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.
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).

**WHAT IS SELECTIVE LASER TRABECULOPLASTY**

Selective Laser Trabeculaplasty, widely referred to as SLT is simple, yet highly effective laser procedure that reduces the intraocular pressure associated with glaucoma.

SLT treatment uses short pulses of low-energy laser light to target the melanin in specific cells of the affected eye, triggers body’s natural healing mechanisms to rebuild these cells and does not cause any collateral damage to the underlying structure.
SLT FUNDAMENTALS

SLT is derived from selective photothermolysis, which is based on three principles:

- Absorption of intracellular targets must be greater than that of the surrounding tissues (For visible wavelengths, melanin is an abundant chromophore in the trabecular meshwork.)
- A short pulse is required to generate and confine heat to the pigmented targets, and the wavelength must match the absorption wavelength of the target (The absorption of melanin is significant over a large spectrum.)
- The pulse duration must be less than the thermal relaxation time of the target.

When all of these parameters are achieved, target specificity is independent of focusing. Typical SLT parameters are:

- 3 nanoseconds pulse width (fixed with LIGHTLas SLT)
- Q-switched, frequency doubled Nd:YAG laser (532nm)
- Power = 0.6 – 1.2 mJ (average)
- 400 micron spot size (fixed with LIGHTLas SLT)

MECHANISM AND EFFICACY OF SLT

The natural restoration process of the Trabecular Meshwork (TM) cells is intelligently triggered through a number of steps achievable only by an SLT laser. This mechanism consists of the following steps:

- Macrophage recruitment takes place to remove damaged cells.
- Trabecular meshwork cells divide to replace the lost cells.
- Release of growth factors (cytokines, MMP’s) which regulate the structure of the TM beams.
- A healthier, more porous trabecular meshwork restores balanced aqueous outflow.
- This process occurs differently from person to person but typically takes about a week.
- Effective in approx 75% of patients, 25% reduction in pressure.

SLT CHARACTERISTICS

The SLT can be distinguished by its unique characteristics as;

**Smart**

Stimulates the body’s natural mechanisms to enhance outflow of the fluid in the eye.
damage to non-targeted tissue.

Selective

Selectively targets only the melanin-rich cells of the trabecular meshwork. The point and shoot approach of ophthalmic laser treatments that has been used in the past three decades, will soon become extinct. Today, ophthalmologists want to achieve spatial and tissue biological selectivity. SLT selectively targets specific tissue, causing minimal

Safe

SLT is not associated with systemic side effects.

Conservative

With SLT, normal trabecular tissue is minimally affected, in a similar manner to photodynamic therapy for treatment of macular degeneration. Through a photochemical mechanism, the choroidal neovascular membrane is heated, but the overlying neurosensory retina is minimally damaged.

Non-Collateral

SLT is a non-thermal laser treatment. The short pulse duration of SLT is below the thermal relaxation time of the TM tissue, thereby eliminating the incidence of thermal damage. Non-thermal laser treatment uses a photochemical activation mechanism, such as the mechanism used in photodynamic therapy for treatment of macular degeneration, in which sub-thermal light does a drug in-situ. Non-thermal laser treatment also uses short-pulsed laser to decrease heat damage to adjoining tissue. An example of this process is the use of a short-pulsed CO2 or Erbium:YAG laser to selectively remove epidermis.

Repeatable

Treatment can be repeated without causing harm or further complications. It is One of the major advantages of SLT is repeatability. If the initial SLT achieves inadequate IOP control, subsequent SLT treatments can be performed to further reduce IOP, without adverse effects. In contrast, studies of patients treated with ALT show that multiple ALT treatments damage the trabecular meshwork.

Sensible

Established as standard proven therapy, reimbursed by insurance providers minimizing out-of-pocket expenses. It offers a great alternative also to patients who do not have the regime to take medications daily for the rest of their lives and, or subsequently find medication as expensive.
Effective

Data collected over 10 years from various clinical studies demonstrate the SLT to be an effective and successful treatment in 75% of cases, achieving a 25% reduction in IOP pressure. SLT is thus recommended as first line approach or ideal adjacent to medication as Combined treatment.

SLT OR ALT

SLT treatment provides unmatched benefits as the better Laser Trabeculoplasty procedure when compared to ALT:

- Effective as first line treatment.
- Easier to perform (focusing not critical).
- Works even on very lightly pigmented TM’s.
- Can be performed in presence of synechiae. (the iris adheres to the cornea or to the capsule of the crystalline lens).
- No structural change & coagulative damage.
- Reduced side effects (e.g. inflammation).
- No membranes – no Peripheral Anterior Synechiae (PAS).
- Repeat treatments, give repeat IOP reduction.

The effects of ALT & SLT on the Trabecular Meshwork as seen using scanning electron microscopy showing evidence of coagulative damage to TM after ALT and none post SLT.
SLT OR MEDICATIONS

The SLT procedure has been clinically proven to be a successful and effective as first line treatment in the fight against primary open-angle glaucoma (POAG) for well over 10 years.

In most POAG patients, SLT reduces intraocular pressure (IOP) significantly for a few years without any major or permanent side effects or complications. Consequently, the idea of potentially gaining some drug-free years for a newly diagnosed POAG patient by using SLT as the initial therapy is becoming increasingly more appealing.

Some Ophthalmologists however, are still reluctant to use SLT in this situation due to the reputation of argon laser trabeculoplasty (ALT) as damaging to the anterior chamber angle structures and its unrepeatability, further aggravated by the aggressive marketing approach of pharmaceutical companies to promote medication as the easy and primary option.

Whilst medications may still be the easiest organic approach by most Ophthalmologists today, undoubtedly the most significant problem with eye drops is patient compliance. Since most POAG sufferers have no noticeable symptoms (except to their doctor) they are not reminded by pain or loss of function to take their medicine.

A recent patient survey found that approximately 33% of patients who are presented a glaucoma prescription at a pharmacy never picked up the medication thus SLT approach enables:

- Control of patients’ treatment effectively lowering IOP without compliance issues and side effects associated with drug therapy.
- SLT is particularly appropriate for individuals who cannot correctly administer, or are intolerant to, glaucoma medications
- Can also be used effectively in conjunction with drug therapy

Further, among patients who started taking medications for the first time, only 40% took the medication for the full year. In patients already on other glaucoma medications, only 64% finished the year taking a medication (e.g. prostaglandin), and less than half (44%) complied with their dosing regimen for other medications.

Other common difficulties (excluding Patient’s lack of rigour and persistence) facing glaucoma medication approach only are;

- Intolerance to medication.
- Limit to how many medications the patient can take.
• Non compliance with medication regimen (e.g. literacy, religion)

Then there are of course cost and side effect concerns associated with glaucoma medicines. Most commonly include:

• Patient discomfort (e.g. itching, burning, redness of the skin surrounding the eyes)
• Changes in pulse and heartbeat and breathing (especially in patients with asthma or emphysema).
• Changes in energy level.
• Dry mouth and eyelash growth.
• Blurred vision and change in eye colour.
• Often expensive and some need to be taken for the rest of patient’s life.

It is important to consider that also approximately 34% of glaucoma patients don’t respond to medication, whilst topical glaucoma drops increase possibility of ocular surface infection by 38%.

Finally, it is almost inevitable that medications needs to be taken either daily or in many cases for the rest of patients life so ‘medication as a low-cost option’ seems viable only at the beginning.

*If you or your patient were experiencing problems with your glaucoma medication, wouldn’t you appreciate your a treatment that…*

• Provides prolonged reduction of intraocular pressure.
• Alternative for patients who do not respond or are noncompliant with medication.
• Complementary or adjunct to medication.
• Sustained IOP reduction post-surgery.
• Same effective response between low and high pigmented eyes.
• Does not produce peripheral anterior synechiae.
• Proven safe and effective.
• No side effects and can be repeated if necessary.
• Simple and fast with little to no discomfort.

**SLT TREATMENT GUIDELINES**

The following treatment guidelines are based on the generic results of clinical studies and provided to serve for common purposes only. We recommend that it is ophthalmologist’s
responsibility to familiarize themselves with the latest recommended techniques and apply protocols based on assessment of specific patient and their condition.

**PATIENT SELECTION**

Research has demonstrated that SLT treatment is suitable for majority of patients suffering increased IOP that qualifies for means of IOP reduction. Primary suited patients;

- Require immediate IOP reduction as means of primary or secondary treatment.
- Unlikely to comply and/or persist with drug therapy.
  - Difficulty administering eye drops.
  - Drug therapy induced side effects.
  - Affected quality of life due to drug therapy.
- Failed drug therapy.
- Failed ALT treatment,
- Failed SLT treatment, or first SLT proved insufficient
- Normal tension glaucoma.
- Ocular hypertension.

**TREATMENT CONSIDERATIONS & CONTRA-INDICATIONS**

Special approach and care needs to be taken in cases where;

- Treatment on Pigmentary Glaucoma patients require high degree of caution due to increased risk of post-SLT IOP spike.
  - Treat maximum one quadrant (360°) of TM
  - Maintain maximum energy at 0.4mJ – 0.5mJ
  - Use a prophylactic agent to avoid post-op IOP spike; and NSAID to avoid post-op inflammation. Assure strict follow-up (minimum one hour post procedure, with subsequent follow up in 24 hrs. then two weeks, six weeks and in three months)
- Restricted or Unclear view of the Trabecular Meshwork (TM).

SLT has not demonstrated high level of efficacy on;

- Paediatric and Juvenile glaucoma patients.
- Primary or secondary narrow-angle glaucoma.

SLT procedure is not recommended for;

- Patients with Inflammatory or Uveitic glaucoma.
- Patients with neovascular glaucoma (NVG)

**PRE-TREATMENT**
Pre-operative medications typically include an alpha agonist (e.g. brimonidine), and topical anaesthesia, such as proxymetacaine hydrochloride. Recommended especially heavily pigmented patients and when performing 360° TM treatment.

**TREATMENT**

Even after more than 20 years of successful SLT use worldwide, its regimen continues to evolve and the exact protocols vary of 360°, 270°, 180° and 90° of TM treatment.

The approach often remains at the physicians’ preference, although research has demonstrated that also the ethnic background should be factored in deterring the adequate protocol, as it plays an important role in efficacy of the SLT procedure outcomes.

Generally it is assumed the 360° or 180° TM treatment as most common considering:

- **360° treatment of TM** provides the best therapeutic results, however the more assertive the treatment the higher the risk of inducing a post-op IOP spike, which diminishes within 24-48 hours.
  - Typically 100 non-overlapping laser pulses around the full circumference of TM.
- **270° treatment of TM** offers a higher degree of assertiveness, but provides slightly reduced risk of large post-op IOP spike.
  - Typically 75 non-overlapping laser pulses with nasal half for first 180°
- **180° treatment of TM** is also commonly used reducing the prevalence of post-op IOP spike, although the degree of treatment success rate varies.
  - Typically 50 non-overlapping laser pulses recommend treating the inferior or the nasal half of the TM due to variations in pigmentation levels.
- **90° treatment of TM** is applied in cases where extra caution needs to be taken due to highly increased risk of post-op IOP elevation and contra-indicated conditions.
  - Typically 25 non-overlapping laser pulses treating the inferior or the nasal quadrant.

**Contact Lens**

- Latina SLT Gonio lens is recommended as the primary option for SLT procedure.
- Other Gonio lenses may also be used, however it is recommended to always consider that some magnified lens may affect the spot size and treatment power density altering the safety and efficacy of procedure.
- Viewing with other non-magnified lens can be compensated by increasing slit lamp magnification, although to maximise the viewing angle the Gonio lens such as CGA-1 provides adequate angle further reducing the need of frequent lens rotation.

**Spot Size Adjustment**
LIGHTLas SLT treatment spot size is pre-set at 400μm in line with acknowledged SLT protocols. The spot exposes the whole width of the TM, with marginal excess (overspill) beyond the TM edges. There is no concern as the nature of SLT treatment is non coagulative, whilst the iris overspill is assumed to further enhance the procedure outcomes.

Whilst the aiming of the laser is easier and considered not as critical as in ALT procedure, it is important to obtain a clear view of the TM and assure treatment spot focus must target tissue.

**Treatment Steps**

1. Determine the optimal treatment power for each patient, by setting the laser initially at 0.6mJ (set the energy at 0.4mJ for patients with heavily pigmented TM).

   a) Apply laser and adjust the energy in 0.1mJ increments until the therapy point is identified (observed as mini-bubble formation (champagne effect or micro cavitation bubbles)).

2. After the therapy point is achieved, reduce the energy by 0.1mJ and maintain that as the threshold energy level during the procedure.

   a) LIGHTLas SLT features an exclusive KTP management system ensuring superb energy stability, however due to possible TM pigment variations it is recommended to reassess the energy threshold commencing treatment of each quadrant.

   b) Heavily pigmented TM will typically require lower energy levels in order to achieve the adequate thresholds (approximately 0.6mJ – 0.8mJ)

   c) Lightly pigmented TM will typically require higher energy in order to achieve the adequate thresholds (approximately 0.8mJ – 1.3mJ)

3. To ensure optimum clinical outcomes it is important to consider that pigmentation may often differ between the superior and inferior halves. Therefore it is highly recommended to titrate the power levels accordingly to the treated area, splitting at each half or quadrant depending on the applied protocol (depending on the degree of TM coverage);

   a) Treat the nasal half for first 180° treatment then target temporal half.
b) Treat the nasal half for first 180° treatment then target temporal half.

**POST TREATMENT**

1. Patient follow-up should be done typically within 1-hour after procedure (IOP check) and addressed adequately to their risk of a post-op IOP spike.
2. Non-steroidal anti-inflammatory drops (NSAIDs) are applied four times daily for three to five days (It is not recommended to apply steroidal medication to prevent their interference with the SLT treatment).
3. For patients with low risk of post-op IOP spike, the typical follow-up visits are scheduled at two weeks, one month, three months and six months after the treatment. Subsequent visit in 6 months thereafter to ensure stable IOP.

**EXPECTED RESULTS**

- Successful drop in IOP should occur within 1 – 3 days post SLT treatment (although it is common to observe a slight IOP increase within the first day post procedure)
- SLT has demonstrated efficacy in approximately 75% or patients offering a sustainable IOP reduction, although ongoing monitoring is advisable, as SLT does not provide a permanent cure if not repeated or unsupervised.
- Certain patients may respond after several weeks (typically a notable drop of IOP within 3 – 6 weeks is a good indication of successful procedure).

**POTENTIAL SIDE-EFFECTS**

There are minimal observable side effects resulting from SLT treatment; these include mild discomfort during the procedure and tender eyes, perhaps with mild photophobia, for 2-3 days.

The absence of adverse side effects is one of the major benefits of SLT treatment.

In a small percentage of cases (<10%) some postoperative increase in IOP has been observed, usually appearing within the first 24 hours and disappearing within a further 24 hours. However, a few cases of sustained IOP increase requiring follow-up treatments have been reported.
RE-TREATMENT

If required, its advisable to allow up to three months before re-treatment as some patients may exhibit delay in IOP reduction after the initial SLT procedure.

- If initial procedure covered 180° of TM, treat the opposite 180°
  - It is common that during re-treatment physician will apply an enhancement approach, treating exultingly applied and additional 180° of the TM.
- If initial procedure covered 360° of TM, repeat the procedure.

SLT CLINICAL HINTS

The following hints are conducted LightMed clinical research, claimed by some committed physicians using the LIGHTLas SLT lasers as well as their publically available journals and published papers. The physician assessing their patient and condition should only determine treatment protocol.

GENERAL APPROACH OBSERVATIONS

- The use of SLT Latina lens is vital for adequate procedure protocols; it is crucial that patients are well compliant and comfortable during the procedure.
  - Patient should always be instructed to look towards the mirror (extremely helpful, when treating eyes with a narrow angle inlet & posterior annual synchiea (also known as iris bombé)). After each lens rotation, the patient is instructed to change the gaze and follow.”
  - In cases of posterior annual synchiea (also known as iris bombé), the patient should be requested to look towards the lens mirror, rather that trying to move the lens towards the eye.
- In patients with Acute clousure glaucoma treat only the visible area and avoid to not touch the peripheral anterior synchiea. (typically none or minimal peripheral anterior synchiea formation with SLT as opposed to ALT)
- Blanching may not be apparent with heavily pigmented TM, therefore a small champagne bubble is considered as good treatment power level threshold.
- To maximise the outcome of the conservative 180° approach, its important to consider that typically the inferior and temporal TM areas are larger than superior or nasal areas, which enhances the visibility of the structures and thereby makes the treatment easier typically when commenced from 3 to 9 o’clock.
- SLT can be potentially performed in cases of narrow angle glaucoma, as long as the trabeculum can be observed during gonioscopy. When the angle is narrow but remains open, an agonist can be applied (i.e. pilocarpine) to open the angle further, facilitating easier SLT procedure.
For patients with convex irises consider pre-op medication such as pilocarpine. Application of brimonidine or apraclonidine an hour prior to SLT treatment will help blunt post-operative IOP spikes.

SLT procedure outcome may be enhanced by washing out the patients from medication (such as prostaglandin-analogs) prior to the procedure, although patient should exhibit a stale IOP.
  o Pre-operative medications typically include an alpha agonist, such as brimonidine tartrate, and topical anaesthesia, such as proxymetacaine hydrochloride. Pilocarpine may be administered to improve visibility of the angle.
  o Physicians at growing rate are opting not to prescribe post-op medications believed to affect the natural mechanism of SLT treatment.

Repeated SLT is advisable as standard of care typically at six to eight months post initial procedure, with repeat of the same protocol as initial. Well responders (patients with notable IOP reduction) have especially greatly benefited by prolonged IOP reduction without the need of any medication.

YAG CLINICAL APPLICATIONS

INTENDED APPLICATIONS

The LightLas YAG is mainly intended for clinical use in:

  o Posterior Capsulotomy (dissection of the posterior capsule of the eye in Secondary Cataract).
  o Posterior Membranectomy (dissection of the pupillary membrane of the eye).
  o YAG Laser iridotomy (opening a hole in the iris in).
  o YAG Sweeping
  o YAG Corticolyis
  o YAG Vitreolysis
  o YAG Corneal stromal reinforcement

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

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 intraocular 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.

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 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 session.

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. Anaesthesia: 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 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 (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

**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**
a) Usually 0.2 to 1.0mJ of energy per pulse is sufficient.

b) 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.

c) 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)

d) 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.

![Image](image.png)

**YAG Laser Sweeping – Laser defocussed anteriorly. Inset showing deposits, precipitates, pigments.**

1. Deposits are dislodged by acoustic shock wave.
2. Wave developed in the anterior chamber.

**Post op Advice**

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

Corticolyis Technique Proper

a) Usually 4 to 5 mJ of energy per pulse from the YAG laser is the adequate energy measure.
b) Pulse mode is preferred over double burst mode.
c) YAG laser is focused posterior to intraocular lens (IOL) and within the substance of retained cortical matter.
d) The aim is not to disrupt the posterior capsule.
e) 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 LASER VITREOLYSIS

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 ANTERIOR 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 maybe 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.

4. Antiglaucoma medication.

5. Anesthesia.


7. Steady fixation.

8. Illumination of room: Darkened.

9. Gonio lens insertion.

10. 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:**

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

**Disadvantages**

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

**Near the limbus**

**Advantages**

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

**Disadvantages**

- Pigment dispersion may be more causing poor visibility.
- Damage to the iris below and cornea above may occur due to poor visibility leading to poor focusing.
- 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:

- At his site vitreous traction force is very poorly defined.
- 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.
- Anterior vitreolysis at this site is rarely successful.
- Pigment dispersion and microhemorrhages may cause poor visibility.

**Following observations:**

- Change in the shape of deformed pupil.
- Iridodonesis.

**Post-laser Advice**

- Anti-inflammatory: prednisolone acetate 1% eye drop 4 times daily may be required up to 2-3 months.
- Antiglaucoma: usually required for 1-2 weeks.
- Mydriatic/Miotic: usually not required.
- 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.
- Systemic drugs to reduce Gastric irritation by Indomethacin.

**YAG POSTERIOR 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

   - 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.

   **Table 1: Choice of YAG laser lenses according to site in vitreous (specifications courtesy Ocular Instruments, Bellevue, WA, USA)**

<table>
<thead>
<tr>
<th>Laser lens</th>
<th>Image magnification</th>
<th>Laser spot factor magnification</th>
<th>Site of focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peyman Widefield 12.5mm</td>
<td>1.40x</td>
<td>0.71x</td>
<td>Anterior vitreous</td>
</tr>
<tr>
<td>Peyman Widefield 18mm</td>
<td>1.41x</td>
<td>0.71x</td>
<td>Mid vitreous</td>
</tr>
<tr>
<td>Peyman Widefield 25mm</td>
<td>1.36x</td>
<td>0.71x</td>
<td>Posterior vitreous</td>
</tr>
</tbody>
</table>

8. Room illumination: Darkened.
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 be 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 suprathreshold energy level close to retina.
   - Section of epiretinal membrane or band within 4 mm from 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.

GENERAL SUGGESTED ENERGY SETTINGS TABLE

<table>
<thead>
<tr>
<th>PROCEDURE</th>
<th>SUGGESTED LIGHTLAS YAG ENERGY SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior Capsulotomy (with laser lens)</td>
<td>0.5 to 1.5 mJ</td>
</tr>
<tr>
<td>Posterior Capsulotomy (without laser lens)</td>
<td>0.9 to 2.0 mJ</td>
</tr>
<tr>
<td>Peripheral Iridotomy (light iris)</td>
<td>3.0 to 3.5 mJ</td>
</tr>
<tr>
<td>Peripheral Iridotomy (dark iris)</td>
<td>4.0 to 5.0 mJ</td>
</tr>
<tr>
<td>Severing Vitreous Strands</td>
<td>1.5 to 2.0 mJ</td>
</tr>
<tr>
<td>Removal of Synechiae</td>
<td>1.0 to 2.0 mJ</td>
</tr>
<tr>
<td>IOL Surface Cleaning</td>
<td>0.3 to 0.5 mJ</td>
</tr>
<tr>
<td>Vitreolysis</td>
<td>5.5 to 10 mJ</td>
</tr>
<tr>
<td>Cortycolysis</td>
<td>3 to 4 mJ</td>
</tr>
<tr>
<td>Corneal Stromal Reinforcement</td>
<td>0.3 – 0.6 mJ</td>
</tr>
<tr>
<td>Treating Vitreous Opacities</td>
<td>0.7 to 2.0 mJ</td>
</tr>
</tbody>
</table>

NOTE: LightMed suggest these energy settings as a guide only. The physician may wish to increase or decrease the energy settings depending on results. A 2-3 pulse is recommended.