Role of Lasers in Current Retinal Practice

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Abstract: *Discovery of the argon laser in 1964 provided a new tool with emission in the blue (488-nm) and green (514-nm) range of the spectrum, which had the advantage of being strongly absorbed by hemoglobin and melanin. Coherent, Inc, began to market the argon laser photocoagulator in 1970, and by 1971, a series of clinical articles published by the American Academy of Ophthalmology signalled the dissemination and acceptance of the new technology. The era of wide use of retinal photocoagulation in clinical practice had begun.*

Historically, a number of light sources have been utilized for retinal phototherapy including the sun, various flash lamps, and lasers. Lasers became the preferred light source for retinal photocoagulation since 1970 due to their narrow spectrum, wide selection of wavelengths, excellent collimation (directionality), high brightness, and variable pulse duration. The highly collimated laser beam is easy to guide before its introduction into the eye, and to focus into very small spots. Its monochromaticity makes it possible to choose a wavelength for selective absorption in specific tissues of the eye. Adjustable pulse duration allows controlling the extent of thermal diffusion, thus producing very precise and selective interactions with minimal collateral damage.

The concept of ocular therapy using light first was conceived by Meyer-Schwickerath[1], who took patients to the roof of his laboratory in 1949 and focused sunlight on their retinas to treat melanomas. Meyer-Schwickerath demonstrated that photic burns could be beneficial therapeutically. But the technique was hardly practical for wide use because it required sunny weather. By the mid-1950s, the xenon arc photocoagulator had been developed and was made commercially available by Zeiss. This instrument was effective for sealing retinal breaks and treating tumors but it was hard to control, and the burns it caused were large and severe. In 1960, Maiman produced the first functioning LASER (light amplification by stimulated emission of radiation) (Figure 1). Laser radiation has several features distinct from thermal and other noncoherent sources of light: its photons are emitted at the same phase (coherence), its wave length range is narrow (monochromatic), and its beam is well collimated (directional). The potential of this new technology was immediately obvious in many fields in which focused and powerful light beams could produce damage or repair; the recognition of its potential application to the eye was almost immediate (Figure 2). The first study regarding the creation of ocular lesions in rabbits with a ruby laser was reported in 1961. Whereas with the xenon arc, light was applied continuously until damage became visible, laser energy could be delivered in calibrated bursts and adjusted in small increments to achieve a desired level of injury. The xenon lamp was an effective photocoagulator for years, but it was eventually replaced by the ruby laser, the argon blue-green and green lasers, the krypton laser, the tunable dye laser, and most recently the infrared diode and frequency-doubled diode laser. Although the results of ruby laser application were impressive, they were also troubling. The retinal burns were intense and could produce chorioretinal adhesion or destruction of pigmented lesions. The deep red wavelength (694 nm) was poorly absorbed by blood, such that vascular lesions could not be treated effectively. It was hard to produce vascular damage or closure without hemorrhage or intense scarring.

Discovery of the argon laser in 1964 provided a new tool with emission in the blue (488-nm) and green (514-nm) range of the spectrum, which had the advantage of being strongly absorbed by hemoglobin and melanin. Coherent, Inc, began to market the argon laser photocoagulator in 1970, and by 1971, a series of clinical articles published[2,3,4,5,6] signalled the dissemination and acceptance of the new technology. The era of wide use of retinal photocoagulation in clinical practice had begun.

It became clear early in the treatment of neovascularization in diabetic retinopathy, that treating the retinal pigment epithelium (RPE) and retina was safer and more effective than direct coagulation of new vessels themselves. The initial techniques of focal and panretinal (PRP) photocoagulation and a later grid photocoagulation approach for treating macular edema were shown to be effective therapies for proliferative diabetic retinopathy (PDR) and macular edema in the Diabetic Retinopathy Study (DRS)[7,8,9,10] and the Early Treatment Diabetic Retinopathy Study (ETDRS)[11,12]. These trials validated the efficacy and institutionalized the indications and variables for treatment that have remained the criterion standard since that time. Although the initial validation of laser therapy occurred mostly with rather cumbersome water-cooled argon lasers, these have been replaced mostly with much smaller air-cooled Nd:YAG lasers that also can produce green (532-

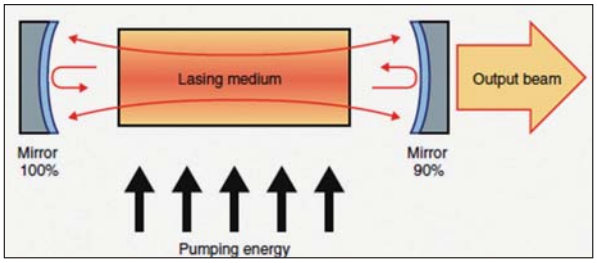

Figure 1: *Laser typically consists of the energy source (pump), the lasing medium, and the optical cavity with a partially transparent front mirror.*

Table 1: A number of wavelengths are available to the surgeon	
Laser	wavelength
Diode	810 nm
Ruby	694 nm
Krypton red	647 nm
Frequency doubled NdYAG	532 nm
Argon green	514 nm
Argon blue	485 nm

Table 2: Different Pigments of Retina			
Pigment	**Present In**	**Absorbs**	**Passes**
Xanthophyll	Plexiform Layer of Retina Especially Macula	Blue	Green, Yellow, Red
Hemoglobin	In Red Blood Cells	Blue, Green, Yellow	Red
Melanin	Retinal Pigment Epithelium And Choroid	Absorbs All Visible Wavelengths	None

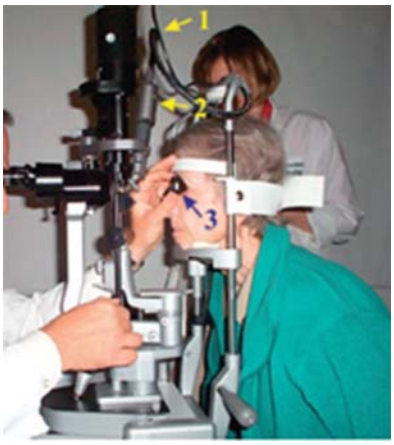

Figure 2: *Laser photocoagulation on a slit lamp system. 1, Optical fiber and electronic cable connecting laser with a slit lamp system. 2, Optical coupler projecting the beam exiting from the fiber onto the retina. 3, Contact lens.*

nm) light through use of the second harmonic . The diode lasers are highly efficient as they derive power from standard electrical outlets without the need for specially installed, high voltage outlets. Most current laser systems have abandoned the use of Nobel gases (argon and krypton) and tunable dyes and have migrated to diode technology. Diodes are reliable, durable, and portable and require minimal servicing, and unlike the old gas-generated lasers, diodes work with 120 volt electrical outlets, thereby making installation easier and use in the clinic and operating rooms safer. They produce a 532 nm beam that is moderately absorbed by oxyhemoglobin and minimally absorbed by retinal xanthophylls. When lasers are used to treat the retina rather than vessels, the light is absorbed by melanin in the RPE and in the pigmented choroid. The energy is converted into heat, which diffuses into the retina and choroid. Laser power in photocoagulation typically is titrated to a visible clinical effect (graying or whitening of the retina), which corresponds to damage to the photoreceptors and, at higher settings, to the inner retina.

MECHANISM OF ACTION

Conventionally, the mechanism of action of lasers for retinal applications has been retinal photocoagulation, wherein light energy is converted to heat at the level of the retina, leading to protein denaturation. Several mechanisms have been proposed for how laser photocoagulation works in the retina in reducing macular edema: first, from direct action on the vessels, leading to closure and reduced leakage; and second, from reduced oxygen demand and increased oxygenation of the inner retina following scarring and burns at the level of the retinal pigment epithelium (RPE) and photoreceptors. A third theory is that RPE activation following photocoagulation injury leads to cytokine production, and ultimately to reduction of VEGF load and, thus, edema. This theory is of most interest today, as it suggests the possibility of nondamaging laser treatment that promotes retinal rejuvenation.

CHOICE OF WAVELENGTH (TABLE 1)

The key pigments found in ocular tissues and there absorption characteristic are (Table 2):

(a) Melanin located in the retinal and iris pigmented epithelia, choroid, uvea, trabecular meshwork; Excellent absorption of green, yellow, red and infra-red wavelengths.

(b) Hemoglobin, located in the red blood cells; Hemoglobin easily absorbs blue, green and yellow with minimal absorption of red wavelength

(c) Macular xanthophyll, which is located in the plexiform layers of the retina, especially in the macula; Macular xanthophyll absorbs blue but minimally absorbs yellow or red wavelengths.

The reasons to pick one wavelength over another are mostly theoretical, but the overriding concern is an attempt to increase the therapeutic index. One wavelength, argon blue, should not be used as blue light, is more likely to be scattered and has the potential to be absorbed by the xanthophyll in the macula causing unintended macular damage. Xanthophyll pigment of the retina absorbs blue light, but passes green, yellow and red. Hemoglobin in blood vessels absorbs blue, green and yellow light, but does not absorb red as well. Melanin in RPE and the choroid absorb all visible wavelengths. In the macula, the critical pigments that absorb light and their respective peak absorption spectra are xanthophylls (420-500 nm) within neurosensory retina, melanin (400-1,000 nm) within the retinal pigment epithelial cells and choroidal melanocytes, and hemoglobin (450-550 nm) within red blood cells, contained within the retinal and choroidal vessels or within areas of extravasated blood. Longer (towards red) wavelengths are scattered less and therefore penetrate the cloudy media better. Longer wavelengths (like diode), owing to their increased penetrance, are frequently more painful. For macular disorders, both green (495-570 nm) and yellow (570-590 nm) wavelengths are suitable as they are well absorbed by melanin and hemoglobin and only minimally by macular xanthophylls.

COMMONLY USED LASER LENSES FOR RETINAL PHOTOCOAGULATION

Currently, retinal laser photocoagulation relies on the use of contact lenses, and the most common types are listed below (Table 3). The universal (Goldmann) three-mirror contact lens provides a flat front surface

Table 3: List of Ocular Contact Lenses and Their Magnifications in a Human Eye		
Lens	**Image Magnification**	**Laser Beam Magnification**
Ocular Mainster Std	0.95	1.05
Ocular Fundus Laser	0.93	1.08
Ocular 3 Mirror Univ.	0.93	1.08
Ocular Mainster Wide	0.67	1.50
Ocular Mainster Ultra	0.53	1.90
Ocular Mainster 165	0.51	1.96
Rodenstock Panfundoscope	0.67	1.50
Volk Area Centralis	1.06	0.94
Volk TransEquator	0.69	1.44
Volk SuperQuad 160	0.5	2.00
Volk QuadrAspheric	0.51	1.97
Goldmann 3 mirror	1.00	1.00

that nearly cancels the positive refractive power of the front surface of the cornea. Mirrors at 59°, 67°, and 73° aid in visualization and photocoagulation of the periphery and anterior segment. To obtain effective results in photocoagulation the operator should hold the contact lens so that the flat surface is nearly normal (within 5 degrees) to the laser beam.

The use of mirrors in contact lenses helps the operator keep the laser beam properly aligned to the lens while photocoagulating over a large field. Another useful photocoagulation lens is the inverted image lens system, typified by the Rodenstock, Quadraspheric, and Mainster photocoagulation lenses. These lenses contain a lens element in contact with the corneal surface and another positive lens element at a fixed distance from the cornea. These systems magnify the spot size on the retina, while increasing the field of view, requiring the operator to adjust the power accordingly.

The most common laser delivery methods include the slit-lamp biomicroscope, indirect laser ophthalmoscope, and intraocular probe. Each of these instruments produces a collimated beam of coherent light that is transmitted through the ocular media to the retina where it is absorbed by retinal chromophores – xanthophyll, hemoglobin, and melanin. Light absorption produces a photothermal effect that heats the surrounding tissues and induces inflammation and edema that eventually causes localized tissue necrosis. High-intensity laser pulses produce burns that affect all levels of the retina, retinal pigment epithelium (RPE), and choroid, whereas low-energy pulses affect primarily the photoreceptors and RPE but spare the inner retina. Longer wavelengths penetrate deeper into the choroid because they are absorbed poorly by xanthophyll chromophores. In the outpatient or clinic setting, slit-lamp delivery systems are most commonly used, particularly for the treatment of DME. The retina is visualized through a high-diopter condensing lens or a contact lens which may be flat (for the macula), may invert images (such as the panfundus or Mainster lenses that are generally used for panretinal or scatter photocoagulation), or may be mirrored (for treatment of the peripheral retina). Panfundus and Mainster lenses magnify the spot size by factors of 1.75 and 2.2, respectively. Topical anesthesia is usually sufficient for most treatments though retrobulbar anesthesia improves pain control and limits ocular motility.

INNOVATIONS IN TREATMENT PATTERNS

Micropulse Laser (Nondamaging Photothermal Therapy)

There is a growing body of clinical evidence that many macular diseases, such as central serous chorioretinopathy, diabetic macular edema (DME), and branch retinal vein occlusion (BRVO), can be successfully treated without visible tissue damage. Now, it is possible to deliver a subthreshold micropulse laser that is above the threshold of biochemical effect but below the threshold of a visible, destructive lesion thereby preventing collateral damage. A pulsed version of a laser with smaller spot sizes (125 μm) has been applied for nondamaging retinal therapy. The "micropulse" laser delivers 100–300 ms bursts of pulses of 100–300 μs in duration. Adjusting the pulse duty cycle and peak power, the average power should be set below the clinically detectable tissue damage. Clinical trials have shown that micropulse treatment of DME delivered with high spot density is equally efficient or superior to the standard mETDRS protocol. The micropulse laser treatment also reduced the subretinal fluid and improved visual acuity in patients with central serous chorioretinopathy, compared to the untreated control group. Micropulse laser also demonstrated equivalent clinical efficacy to conventional lasers in treatment of macular edema secondary to BRVO, but without the side effects of tissue damage. High density coverage of the macula with relatively small spots and long pulses requires lengthy treatment, which is difficult to perform without a scanner. Significant advantages of the retinal phototherapy with nondamaging endpoint are the absence of scotomas and scarring, the ability to treat foveal areas, as well as improved preservation of color vision and contrast sensitivity. The lack of chorioretinal damage permits high-density therapy, which greatly improves therapeutic outcomes, compared to conventional sparse laser treatment protocols in the macula. Nearly confluent laser applications could be safely delivered over the entire edematous areas if short pulse treatment and pattern scanning were to be applied. This approach would also allow retreatment of the same areas, even in a close proximity to the fovea. Subthreshold micropulse laser is thought to limit damage to adjacent tissue. The length of these pulses must be shorter than the thermal relaxation time of the target tissue (the time required for heat to be transferred away from the irradiated tissue). Micropulse laser thereby induces a temperature rise insufficient to cause ancillary damage to surrounding retinal tissue. This technology has been most extensively explored in the treatment of DME. It has been shown to minimize scarring to the extent that laser spots are generally undetectable on ophthalmic and angiographic examination. At the same time, it has been shown to stimulate the RPE and have a beneficial effect on its activation.

PATTERN SCANNING LASER PHOTOCOAGULATION

A semiautomatic pattern scanning photocoagulator (PASCAL, Topcon Medical Laser Systems Inc.) was introduced in 2005. It delivered patterns

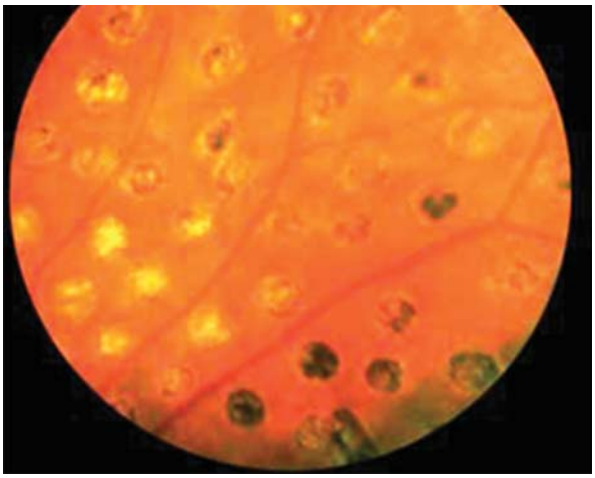

Figure 3: *In PRP laser scars are placed at distance of one burn width.*

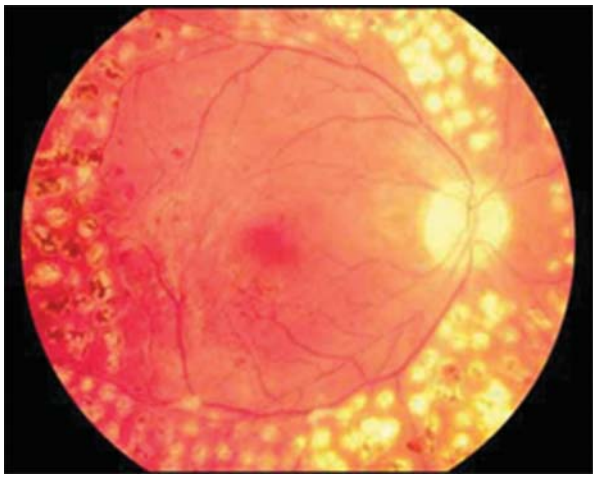

Figure 4: *Sparing of macula in PRP*

of laser spots ranging from a single spot to 56 spots applied in a rapid sequence with a single depression of a foot pedal. The control of laser parameters was performed by means of a touch screen graphic user interface, facilitating selection of the different patterns of photocoagulation. The laser was activated by pressing a foot pedal, which was kept depressed until the entire pattern was completed. The physician can release the foot pedal and stop the laser at will prior to completion of the pattern, if clinically indicated. To deliver the whole pattern within the eye fixation time and avoid beam shift due to the eye movements, each exposure was required to be shorter duration of 10–20 ms instead of 100–200 ms, traditionally applied with single spot exposures. Reduced heat diffusion into choroid during shorter exposures also resulted in patients experiencing less pain. Short pulse lesions appear smaller and lighter than conventional burns produced with the same beam size, and therefore a larger number of them are required to treat the same total area. An automatic laser delivery, guided by diagnostic imaging and stabilized using eye tracking, has been introduced in a Navilase system.

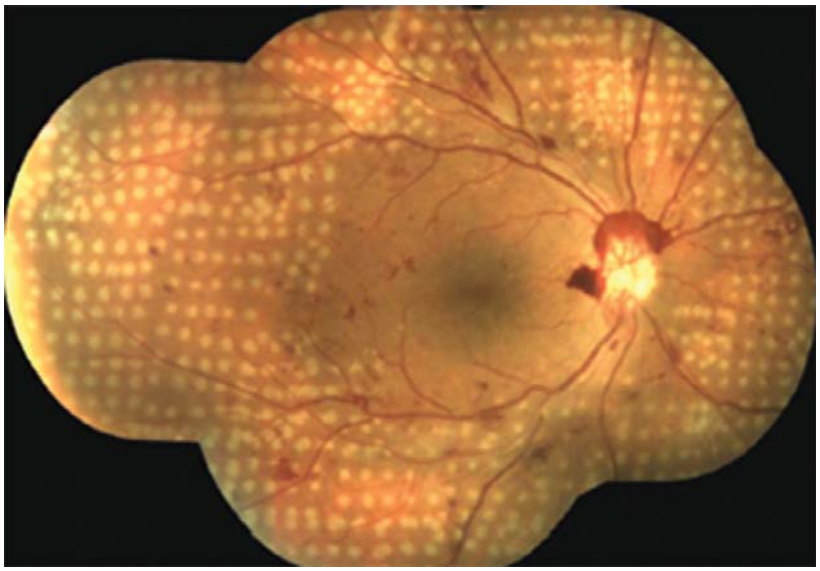

Figure 5: *Fundus photograph of a patient after PRP with 532 nm laser*

INDICATIONS FOR LASERS

Proliferative Diabetic Retinopathy

National Eye Institute initiated Diabetic Retinopathy Study (DRS) in the early 1970s, which compared xenon arc and argon laser photocoagulation to no photocoagulation in patients with PDR. The DRS provided the initial evidence to establish the safety and efficacy of modern panretinal (scatter) photocoagulation (PRP) (Figure 3,4,5). The DRS conclusively demonstrated that PRP significantly reduces the risk of severe visual loss (SVL) from PDR, particularly when high-risk PDR is present. The DRS concluded that for eyes with high-risk characteristics, the chance of benefit from treatment clearly outweighed its risk and recommended prompt photocoagulation for most such eyes.

PDR with HRC s are

1 NVD (neovascularisation on disc) equal to or greater than 1/ 4 to 1/3 disc area
2 any amount of NVD with fresh vitreous or pre retinal haemorrhage.
3 NVE (neovasularisation elsewhere) equal to or greater than ½ disc area with fresh viterous or pre retinal haemorrhage.

For eyes with severe NPDR or early (not high-risk) PDR, DRS results were not helpful in determining which of two treatment strategies would be attended by a more favorable visual outcome: (1) immediate photocoagulation or (2) frequent follow-up and prompt initiation of photocoagulation only if high-risk PDR developed. One of the goals of the Early Treatment Diabetic Retinopathy Study (ETDRS), a randomized clinical trial sponsored by the National Eye Institute, was to compare these alternatives (designated "early photocoagulation" and "deferral of photocoagulation," respectively) in patients with mild to severe NPDR or early PDR. Other goals were to evaluate photocoagulation for diabetic macular edema. The ETDRS recommended that scatter treatment not be used in eyes with mild to moderate NPDR but that it be considered for eyes approaching the high-risk stage (i.e., eyes

with very severe NPDR or early PDR) and that it usually should not be delayed when the high-risk stage is present.

The DRS and ETDRS validated the effectiveness of PRP and established the indications and parameters for the treatment of PDR several decades ago. These concepts persist mostly unchanged to this day as a result of their remarkable efficacy.

Results from a recent DRCR.net Protocol S study[14] comparing the safety and efficacy of intravitreous anti-VEGF therapy (ranibizumab) with deferred PRP to prompt PRP demonstrate that visual acuity after 2 years of treatment is noninferior in eyes treated with anti-VEGF for PDR. Moreover, this trial found that eyes treated with anti-VEGF had less visual acuity loss, less visual field loss, less need for vitrectomy and less frequent development of DME than eyes that received PRP. These findings suggest that anti-VEGF may be a reasonable alternative to PRP in eyes with PDR, especially those eyes with concurrent central involved DME. Given the excellent visual and anatomic results obtained with ranibizumab therapy in this study, many clinicians may choose to consider anti-VEGF as an alternative first-line therapy to PRP in eyes with PDR especially in Eyes that present with PDR accompanied by central-involved DME. Although only the 2-year primary results have been reported to date, this study will continue for a total of 5 years follow-up. Further results from this trial will help better define the role of VEGF inhibitors in the management of diabetic ocular neovascular complications.

Ranibizumab Plus PRP versus PRP alone for High-Risk Proliferative Diabetic Retinopathy was compared in PROTEUS Study in 2018. It concluded that treatment with RBZ+PRP is more effective than PRP monotherapy for NV regression in HR-PDR participants over 12 months.

In panretinal photocoagulation, (Table 4) pulses of 100 to 200 milliseconds have been commonly used, and more than a thousand lesions are typically applied, coagulating as much as 30% of the peripheral retina. Although clinically effective, panretinal photocoagulation frequently leads to unwanted secondary effects, including scotoma, reduced night vision, and disruption of the retinal anatomy through scarring. Proliferative diabetic retinopathy has been treated with scatter or panretinal photocoagulation (PRP) for the past 50 years. Moderate-intensity spots of 350–500 µm in diameter and 0.075–0.2s. in duration are delivered through a panfundus contact lens or 3-mirror contact lens to the mid-peripheral retina. Spots are spaced 1 diameter apart and are applied from just outside the major vascular arcades to the far peripheral retina. Complete treatment usually consists of 1200–3000 spots, but more may be delivered either primarily or for resistant cases. PRP can also be performed with an indirect ophthalmoscopic delivery system, which enables physicians to more completely treat the far peripheral retina . Treatments are often divided into 2–3 sessions to improve patient comfort. Many physicians choose to photocoagulate the inferior retina first so that if the post-laser course is complicated by a vitreous hemorrhage, the view of the superior retina is less likely to be obstructed and the course of treatment can be completed. Smaller spot sizes and longer wavelengths (such as 810 nm) penetrate vitreous hemorrhages better. Preretinal neovascularization usually regresses within 3 weeks of adequate PRP. Exudative choroidal detachments may complicate intensive, widespread PRP, but this rarely occurs after split-session treatments. High-intensity burns can rupture Bruch's membrane and lead to retinal and vitreous hemorrhages and the ingrowth of choroidal neovascular membranes. Peripheral visual field loss and night blindness can follow high-intensity PRP. Worsening of preexisting vitreoretinal traction can occur after intense photocoagulation, but treatment with divided sessions usually avoids this complication.

Table 4: Modified-ETDRS Focal/Grid Laser Photocoagulation Technique Used by the DRCR.net

Grid treatment	500–3000 µm superiorly, and inferiorly from center of macula;500–3500 µm temporally from macular center; no burns placed within 500 µm of disc Burn size 50 µm Burn duration 0.05–0.1 seconds Burn separation Two visible burn widths apart
Direct treatment	Directly treat all leaking microaneurysms in areas of retinal thickening between 500 and 3000 µm from the center of the macula Spot size 50 µm Burn duration 0.05–0.1 seconds

DIABETIC MACULAR EDEMA

The efficacy of focal/grid laser photocoagulation for treatment of DME was established in the ETDRS. EDTRS concluded that focal/grid laser photocoagulation decreased moderate visual loss by 50%in patients with clinically significant macular edema CSME defined as: (1) retinal thickening within 500 µm of the macular center or (2) hard exudates with in 500 µm of the macular center with adjacent thickening or (3) zone of retinal thickening 1 disc area in size any portion of which is within 1 disc diameter of the macular center. Laser treatment is second line to anti-VEGF therapy. Intra vitreal Anti-VEGF have been shown to be very effective therapies for macular edema involving the fovea (center-involving); ranibizumab (DRCR.net Protocol I,[13] DRCR.net Protocol T, RISE, RIDE, RESTORE, and RESOLVE studies), aflibercept (DRCR. net Protocol T, VIVID, VISTA studies) and bevacizumab (DRCR.net Protocol T). Since the introduction of anti-VEGF therapy, laser photocoagulation has taken a back seat in management of diabetic macular edema .Anti-VEGF therapy is the preferred choice for center-involving DME; however, focal laser photocoagulation is still useful in the treatment of extrafoveal edema. In addition, focal laser targeting leaking microaneurysms or grid laser targeting areas of diffuse leakage on the retina can be useful to reduce the need for repeated anti-VEGF injections and also to reduce the burden on health care systems. Subthreshold micropulse laser has been shown to be as effective as focal laser in reducing edema and subsequently reducing the need for frequent injections.

Landmark studies in the 1970s and 1980s established the efficacy of laser photocoagulation (Table 5), which reduces risk of moderate vision loss from DME by 50% and risk of blindness from PDR by 90%. Recent clinical trials have established the superiority of VEGF antagonists delivered by intravitreous injection compared with focal/grid laser

Table 5: Final recommendations		
Disease	Study	Treatment
PDR + HRC	DRS	PRP
Severe NPDR PDR without HRC	ETDRS	Consider PRP
Mild & Moderate NPDR	ETDRS	No PRP
Centre Involving Macular Odema	DRCR .NET PROTOCOL I	Intravitreal Anti VEGF
Centre Sparing ME	ETDRS	Focal Or Grid Laser

photocoagulation for DME involving the center of the macula.

ARMD

Since LASER treatment destroys retinal tissue (and corresponding function), such treatment generally is reserved only for cases that are extrafoveal CNVM and in which it is judged that a scotoma from the laser is preferred over proceeding with anti-VEGF therapy.

LASER IN THE TREATMENT OF RVO

The Branch Vein Occlusion Study showed the efficacy of grid laser in macular edema and sectoral laser for neovascularization secondary to branch retinal vein occlusion (BRVO), and the Central Vein Occlusion Study showed the benefit of scatter photocoagulation in the management of neovascularization in central retinal vein occlusion (CRVO) for prevention of neovascular glaucoma. However, with the advent of Anti-VEGF therapy, it has now become the first choice of treatment for macular odema secondary to BRVO and CRVO. Laser continues to be valuable in the presence of neovascularization that involves the retina, iris, or angle. Full PRP for CRVO or sector PRP for BRVO will prevent further progression and induce regression of neovascularization in most cases.

CENTRAL SEROUS CHORIORETINOPATHY

Lasers have long been used for management of focal leaks in the treatment of persistent cases of nonresolving central serous chorioretinopathy (CSR). Laser photocoagulation, when applied to the RPE leakage points, causes direct thermal sealing effects on focal RPE defects that promote a healing response and favor stimulation of surrounding RPE cells. This often hastens the resolution of CSR but rarely alters final visual outcome or rate of recurrence. The introduction of micropulse laser has allowed clinicians to manage not only extrafoveal leaks but also subfoveal leaks, along with areas of diffuse RPE dysfunction, quite successfully. Micropulse laser can be considered an alternative to photodynamic therapy in eyes with chronic CSR with or without subfoveal leaks.

RETINAL BREAKS

Retinopexy around retinal breaks is performed by promoting chorioretinal adhesion secondary to laser photocoagulation and sealing the area surrounding the break. This plays a key role in prevention of retinal detachments.

EXUDATIVE RETINAL VASCULAR DISORDERS

In exudative retinal vascular disorders such as Coats disease, retinal capillary hemangioma, or retinal artery macroaneurysms, laser photocoagulation can be used to directly close the leaking vessels by promoting thrombosis.

RETINOCHOROIDAL NEOVASCULAR DISEASES

Retinochoroidal neovascular diseases, such as extrafoveal choroidal neovascular membrane, extrafoveal retinal angiomatous proliferation lesions , and polyps in polypoidal choroidal vasculopathy, can be addressed with thermal photocoagulation efficiently and with great results.

PERIPHERAL RETINAL ISCHEMIC RETINOPATHIES

In peripheral retinal ischemic retinopathies such as vasculitis, familial exudative vitreoretinopathy, and retinopathy of prematurity, laser can help to reduce the hypoxic load on the retina and prevent devastating complications.

TUMORS

For vasoproliferative retinal tumors, angiomas, etc., laser photocoagulation can promote closure, much as described above for other neovascular complexes.

CONCLUSION

For decades, laser photocoagulation was the first-line therapy for proliferative diabetic retinopathy (PDR) and diabetic macular edema (DME) and ARMD and vascular occlusions. In recent years, intravitreal anti-VEGF injections have become popular as treatments for centre involving macular odema in Diabetes, BRVO and CRVO , and CNVM with ARMD, and their safety and efficacy have been demonstrated in clinical trials. Anti-VEGF injections have shown superiority over laser and they are easy to administer and provide rapid improvement in vision. All of this has caused many ophthalmologists to prefer anti-VEGF injections over laser, and as a result, laser has become a second-line therapy for these indications.

However, anti-VEGF agents are far from perfect. They are short-acting and expensive, and they carry the risks of endophthalmitis and stroke, which are not concerns with retinal laser photocoagulation. In addition, the Protocol T clinical trial of the Diabetic Retinopathy Clinical Research Network found that 50% of patients with DME required additional laser treatment after 24 weeks of anti-VEGF treatment.

Lasers as a modality of management for retinal diseases continue to evolve in terms of management protocol, innovations, and ever-expanding indications. Conventional laser photocoagulation has been proven to be an effective means to treat ocular diseases. However, it results in full-thickness damage to the RPE, choroid and retina, scotoma formation, choroidal neovascularization, foveal distortion and subretinal fibrosis. Laser photocoagulation is evolving toward laser protocols that can limit and minimize collateral damage. Laser therapy remains an integral component of conservative management in a number of vitreoretinal disorders. LASER should be considered as a supplement treatment to anti VEGF injections especially in DME and WET ARMD, macular odema secondary to BRVO and CRVO . LASER still is the considered the treatment of choice in PDR ,extrafoveal DME , extrafoveal odema in BRVO and CRVO with good visual acuity.

On the whole, medical management in the form of intravitreal anti VEGF and steroid injections of many retinal diseases has dramatically improved our ability to stop and even reverse anatomic deficits and restore vision. However, medical therapy is not universally effective, nor

is it always the best option for treating a particular clinical manifestation. Thus, laser remains an important treatment option, even in the era of pharmacotherapy.

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