMA (POAG)**

Is the most common form of Glaucoma affecting approximately 75% of sufferers? The risk of developing chronic open-angle glaucoma increases with age. The drainage angle of the eye becomes less efficient over time, and pressure within the eye gradually increases, which can damage the optic nerve. In some patients, the optic nerve becomes sensitive even to normal eye pressure and is at risk for damage. Treatment is necessary to prevent further vision loss.

**WHAT IS CATARACT**

The LIGHTLas YAG is used to treat Secondary Cataract, that progresses in up to 45% of post Primary Cataract surgery cases, however to fully appreciate its scope and application it is important to first understand the primary cause.

Cataract is the most common and treatable vision impairment and cause of blindness in the World, whilst treatment is one of the most frequently performed surgical procedures. During a treatment at an outpatient clinic, the natural crystalline lens, which has become cataractous, is replaced with an artificial lens. The treatment itself today takes about 15 to 20 minutes and is performed with a Phaco Device such as the LightMed LightSonic™, whilst the entire procedure including pre and post op patient care will not take longer than 3-4 hours.
It is accepted that eventually Cataract will affect us all. With time, our natural crystalline lens in our eyes becomes opaque, and our visual acuity deteriorates. Cataract is primarily observed in the elderly where it is referred to as senile cataract.

Cataract, however, is also a phenomenon increasingly witnessed in younger people and can even be congenital. Cataract is also known to accelerate for people suffering from Glaucoma, or those having undergone recent Glaucoma treatments.

The Natural Crystalline Lens

The natural lens, like the cornea, makes sure that the light rays, which enter the eye, are refracted. This results in a sharp image on the retina. The lens has a diameter of about 9 mm, is 5 mm thick and has a convex front and rear side. The lens is clear and transparent which enables light to pass through it easily.

The natural crystalline lens consists of several elements:

- The lens capsule, an elastic membrane enveloping the lens,
- The cortex, the outer shell
- The nucleus

What causes Cataract

The lens lies behind the iris and the pupil. It works much like a camera lens. It focuses light onto the retina at the back of the eye, where an image is recorded. The lens also adjusts the eye’s focus, letting us see things clearly both up close and far away. The lens is made of mostly water and protein. The protein is arranged in a precise way that keeps the lens clear and lets light pass through it.
However, as we age, some of the protein may clump together and start to cloud a small area of the lens. This is a cataract. Over time, the cataract may grow larger and cloud more of the lens, making it harder to see.

Researchers suspect that there are several causes of cataract, such as smoking and diabetes. Alternatively, it may be that the protein in the lens just changes from the wear and tear it takes over the years. Clouding of the crystalline lens by natural age progression. In younger population, the Crystalline Lens is usually soft, flexible and “crystal” clear so that it has excellent transparency and optical clarity. As we progress through our 50’s and 60’s, the normally “crystal” clear lens will gradually become yellow and cloudy.

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and optical clarity. As we progress through our 50’s and 60’s, the normally “crystal” clear lens will gradually become yellow and cloudy.

Cataract Treatment

The symptoms of early cataract may be improved with new eyeglasses, brighter lighting, anti-glare sunglasses, or magnifying lenses. If these measures do not help, surgery is the only effective treatment. Surgery involves removing the cloudy lens and replacing it with an artificial lens.

A cataract needs to be removed as soon as the vision loss interferes with the everyday activities of the sufferer, such as driving, reading, or even watching TV. In most cases, delaying cataract surgery will not cause long-term damage to the eye or make the surgery more difficult, however at times the cataract should be removed even if it does not cause problems with the vision. For example, a cataract should be removed if it prevents examination or treatment of another eye problem, such as age-related macular degeneration or diabetic retinopathy.

There are two types of cataract surgery treatments:

- Phacoemulsification (Phaco): A small incision is made on the side of the cornea, the clear, dome-shaped surface that covers the front of the eye. The surgeon inserts a tiny probe into the eye. This device emits ultrasound waves that soften and break up the lens so that it can be removed by suction.
- Extracapsular surgery: The surgeon makes a longer incision on the side of the cornea and removes the cloudy core of the lens in one piece. The rest of the lens is removed by suction.

After the natural lens has been removed, it often is replaced by an artificial lens, called the Intra-Ocular Lens (IOL). An IOL is a clear, plastic lens that requires no care and becomes a permanent part of your eye. Light is focused clearly by the IOL onto the retina, improving your vision. You will not feel or see the new lens.

In limited cases, some people cannot have an IOL, as they may have another eye disease or have developed problems during surgery. For these patients, a soft contact lens, or glasses that provide high magnification, may be suggested.

NOTE: Most cataract surgery today is done by Phacoemulsification, also called “small incision cataract surgery.” LightMed also offers the LightSonic™ Phacoemulsification system as well as superb quality IOL’s.
WHAT IS SECONDARY CATARACT

Secondary Cataract is the condition where the patient re-experiences the same kind of eye clouding after the initial cataract surgery has been performed. It is very common for the same symptoms that caused by the original cataract are perceived again during this condition.

About to 40% – 45% percent of patients tend to develop this condition after their first cataract surgery, and in accordance to the data published by US National Eye Institute (NEI: [www.nei.nih.gov](http://www.nei.nih.gov)) the prevalence of the secondary cataracts is set to continue to increase due to the introduction of new IOL’s compound materials.

The onset of a secondary cataract can occur months or years after the original surgery has been performed. If it happens in one eye, then it is more than likely it will happen in the other eye too.
Secondary cataract, which also known as ‘*posterior capsular opacification*’ happens due to the two following events:

- After the first surgery, there might be some leftover of natural lens cells that proliferate on the back of the capsule.
- The capsule becomes cloudy gradually and interferes with clear vision as the same way of the original cataract did.

According to a NEI research that was completed in 20011, the probability for a patient to develop a secondary cataract was 9% at the first year, 18% on the second year, 30% on the third years and as high as 45% between seven to nine years. Secondary cataract are more likely to happen in younger patients, those that suffering from diabetes or when cataract surgery is performed together with *vitrectomy (a process of clearance of debris from the fluid in the eye)*.

Secondary cataract is not very risky and it can be treated with a laser surgery. The doctor will use a laser to make a small hole on the cloudy capsule that is causing the problems and clear it. This is a very fast and safe procedure and it normally takes a few minutes to complete. As with the original surgery, this will involve common complications too such as glaucoma, retinal tears and inflammation and swelling.

![Secondary Cataract Opacification](image)
Typically, open-angle glaucoma has no symptoms in its early stages, and vision remains normal. As the optic nerve becomes more damaged, blank spots begin to appear in your field of vision. You typically will not notice these blank spots in your day-to-day activities until the optic nerve is significantly damaged and these spots become large. Once the optic nerve fibres die, blindness occurs. Its strains can be further defined as:

- “Normal Tension”, which exists in eyes that do not tolerate seemingly normal pressure.
- “Ocular Hypertension”, a condition in which the IOP is high without loss of visual field.

**Primary (Chronic) Open-angle Glaucoma (POAG) can be effectively treated with Selective Laser Trabeculoplasty (SLT).**

**YAG LASER CLINICAL APPLICATIONS**

The following section is dedicated to provide an overview of clinical applications of the Nd: YAG 1064nm Laser Photodisruptor.

**INTENDED APPLICATIONS**

The LightLas YAG is mainly intended for clinical use in:
THEORY OF OPERATION

The LightLas YAG uses a pulsed mode of operation commonly called Q-switching. In this system, a component called a Crystal Q-switch is added to the laser system to cause the laser to produce a short pulse (of the order of a few nanoseconds) each time the laser is fired.

The Q-switch can produce a number of laser pulses for a single firing of the flash lamp (laser cavity). The number of pulses emitted is proportional to the energy input to the laser cavity, which is provided by a conventional capacitor-charging power supply.

When the instrument is ready for firing and the fire switch on top of the joystick is pressed, the microprocessor initiates a series of safety checks. If these are successful, it then opens the safety shutter and sends a signal to the treatment laser power supply. This supplies pulses of electrical power to the laser, which converts them to pulses of laser energy. (To a naked eye, this process takes place in a fraction of a second)

The opened shutter allows the pulses of laser energy to enter a beam expander, which converts the 3 mm diameter laser beam to 27 mm diameter. The expanded beam is then reflected 90 degrees and enters an objective lens, which focuses the beam to a high energy spot of approximately 8μm in diameter.

The beam of the LightLas YAG, like that of other ophthalmological surgical lasers, is made up of short, individual pulses of focused infrared light with a wavelength of 1064nm.

The focused spot can be accurately positioned on the membrane or tissue within the patient’s eye with the aid of a slit lamp microscope and a ‘twin dot’ aiming system.

The energy of the laser pulses is readily adjustable, and is normally set at the lowest possible effective level in order to minimise unwanted side effects such as retinal detachment.

Photodisruption Effect

The 8μm spot produces a small ionization site (plasma) at the focal point. This creates an acoustic wave that disrupts nearby tissue in a process known as the ‘photo-disruptive effect’
Once formed, the plasma absorbs and scatters further incident light, and this shields the underlying structures from damage. The beam divergence after the focal point also protects the retina from damage that could otherwise occur by the absorption of concentrated treatment energy.

As the treatment energy is increased, the size of the plasma formed also increases, which causes a larger, stronger acoustic wave. To avoid the possibility of the plasma entering the intraocular lens (IOL) and causing cracking or chipping, and to allow the accompanying shock wave to grow to its most effective size, the treatment beam may be offset further behind the membrane to be penetrated.

Hence also posterior to the focal plane of the slit lamp, which is focused on the membrane). A posterior / anterior YAG offset control allows the doctor to select the amount of offset required.

**POSTERIOR CAPSULOTOMY**

**POSTERIOR CAPSULOTOMY**

Nd: YAG Laser Capsulotomy is the most successful and frequent indication of YAG laser application for removal of the secondary cataract tissue. It has long replaced surgical discussion by Zeigler’s knife of posterior capsule as a much safer alternative.

Indications

- Posterior capsular opacification (PCO) causing reduced visual acuity and or excessive glare.
- PCO with inadequate or very small YAG capsulotomy opening.
- Capsular distension following retention of residual viscoelastic material between posterior surface of intraocular lens (IOL) and transparent posterior capsule (In Cap [sulorhexis] clinically suspected by myopic error of refraction in postoperative follow up).
- Re-opacification (post Nd: YAG capsulotomy).

Posterior capsule opacification
Cataract extraction involves the removal of the natural lens of the eye, and this lens is usually replaced with a plastic intra-ocular lens (IOL) implant.

If one were to imagine the natural lens of the eye to be like a polythene bag full of jelly, then in the most common methods of cataract surgery, only the contents of the bag are removed.

The outer capsular bag or membrane of the lens is left in the eye, and is used to support the intra-ocular lens implant. In some cases following cataract extraction, cells grow on the capsular membrane, causing a progressive thickening and opacification of the lens capsule.

This leads to a gradual deterioration of vision, similar to the visual loss from the original cataract. The incidence of posterior capsular opacification varies but may be significant in up to 30% of people having cataract surgery.

Factors that account for the variability of capsular opacification include the design of the intra-ocular lens implant, and the type of material from which it is made. The age of the patient, the amount of inflammation in the eye following surgery and the length of time since the surgery was carried out are also important.

The Capsulotomy Procedure

If opacification of the lens capsule is affecting a patient’s vision, then treatment by YAG laser capsulotomy is generally recommended. The YAG laser emits an invisible infrared laser beam, which is used to create an opening in the lens capsule in the central pupillary area, such that light rays can once more pass clearly to the back of the eye. The YAG laser beam is focussed to a point inside the eye, and when the laser beam is fired, the high level of energy achieved at the focal point vaporises any tissue at the point of focus, and causes a small shock wave, which helps to physically disrupt the capsular membrane.

Since the capsule does not have any nerves in it, the procedure is completely painless. Typically, anaesthetic drops are put into the eye, so that a special contact lens can be applied to the corneal surface, in order to help focus the laser beam onto the lens capsule. During the treatment, the laser makes a small clicking sound when it is fired, and the patient may see little flashes of light from the plasma formations.

In Posterior Capsulotomy Procedure surgeon must particularly:

- Avoid possibility of the plasma entering the IOL, causing pitting & cracking
- Allow the accompanying shock wave to grow to its most effective size
- The reverse applies when smaller amounts of energy are used, when the focus should be brought closer to the membrane

Sequential Posterior Capsulotomy Steps

The Capsulotomy is developed in a horizontal and vertical pattern, with 1-2 mJ per pulse on average and a range of 1-3mJ, single pulse
A. The first shot is made at the top near fine tension lines

B. The second shot is aimed inside the lower edge of the initial opening

C. The next shot is made at the 6 o’clock position of the Capsulotomy border

D. The fourth shot is made below the tension lines to allow the Capsulotomy to widen

E. The opening is nearly 3mm wide, and a shot at the 3 o’clock Capsulotomy margin widens it further.

F. The opening is then directed left, with a shot at 9 o’clock.

G. The opening has been accomplished, but a triangular flap extends into the pupillary space from the 7:30 region in the left inferior pupil. A shot is applied to the flap, to both cut it and push it toward the periphery.

H. The Capsulotomy is complete, and the pupil will be clear of capsule when the dilation wears off.
Effects of YAG laser capsulotomy

The benefits from laser capsulotomy are generally apparent straight away after treatment, and patients can return to normal activities without any delay. It is often timely to have the spectacle prescription checked once the laser treatment has been done. Although some of the capsular membrane is actually vaporised by the YAG laser, the central part of the capsular membrane is usually broken free from its surrounding attachment, and fragments of the capsule are dispersed into the vitreous. These may be apparent to the patient as ‘floaters’, but are not generally troublesome. Because the lens capsule is in close contact with the intra-ocular lens implant, the laser may sometimes cause some pitting of the lens surface, but this seldom has any perceptible effect on the vision.

Rarely, after the laser treatment, there may be some inflammation in the eye, or the intra-ocular pressure may become raised. Very occasionally, the laser capsulotomy causes problems in the retina, such as retinal tears, retinal detachment, or water logging of the retina – cystoid macular oedema.
Long-term outcome

If an adequate opening in the lens capsule is achieved, a single laser treatment is all that is required. Although the lens capsular cells continue to grow and cause progressive thickening of the peripheral capsular membrane behind the iris, in the central pupillary area the support for the cells has been removed, so they cannot regroup there to cause further visual problems.

LASER IRIDOTOMY

LASER IRIDOTOMY

A YAG laser peripheral iridotomy (PI) is performed as the standard treatment (exclusively) for patients with Narrow Angles, Narrow angle Glaucoma, or Acute angle Closure Glaucoma.

Narrow angle Glaucoma

There are a number of different types of glaucoma, and these glaucoma conditions have in common the fact that the pressure inside the eye is raised, and that this causes damage to the optic nerve, and to the field of vision.

Narrow angle glaucoma refers to a situation where the rise in IOP is due to obstruction of the flow of aqueous fluid out of the eye, because access to the normal drainage channels is obstructed by the narrowness of the angle between the iris and the cornea. In a normal eye, aqueous fluid is formed in the ciliary body behind the iris, and circulates over the surface of the lens, through the pupil, into the anterior chamber, and finally out through the trabecular meshwork.

Normally there is no obstruction of flow to the trabecular meshwork, but in some situations the access to the meshwork is closed off because the space between the iris and cornea becomes too
narrow. The reason that this situation arises is related to the size of the eye, the size of the lens, and the size of the pupil.

Laser Iridotomy Procedure

In the past, narrow angle glaucoma was treated surgically by cutting a small hole in the peripheral iris, to allow aqueous fluid to pass directly into the anterior chamber. By equalising the anterior and posterior chamber pressures, the forward bowing of the iris is eliminated, allowing it to fall back and open the drainage angle. Although surgical peripheral iridotomy is still an option, nowadays a similar effect can be achieved with a YAG laser such as the LightLas YAG providing a faster, safer and controllable option.

The YAG Laser beams are focussed onto the iris, and can be used to vaporise the iris tissue to create one or two small channels for the aqueous fluid to pass through. Typically, the treatment is carried out by putting anaesthetic drops into the eye, and placing a special contact lens onto the surface of the cornea to help focus the laser beam.

The treatment itself is virtually painless, and takes only a few minutes to complete. Normally the treatment does not affect the vision, but occasionally bleeding from the iris can cause temporary blurring of vision.
Effect of laser iridotomy

Provided that the laser treatment creates an adequately sized hole in the iris, the risk of developing acute angle-closure glaucoma is virtually eliminated by laser iridotomy treatment. In some patients, who have very narrow angles, which have been untreated for some time, the laser iridotomy will prevent acute angle-closure, but may not eliminate some chronic angle-closure. This may mean that additional medical or surgical treatment is required to reduce the intra-ocular pressure to normal.

It is thought that laser iridotomy can possibly accelerate cataract formation. If a cataract develops, this can be treated surgically in the normal way by cataract extraction with intra-ocular lens implantation. In patients who have narrow angles and who already have early cataracts, an alternative approach is to carry out cataract surgery as the only procedure, since by doing so the risk of angle closure is avoided. This is because the intra-ocular lens implant is physically smaller than the natural lens of the eye, and this allows the angle between the iris and cornea to open up.
YAG LASER MEMBRANECTOMY

YAG laser membranectomy is effective in reopening blocked glaucoma tube shunts.

Thick nonelastic papillary membrane in front of the intraocular lens caused significant reduction of vision often restricted to perception of light and projection of rays.

It is very important to assess thickness, density and type of membrane by slit-lamp biomicroscopy.

**Indications**

- Inflammatory papillary membrane after extra capsular extraction of lens with or without posterior chamber intraocular lens particularly in diabetic patients and patients with residual cortical matter.
- Patients with above indication and poor risk for further surgical procedure.

**General Steps**

1. Explain the procedure: May require multiple sessions.
2. Signing informed consent
3. Anti-glaucoma medication: (example only) 1 drop Apraclonidine (1%) or Brimonidine tartrate (0.15%-1.2%) eye drop one hour before the procedure is sufficient.
4. Mydriasis: (example only) Tropicamide (1%) eye drop applied topically starting 2 hours before the laser application.
5. Anesthesia: Usually contact lens is applied.
7. Steady fixation.
8. Contact lens: Usually Required
10. Adjustment of slit lamp.

**Membranectomy Technique Proper**
1. Membranectomy requires high energy per pulse ranging from 4.5 to 11mJ due to increased thickness and lack of elasticity property of the membranes.

2. The energy per pulse is gradually increased until the thick membrane begins to disrupt.

3. Frequently more than 100 shots are required to achieve a visually significant opening in the papillary area from a Q-switched Nd: YAG laser.

4. The papillary opening is created by “Chipping away technique” at the edge of the membrane bit by bit. The membrane is detached from papillary margin and allows it to dilate. Residual membrane may remain attached to one side without causing any visual disturbance.

**Post Membranectomy Treatment Advice**

This is the same as that advised after Nd: YAG capsulotomy (see chapter 20) but for a prolonged duration. This is due to the fact that post-laser elevation of intraocular pressure and inflammation may be more pronounced than with Nd: YAG laser capsulotomy.

**Potential post-op Complications**

All complications are directly proportional to the energy level and number of pulses applied.

- Uveitis: It may occur from liberation of residual cortex.
- Elevated IOP: It is largely due to block of trabecular outflow by cellular debris.
- Phacoanaphylactic uveitis.

**YAG LASER SWEEPING**

YAG Laser Sweeping (or lens Polishing) is a procedure to remove precipitates and / or pigments from the surface of the intraocular lens (IOL).

In this technique, the laser beam is at first focused at the deposits/precipitates/pigments and then slightly defocused anteriorly in the aqueous by slightly pulling back the joystick of the slit lamp delivery system, then, the laser shots are fired in this way to dislodge the deposits/precipitates/pigments from the surface of the intraocular lens (IOL) by producing an acoustic shock wave in the anterior chamber to prevent damage to the IOL.

**Aetiology**

- Uveitis with iridolenticular synechiae formation
- Uveitis without synechiae formation
- Preoperative excess iris touch
• Blunt trauma.

Contraindication

Active uveitis

General Steps

1. Explain the procedure
2. Signing informed consent
3. Anti-glaucoma medication: 1 drop Apraclonidine (1%) or Brimonidine tartrate (0.15-0.2%) eye drop one hour before the procedure is sufficient.
4. Mydriasis: Pupil should be mid-dilated with a single drop of Tropicamide (1%) eye drop applied topically fifteen minutes before the laser application.
5. Anaesthesia: Usually not required unless contact lens is applied.
7. Steady fixation.
8. Contact lens: Usually not required.
10. Adjustment of slit lamp.

Nd: YAG Sweeping Technique Proper

1. Usually 0.2 to 1.0mJ of energy per pulse is sufficient.
2. Usually 5-20 shots are sufficient to get rid of deposits or pigments from the surface of intraocular lens (IOL) from a Q-switched Nd: YAG laser.
3. The laser beam is at first focused at the deposits/precipitates/pigments and then slightly defocused anteriorly in the aqueous by slightly pulling back the joystick of the slit lamp delivery system of the Nd: YAG laser (Fig.21.1)
4. The laser shots are fired in this way to dislodge the deposits/precipitates/pigments from the surface of the intraocular lens (IOL) by producing an acoustic shock wave in the anterior chamber (as per below figure) to prevent damage to the IOL.
Post op Advice

Nd: YAG laser sweeping causes minimal post laser intraocular pressure spike and minimal post laser inflammation.

- Control of raised IOP: Timanol maleate (0.5%)-One drop twice daily from 3 – 7 days.
- Reduction of inflammation: 0.1% Dexamethasone phosphate or 1% Prednisolone acetate eye drop-1 drop 4 times daily for 3 – 7 days.

YAG LASER CORTICOLYSIS

YAG LASER CORTICOLYSIS

YAG laser corticolyis is a treatment applied to accelerate the process of absorption of residual cortical matter after extra capsular extraction with or without implantation of intraocular lens (IOL) is called corticolyis.

In this technique laser is focused posterior to intraocular lens (IOL) and within the substance of retained cortical matter, whilst its main aim is NOT to disrupt the posterior capsule.
Several laser shots are then fired onto the cortical matter until it becomes “milky”.

**General Steps (Typical)**

1. Explain the procedure.
2. Signing informed consent.
3. Anti-glaucoma medication: (example only) 1 drop Apraclonidine (1%) or Brimonidine tartrate (0.15-0.2%) eye drop one hour before the procedure is sufficient.
4. Mydriasis: Pupil should be mid dilated with a single drop of (example only) Tropicamide (1%) eye drop applied topically fifteen minutes before the laser application.
5. Anesthesia: Usually not required unless contact lens is applied.
7. Steady fixation.
8. Contact lens: Usually not required.
10. Adjustment of YAG slit lamp.

**Corticolysis Technique Proper**

1. Usually 4 to 5 mJ of energy per pulse from the YAG laser is the adequate energy measure.
2. Pulse mode is preferred over double burst mode.
3. YAG laser is focused posterior to intraocular lens (IOL) and within the substance of retained cortical matter.
4. The aim is not to disrupt the posterior capsule.
5. Laser shots are fired several times and the cortical matter becomes “milky” after application of few shots.

**Post laser advice**

The same as that advised YAG posterior capsulotomy, although elevation of IOP and inflammatory reactions may be more slightly pronounced than with Nd: YAG posterior capsulotomy. The absorption of residual cortical matter is usually completed within one week.

**YAG POSTEROIR SEGMENT VITREOLYSIS**

Application of Nd: YAG (both Q-switched and mode locked) in the posterior segment of eye for transection of vitreous membrane and or band is technically much more difficult and riskier than its application in the pupillary plane or anterior segment.

This procedure is also referred to as “YAG Phototransetino”.

**Indications**

It is a non-invasive procedure for:
- Section of elastic vitreous traction band and or membrane to release traction on the retina.
- Section of optically disturbing elastic or fragile vitreous and or membrane.
- Section of vitreoretinal bands along the pathway of intra-ocular foreign body.
- Section of vitreous traction band attached to operculum of a retinal tear (Figs A and B).

Fig. A and B: YAG Phototransection of traction band attached to operculum of a retinal tear (A) Vitreous traction band attached to the operculum of a horse shoe retinal tear. (B) Apex of the operculum with attached Vitreous traction band is cut using Q-switched Nd: YAG laser. The attached retinal area surrounding the tear should also be photocoagulated (2/3 rows of linear, interrupted and interval = 1/4th of spot size coagulations)

Contraindication

Extensively vascularized membrane particularly in proliferative diabetic retinopathy.

Pre-laser Examination Schedule

A detailed ophthalmic history, general medical history (diabetes mellitus, hypertension) and a meticulous ophthalmic examination are a must before contemplating posterior vitreolysis.

- Visual acuity — both corrected and uncorrected
- Indirect ophthalmoscopy
- Slit lamp biomicroscopy — with Goldmann 3-mirror contact lens and the contact lens through which the procedure is to be performed. Carefully evaluate and examine the target membrane and or band.
- Fundus fluorescein angiography (FFA) — It is helpful to exclude vascularization of band or membrane.

Criteria for Selection of Site

- it should preferably be farthest from both retina and posterior capsule of lens (in phakic eyes) or IOL (in pseudophakic eyes).
- YAG laser posterior vitreolysis should be avoided over an area from macula to optic disc, if the band or membrane lies close to retinal surface.
• YAG laser posterior vitreolysis is risky if the membrane or band is located just behind the posterior capsule of lens (in phakic eyes) or implant (in pseudophakic eyes). Cataractous changes or implant damage may occur.
• It is safer to select a site over a previously photocoagulated area.

General Steps

1. Explain the procedure: Several laser sessions may be required to achieve vitreolysis.
2. Informed consent.
3. Maximum mydriasis: Pupil should be well dilated with Tropicamide (1%) and Phenylephrine HC1 (5%) eye drop starting one hour before the procedure.
4. Anesthesia
   1. Topical anesthesia with Proparacaine HC1 (0.5%) a few minutes before insertion of contact lens.
   2. Additionally retrobulbar anesthesia may be required in uncooperative patients and patients with nystagmus.
5. Comfortable sitting.
6. Steady fixation by:
   1. Head strap
   2. Illuminated target
7. Contact lens insertion: Various contact laser lenses are available for YAG laser application in different locations in the posterior segment of the eye (see Table 1). Flat fundus contact lenses, which diminish the angle of beam divergence, should be avoided to avoid retinal injury.
8. Room illumination: Darkened

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Nd: YAG Laser Posterior Vitreolysis Technique Proper

• Start with 1-3 mJ per pulse energy.
• Gradually increase the energy level until the cutting of band is achieved.
• Single pulse mode is preferred.
• The procedure is usually a lengthy one.
• Focus: Focusing is much more difficult in posterior segment application than in anterior segment applications. The focusing task is made more difficult due to peripheral location.
of target issue. Optical aberrations due to natural lens or implant also make focusing task difficult. So, clinical experience and focusing skills of the laser surgeon are vital factors for hazard free posterior segment application.

- Vascularized membrane or and should by thoroughly pre-treated to cause thrombosis of the vessels before Nd: YAG laser posterior vitreolysis.

**Complications**

1. Retinal and choroidal haemorrhage: These are the most common complication and may occur due to multiple factors:
   - Poor focusing.
   - Use of suprathereshold energy level close to retina.
   - Section of epiretinal membrane or band within 4 mm form retinal surface.
   - Optical aberrations derived from nuclear sclerosis of natural lens or implant. Retinal and choroidal haemorrhage is caused by the acoustic and shock waves generated by optical breakdown very close to retinal surface. Usually choroidal and retinal hemorrhages clear within four weeks. If during laser procedure choroidal haemorrhage is detected, pressure on the globe by the laser contact lens will stop it spontaneously.
2. Retinal hole formation and retinal detachment.
3. Cataract formation (in phakic eyes): The suggested laser focus behind the posterior capsule to avoid this complication is 4 mm.
4. Implant damage (in Pseudophakic eyes).
5. Vitreous haemorrhage: Posterior vitreolysis of an untreated vascularised membrane or band causes vitreous haemorrhage.
6. Vitritis.

**CORNEAL STROMAL REINFORCEMENT**

A YAG Laser treatment of recurrent corneal erosions. The LightLas YAG may be used as an alternative to anterior stromal puncture with a needle, epithelial debridement with a spatula or alcohol, superficial keratectomy with a diamond burr, or phototherapeutic keratectomy with an excimer laser.

The advantages of the YAG laser for this procedure are that it does not require removal of the overlying loose epithelium, it is less painful than other options, and there is minimal risk of scarring.

Laser pulses of 0.3 – 0.6mJ are placed in the sub epithelium or superficial stroma.
YAG lasers are also used to treat aphakic and pseudophakic malignant glaucoma by disrupting the anterior hyaloid face either peripherally through an iridectomy or centrally through the pupil with 3 – 11mJ. Laser vitreolysis can also be performed on strands of incarcerated vitreous in the anterior chamber that cause cystoid macular edema. Clear, thin vitreous wicks may be difficult to lyse, so it is best to pre-treat with pilocarpine to induce miosis and stretch the incarcerated vitreous, then use bursts of 5 – 10mJ aimed at a pigmented area of the strand or near the wound. A change in the pupil shape back to round indicates successful vitreolysis.
Approach and criteria recommendations

Vitreolysis is also used to vaporize floaters within the eye. After dilating the pupil, a numbing eye drop is given and a special contact lens for treating eye floaters is placed on the eye. Then the laser, which is focused to an optimum smallest spot, is carefully aimed and the floater is vaporized with the laser or the floater’s attachments are vaporized so that the floater is repositioned to a different part of the eye. This disruption also helps the eye to absorb any remaining particles. After vaporizing the big floater or floaters, the doctor may have to leave tiny particles that are just too small to aim at. Depending on the type and number of floaters, the procedure may take as little as 5 minutes or up to half an hour. Post-operatively there are no restrictions on activities. The patient is seen the next day. Occasionally it is not possible to disrupt the floaters in one sitting. In that case, an additional sitting may be required. Laser vitreolysis is generally considered to be safer than a classic, surgical vitrectomy since it is less invasive. Despite a variety of studies describing this procedure as a treatment for vitreous floaters, it is not widely practiced. This is perhaps due in part to its limitations. In any event there are, generally speaking, three types of floaters that can be treated with lasers:

- One or two small to moderate sized floaters can be treated with approximately 85% success rate.
- Numerous clumps or clumps that are large and free floating in the vitreous, whilst difficult to treat, can still be treated.
- If a large degenerative cloud is suspended within line of sight with one or two strands, the doctor in this instance can cut the strands, which in effect relocates the floater clump to another part of the vitreous clump. Success rates are higher as the results are more dramatic for these floater types (usually approximately 90% or higher)

The success of laser treatment very much depends on the type of floaters and their position. Some patients, predominantly those under the age of 35, cannot be treated (for floaters) as the floaters may be too close to the retina in an area referred to as the ‘pre-macula bursa’ (the consequence of which is that the floater is more dominant in the patients view, its size exaggerated as a result of the distance to the retina).

YAG ANTEROIR SEGMENT VITREOLYSIS

Lysis of vitreous strands in cataract wound by Nd: YAG laser is called anterior segment vitreolysis. Stable visual acuity improvement following anterior vitreolysis occurs within few weeks to several weeks in significant number of cases.

Indications
• Vitreous band/strand incarcerated in cataract wound leading to following complaints/complications:

— CME-loss of vision
— Edge glare
— Photophobia
— Keratopathy

• Vitreous band/strand in corneoscleral wound with a history of retinal detachment in fellow eye.

Pre-laser Examination Protocol

• Recording of visual acuity
• Slit lamp biomicroscopy: The vitreous is best detected with narrow slit lamp beam in an absolutely dark room. Deposition of pigments on the vitreous strand often makes it easily identifiable.
• Gonioscopy: The source of vitreous strand may be easily missed if gonioscopy is not performed routinely in such cases. A careful and meticulous drawing of vitreous strand is very helpful at the time of laser therapy for planning site of vitreolysis.
• Fundus fluorescein angiography (FFA): It should be done prior to laser treatment in clinically suspected cases of aphakic and pseudophakic cystoid macular edema.
• Macular macroanatomy
• Optical coherence topography (OCT): It is very useful in establishing diagnosis of cystoid macular edema.

General Steps

1. Explanation of the procedure: This procedure requires multiple sittings.
2. Informed consent.
3. Miosis/mydriasis: The dilation or constriction of the pupil depends on the location of the vitreous strand.

• Miosis of pupil by pilocarpine nitrate 2% eye drop-1 drop every 15 minutes topically beginning two hours before the laser session induces stretching of vitreous strand passing through miotic pupil. It helps in laser treatment by facilitating identification of the vitreous strand and subsequent release of tension after lysis of the strand.
• Mydriasis of pupil is occasionally required to properly visualize and facilitate lysis of vitreous strand behind iris, i.e. in the posterior chamber.
1. Antiglaucoma medication.
2. Anesthesia.
3. Comfortable positioning.
5. Illumination of room: Darkened.
6. Gonio lens insertion.
7. Adjustment of slit lamp.

Anterior Segment Vitreolysis Technique Preper

The most common anterior segment vitreous strand configurations to the corneoscleral wound are as follows:

1. A narrow discrete vitreous strand.
2. A broad sheet of vitreous without incarceration of iris at the wound.
3. A medium to broadsheet of vitreous band with either tenting upwards of iris due to adhesion or incarceration of iris to the cataract wound along with the vitreous band.

The vitreous strand/band can be lysed/transacted with Nd: YAG laser (Q-switched) in four areas or zones, which are discussed in details below.

At the cataract wound

Advantages

1. Here the vitreous strand is often most discrete and thinnest. It is always desirable to cut the strand at thinnest point.
2. This site is most reliable landmark for anterior vitreolysis.
3. Rate of successful vitreolysis is very high at this site. It may be achieved with three to five well-focused laser shots.
4. Anterior vitreolysis is often facilitated by Abraham contact lens (with peripheral button), which extends view well into the angle of anterior chamber.

Disadvantages

1. Visualization of corneoscleral wound and laser vitreolysis at this site is possible only through gonioscopy lens.
2. Higher energy (6-12 mJ) is required for anterior vitreolysis through gonioscopy lens.
3. Use of gonioscopy lens involves extra expertise and manipulation by the laser surgeon.

Near the limbus
Advantages

1. Usually contact/gonioscopy lens is not required.
2. Lower energy setting (4-8 mJ)

Disadvantages

1. Pigment dispersion may be more causing poor visibility.
2. Damage to the iris below and cornea above may occur due to poor visibility leading to poor focusing.
   1. It is successful, if the cornea is clear at the limbus and vitreous and is not adherent to iris.

In the collarette region of Iris

Advantage

Vitreolysis at this site is particularly successful when vitreous is adherent to iris surface at this area and pulls it upward like a tent.

Disadvantage

Damage to the adjacent iris tissue is very common.

At the pupil

Anterior vitreolysis at this site is usually not recommended due to the following reasons:

3. At his site vitreous traction force is very poorly defined.
4. Here vitreous strand is present in the form of very wide band. Numerous shots (usually 50 to 70), even more than 100 are required to cut a large wide band.
5. Anterior vitreolysis at this site is rarely successful.
6. Pigment dispersion and microhemorrhages may cause poor visibility.

Following observations:

- Change in the shape of deformed pupil.
- Iridodonesis.
Post-laser Advice

9. Anti-inflammatory: prednisolone acetate 1% eye drop 4 times daily may be required up to 2-3 months.
10. Antiglaucoma: usually required for 1-2 weeks.
11. Mydriatic/Miotic: usually not required.
12. Systemic indomethacin: Oral indomethacin 25-50 mg three times daily or 75 mg sustained release capsule twice daily after meal should be continued for a period of 2-3 months until improvement of vision occurs.
13. Systemic drugs to reduce Gastric irritation by Indomethacin.

YAG POSTEROIR SEGMENT VITREOLYSIS

Application of Nd: YAG (both Q-switched and mode locked) in the posterior segment of eye for transection of vitreous membrane and or band is technically much more difficult and riskier than its application in the pupillary plane or anterior segment.

This procedure is also referred to as “YAG Phototransetino”.

Indications

It is a non-invasive procedure for:

- Section of elastic vitreous traction band and or membrane to release traction on the retina.
- Section of optically disturbing elastic or fragile vitreous and or membrane.
- Section of vitreoretinal bands along the pathway of intra-ocular foreign body.
- Section of vitreous traction band attached to operculum of a retinal tear (Figs A and B).
Contraindication

Extensively vascularized membrane particularly in proliferative diabetic retinopathy.

Pre-laser Examination Schedule

A detailed ophthalmic history, general medical history (diabetes mellitus, hypertension) and a meticulous ophthalmic examination are a must before contemplating posterior vitreolysis.

- Visual acuity — both corrected and uncorrected
- Indirect ophthalmoscopy
- Slit lamp biomicroscopy — with Goldmann 3-mirror contact lens and the contact lens through which the procedure is to be performed. Carefully evaluate and examine the target membrane and or band.
- Fundus fluorescein angiography (FFA) — It is helpful to exclude vascularization of band or membrane.

Criteria for Selection of Site

- it should preferably be farthest from both retina and posterior capsule of lens (in phakic eyes) or IOL (in pseudophakic eyes).
- YAG laser posterior vitreolysis should be avoided over an area from macula to optic disc, if the band or membrane lies close to retinal surface.
• YAG laser posterior vitreolysis is risky if the membrane or band is located just behind the posterior capsule of lens (in phakic eyes) or implant (in pseudophakic eyes). Cataractous changes or implant damage may occur.
• It is safer to select a site over a previously photocoagulated area.

General Steps

1. Explain the procedure: Several laser sessions may be required to achieve vitreolysis.
2. Informed consent.
3. Maximum mydriasis: Pupil should be well dilated with Tropicamide (1%) and Phenylephrine HC1 (5%) eye drop starting one hour before the procedure.
4. Anesthesia
   • Topical anesthesia with Proparacaine HC1 (0.5%) a few minutes before insertion of contact lens.
   • Additionally retrobulbar anesthesia may be required in uncooperative patients and patients with nystagmus.
5. Comfortable sitting.
6. Steady fixation by:
   • Head strap
   • Illuminated target
7. Contact lens insertion: Various contact laser lenses are available for YAG laser application in different locations in the posterior segment of the eye (see Table 1). Flat fundus contact lenses, which diminish the angle of beam divergence, should be avoided to avoid retinal injury.

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