Binocular indirect argon laser photocoagulator

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SUMMARY The binocular indirect argon laser photocoagulator was newly designed to enable visualisation of the entire fundus during panretinal laser photocoagulation and to treat retinal tears immediately after buckling procedures of the sclera. The lamp housing of the binocular ophthalmoscope was remodelled and adjusted so that the laser beam and illuminating light are coaxial after leaving the ophthalmoscope. The blocking filter was permanently fixed in the eyepieces to lighten the weight of the ophthalmoscope. This new delivery system of the laser beam supplies the clinician with a better view of the whole fundus than the standard slit-lamp delivery system, and may become the ideal method for panretinal photocoagulation in the treatment of diabetic retinopathy and central retinal vein obstruction and for the repair of retinal tears. However, a fine and delicate laser technique in the posterior pole does not suit the function of this new delivery system well. Proper use of photocoagulation therapy by combining the standard and the new delivery system of the laser beam is preferable, depending on the location and nature of the retinal lesions.

Because of the many advantages of the delivery system and the optimum wavelength, argon laser slit-lamp photocoagulation has become a popular technique. However, limitations and difficulties affect its use. Firstly, only a very small retinal field is seen through the 3-mirror contact lens. Pathological changes in fundus may be missed because an overall view of the fundus is not possible. Secondly, 20° to 40° angles from the macula are 'dead' areas with the Goldmann 3-mirror lens, which makes laser application within these areas difficult. Thirdly, laser photocoagulation around a retinal tear is not available immediately after a buckling procedure because it is not adapted to patients in a supine position. Fourthly, a binocular view of the retina through the Goldmann 3-mirror lens is more difficult in the extreme periphery even with use of a depressor. This difficulty is more pronounced when the operator treats temporal or nasal areas. Fifthly, patients must remain immobile at the slit-lamp, occasionally for long periods of time.

To overcome these problems a delivery system of the argon laser beam called the binocular indirect argon laser photocoagulator has been devised. It enables an operator to apply argon laser photocoagulation without any restriction on patients in a supine position.

Materials and methods

The laser used in this study is an argon laser (NIDEK-model 95) that is incorporated with a LEXE1 Co. laser head (Fig. 1). This continuous-wave system is designed to produce a total power output of 3.0 W. The principal wavelengths are 488 and 514.5 nm, with respective power outputs of 0.87 and 1.04 W. Fig. 2 is a diagram of the optical elements and instrumentation used in the binocular indirect argon laser photocoagulator. The laser beam is guided from the console to the binocular ophthalmoscope by a single flexible quartz fibre that is 85 µm in diameter and 250 cm long.

The Keeler binocular ophthalmoscope was remodelled for this system (Fig. 3). The original lamp housing was replaced. The laser beam is brought to the distal end of the quartz fibre, which is fed into a small 0.2 mm hole in the first mirror, which is placed at 45° to the long axis of the lamp housing. The beam then passes through the projection lens and is reflected by the second mirror before leaving the ophthalmoscope. The illuminating light is supplied by a fiberoptic illuminator (INAMI L-39B, Fig. 1), which contains a 150 W tungsten lamp. The light is delivered through a glass fiberoptic, which is 3 mm in diameter and 250 cm long. The illuminating light enters the housing rectangularly to its long axis, is focused by a condenser, and is reflected by the first

Fig. 1 *Binocular indirect argon laser photocoagulator in operation with use of a scleral depressor.*

mirror. The illuminating and laser beams are coaxial after leaving the first mirror. After passing through the projection system (Figs. 2 and 3) both are reflected again by the second mirror. The beams reach the patient's eye through a hand-held lens.

The laser beam can be focused or defocused by adjusting the projection lens with the head of a pin located outside the housing. In this manner the laser spot size can be varied from 150 to 1000 μm . The 150 μm spot is parfocal with the binocular ophthalmoscope, whereas the larger spot sizes are made by defocusing the laser beam (Figs. 2 and 3). To protect the operator from reflected light a blocking filter is permanently located in front of the binocular eyepiece of the ophthalmoscope. The operator is not encumbered by the remodelled ophthalmoscope, in that it is only 30 g heavier than the original.

The fundus is viewed through a hand-held lens of +14 or +20 dioptres. The aiming light is centred carefully on the aerial image of the fundus before the laser beam is triggered by the original foot switch. Centring of the aiming light must be carefully done to secure useful photocoagulation and to ensure that the laser beam enters through the pupil, thereby reducing the likelihood of accidental damage to the iris. Moreover, the foot switch should not be depressed until the aiming light is focused exactly to provide the desired spot size and laser energy on the fundus.

All patients were placed in a supine position and a lid speculum was inserted (Fig. 1). The cornea was lubricated with saline solution or balanced salt solution during treatment. The pupil was dilated with 1 drop of 0.5% tropicamide and 0.5% pheny-

Fig 2 *Diagram of the optical elements and instrumentation used in the binocular indirect argon laser photocoagulator.*
1. Illuminating lamp housing; 2. Condenser lens; 3. Glass fibre for illumination; 4. Projection lens; 5. First mirror; 6. Quartz fibre; 7. Projection lens; 8. Second mirror; 9. Hand lens; 10. Patient's eye; 11 Operator's eye.

Fig. 3 Diagram of the light housing remodelled from the binocular indirect ophthalmoscope for the purpose of argon laser photocoagulation. 1. Glass fibre for illumination; 2. Condenser lens; 3. First mirror; 4. Quartz fibre for argon laser; 5. Projection lens; 6. Second mirror.

lephrine solution. This was repeated after 10 minutes. Topical anaesthesia was achieved with 0.4% oxybuprocaine. A retrobulbar injection of 2 ml of 4% xylocaine and hyaluronidase was given to those undergoing photocoagulation near the posterior pole. The absence of a retrobulbar injection enabled patients to co-operate in the treatment of peripheral regions of the fundus by assuming an eccentric direction of gaze similar to that employed in routine binocular ophthalmoscopy. Indentation photocoagulation was used to treat retinal tears, holes, or predisposing retinal degeneration in the peripheral fundus and the ora serrata (Fig. 1).

Results

By this new delivery system photocoagulation can be applied freely and in any direction under an

overall view of the fundus. The operator can apply the burns by walking around the patient's head, as in routine bedside ophthalmoscopy. This considerably reduces the time required for treatment. For example, diffuse photocoagulation with 1000 spots was accomplished within 15 minutes, while the slit-lamp system required more than 30 minutes to obtain the same.

The +20 dioptre hand lens is most satisfactory for disseminating or panretinal photocoagulation. The +14 dioptre lens gives greater magnification and is preferable for photocoagulation near the posterior pole.

Severe complications resulting from faulty argon laser photocoagulation techniques such as iris burn, macular pucker, retinal haemorrhage, and accidental burn of the macula have not arisen as yet.

Discussion

As the incidence of diabetes mellitus and hypertension increases, so does the number of patients with diabetic retinopathy and occlusion of the central retinal vein that requires photocoagulation treatment. The binocular indirect argon laser photocoagulation delivery system significantly reduces the time for disseminated or panretinal photocoagulation and also treats patients in a more comfortable supine position. Moreover, this arrangement provides enough freedom for application of the laser beam not only to the central area but to the periphery as well. The greatest advantage of binocular indirect argon laser photocoagulation is that it allows the operator to scan the whole fundus during photocoagulation and to confirm localised pathological changes requiring treatment. It is particularly valuable in panphotocoagulation of the fundus under stereoscopic visualisation.

The binocular indirect argon laser photocoagulation system has successfully overcome the disadvantages of the slit-lamp argon laser system for intraoperative application in retinal detachment surgery and may be the ideal method of photocoagulation in the immediate period after detachment surgery inside or outside the operating room.

Binocular indirect argon laser photocoagulation does not require any special proficiency in its handling by ophthalmologists experienced in binocular ophthalmoscopy. However, several problems have been encountered. Firstly, because of instability and inaccuracy in the aiming of the laser beam, a delicate and fine laser application, such as feeder-front photocoagulation and obliteration of the leaking spot of central serous choroidopathy, is not its most efficacious use. Secondly, the foot switch

and blocking filter do not work synchronously. The filter is permanently glued on to the eyepieces to lighten the weight of the binocular ophthalmoscope. Therefore the fundus is viewed through a yellow filter, which requires a brighter illumination for funduscopy and photocoagulation.

At present the binocular indirect argon laser photocoagulation can be used best in conjunction with the standard delivery system. The binocular indirect argon laser photocoagulator is preferable for retinal detachment surgery and disseminating or panretinal photocoagulation, whereas the standard slit-lamp photocoagulator is best for direct coagula-

tion of neovascularisation and central serous choroidopathy.

I am currently working on a machine that will include both delivery systems. It will enable the operator to alternate the type of system needed for the individual patient.

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