Recent advances in the treatment of cataract

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Introduction

An important advance in the treatment of cataract has been made with the introduction of bifocal intraocular lens implants. Because these new devices can restore clear vision for distance as well as near without the need for additional spectacles, patients may have their vision improved to a level many would not have enjoyed since they were young adults. This breakthrough has been achieved with new lens implant design, improved biometric measurement devices and the use of advanced refractive surgical techniques. The results now possible following cataract surgery are likely to be yet another factor stimulating demand, already rising as a consequence of the demographic changes in the elderly population.

Key words: cataract, bifocal intraocular lens implant

Background

Historically the opaque cataractous lens of the eye was at first treated by dislodging the lens clear of the visual axis. This was achieved by couching — inserting a fine pointed instrument into the globe to rupture the supporting zonular fibres of the opaque lens. Vision is usually reduced by a mature cataract to the level of perception of light only, but once the visual axis is clear a full field of vision is restored. This gives navigational vision even if central acuity remains at the counting fingers level due to the resultant high hypermetropic refractive error. This century, with the introduction of effective anaesthesia, it became feasible to remove cataracts from the eye completely. Nevertheless both ophthalmologist and patient alike had to be content with the limited visual improvement achieved due to the large residual refractive error (*Figure 1*).

In 1952 a British ophthalmic surgeon, Harold Ridley, first successfully implanted a lens prosthesis into the eye following cataract extraction (*Ref 1*). Having observed that perspex fragments retained in the eye following injuries sustained by fighter pilots in the war did not necessarily cause any complication, he designed his lens implant using perspex. It was supported by the lens capsular bag after extraction of the central lens nucleus — a technique called 'extracapsular' cataract extraction. Ridley's work was pioneering, and many problems had to be resolved before lens implantation became routinely successful.

In 1969 a technique of cataract extraction using a cryo probe was developed by Krwawicz in Poland (*Ref 2*). With this method the cataractous lens could be removed intact from the eye without rupture of the fragile lens capsule by grasping the lens on the end of a freezing probe. Such 'intracapsular' extraction is quick and simple, leaving no residual lens matter in the eye and little resulting post-operative inflammation. The technique was rapidly and widely adopted and by the mid 1970s was used almost exclusively as the preferred method of cataract extraction in this country. Since intracapsular extraction removes all the lens capsule, an alternative support for an intraocular lens implant is required.

The first widely used implant was one designed by Cornelius Binkhorst which was supported by the iris. Iris clip lenses had loops lying in front and behind the iris plane, which stabilized the optical part of the implant in the pupil.

Further advances in implant design were made by Peter Choyce, who developed implants that could not only be successfully placed in the eye at the time of cataract extraction, but could also be inserted as a secondary procedure in eyes that had previously undergone cataract extraction without an implant. Choyce's anterior

Figure 1a
In the normal eye the cornea and the lens bring light into focus on the retina.

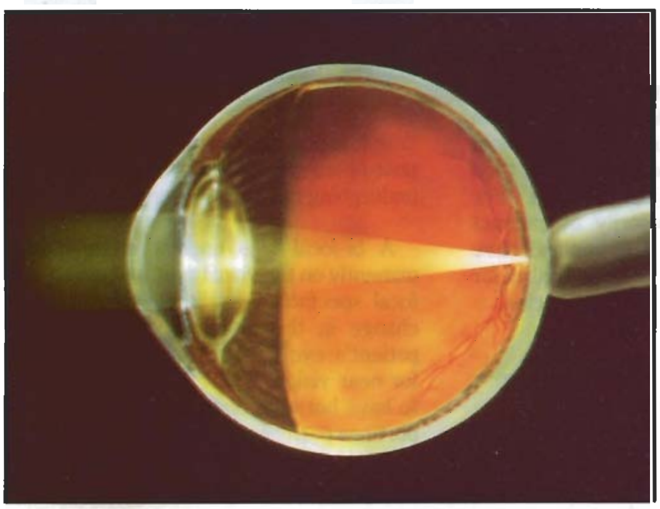


Figure 1b
In an aphakic eye the light is partially focused by the cornea, but without the physiological lens the eye has a large residual refractive error.

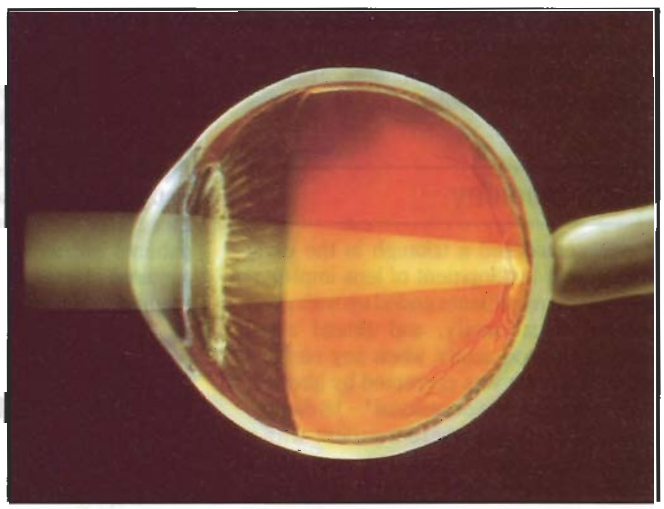


Figure 2
An anterior chamber intraocular lens is supported by struts with stabilization in the angle between the iris and cornea.

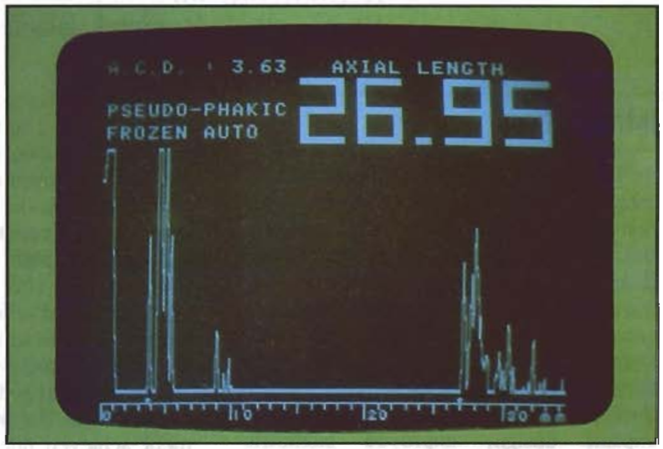


Figure 3
This ultrasonic scan is a biometric ruler to determine the internal dimensions of the eye. The data is used to calculate the correct optical power for the intraocular lens implant.

chamber lenses are supported by stabilizing struts placed in the angle between the iris and cornea, making them much more stable than iris clip lenses. Anterior chamber lenses have undergone continued improvements in their design and quality, and are still used today for secondary implantation in eyes that have had previous simple cataract extraction (*Figure 2*).

In the 1980s there was a move back to the use of lens implants supported by the physiological lens capsular bag. Studies had shown that there were fewer complications following extracapsular extraction than with intracapsular (*Ref 3*). A new generation of lens implants was developed with the optical portion resting on the posterior lens capsule. The centralizing loops pressed against the lens capsule so that the lens implant was held entirely within the capsular bag. Unlike Ridley's first lens implant which weighed 112mg, today's 'in the bag' implants are much smaller, lighter (15–20mg) and have an extremely high success rate. Today some 90% of all implants are placed in the posterior chamber and the earlier designs which used the iris for support have become virtually obsolete (*Ref 4*).

Ocular biometry

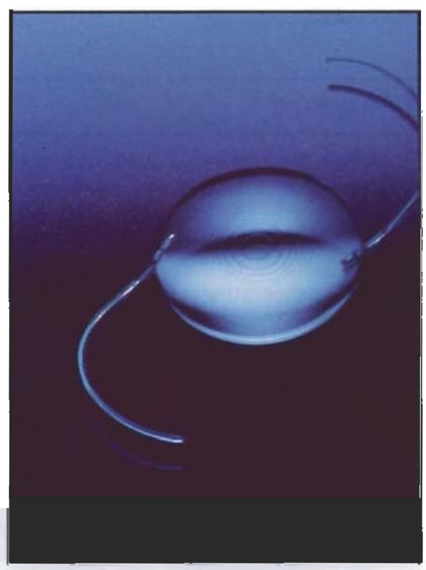
It was considered a triumph in the early days of the development of lens implantation that many patients ended up with good unaided visual acuity, and almost all of them with good acuity when any residual refractive error was corrected by glasses. Unfortunately, the occasional '−18 dioptre surprise' occurred where a patient with a previously highly myopic eye received a standard power lens implant and then required a powerful myopic spectacle lens to compensate for the over-correction achieved by the implant. This unsatisfactory state of affairs was overcome by the development of pre-operative biometric measurement of the eye. The corneal curvature is assessed by a keratometer using the light reflex from the corneal surface to allow measurement of its radius. Ultrasonic biometry is used to measure the axial length of the eye and in conjunction with the keratometry the measurements are used to calculate the required intraocular lens power (*Figure 3*).

Despite these calculations, some inaccuracy of the final post-operative refractive state has remained. Factors such as variation in positioning of the lens implant cannot be predicted pre-operatively, although with biometric assessment, some 80% of cases may achieve a refraction within ±1 dioptre of the predicted value (*Ref 4*). Most cataract operations leave some degree of astigmatism due to surgically induced corneal distortion. This astigmatism requires spectacle correction post-operatively. Even if there is no astigmatism, the patient will require spectacles for near vision if the lens implant is in focus for distance. Equally, if the eye is focused for near then distance glasses will be required. For these reasons, the majority of cataract patients with monofocal lens implants have required glasses for distance as well as for reading, often using bi-focal spectacles.

Bi-focal intraocular lenses

The introduction of bi-focal intraocular lens implants is changing all this. For the first time it is possible to aim at achieving good post-operative unaided vision in a patient undergoing cataract surgery.

Figure 4
A diffractive type bifocal intraocular lens implant. The curved loops support the lens optic in the capsular bag left behind following extracapsular cataract extraction.



A bi-focal lens implant is fixed permanently on the visual axis, and unlike a bi-focal spectacle lens, it does not rely on change in the direction of gaze of the patient's eye for additional optical power for near vision. Therefore it is necessary to have both the distance and near optical portions permanently in focus. One type of bi-focal intraocular lens has a small reading segment in the central part of the lens

Figure 5
The diffractive bifocal lens implanted in a patient's eye. The diffractive rings can only be seen under magnification with a slit-lamp.

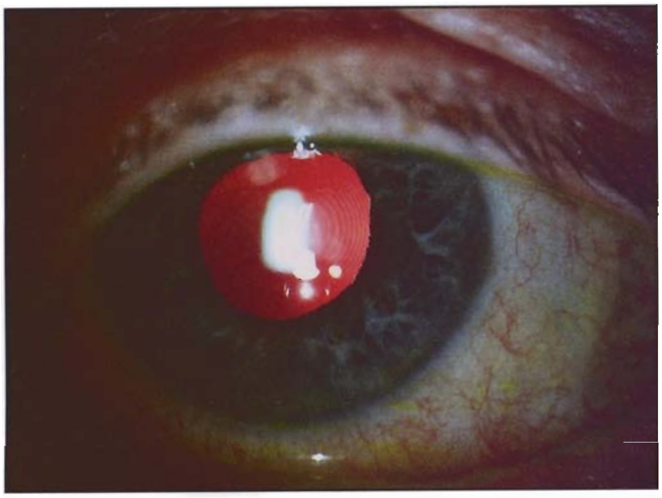
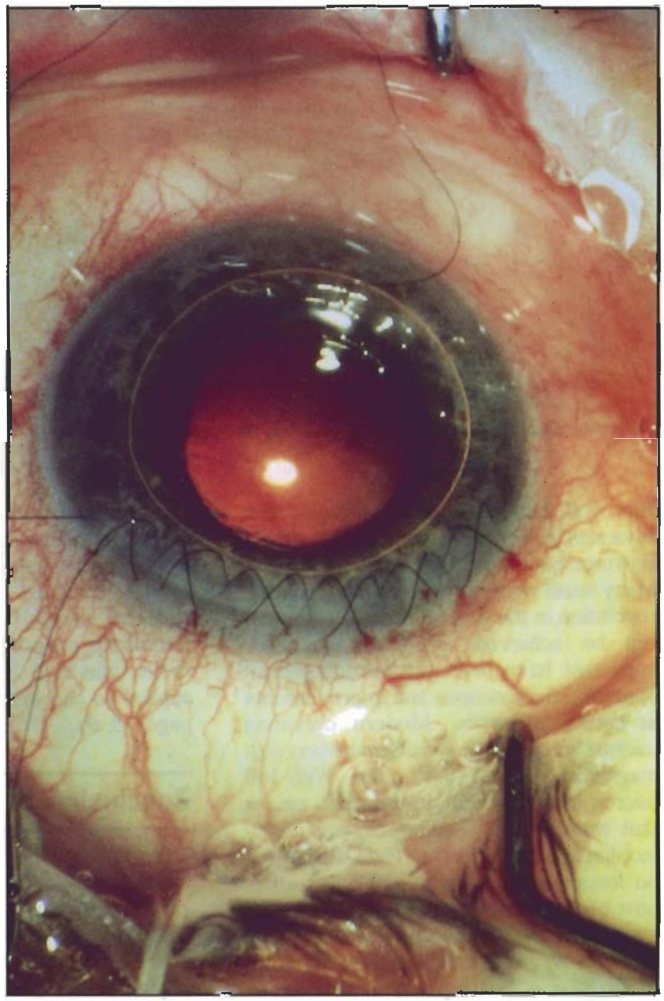


Figure 7
Peribulbar or retrobulbar injection is used to anaesthetize the eye.

Figure 6
Microsurgical suturing of the eye with 10 '0' monofilament will give watertight wound closure and allow immediate post-operative mobilization of the patient.



optic, but its performance may be impaired by variation in pupil size and decentration of the lens.

Another design uses multiple diffractive zones placed over the surface of the lens. The front surface of this lens has a smooth curve and bends the light by conventional refractive means, but on the back surface of the lens are multiple concentric steps about two microns high which direct the light by diffraction to two foci, one for distance and one for near (*Figures 4, 5*, previous page) (*Ref 5*). A recent multicentre clinical trial has shown that over 75% of patients achieve functional vision with such diffractive implants without the need for spectacles (*Ref 6*). The bifocal lens implant obviously offers a measurable benefit to the patient in terms of improved quality of visual outcome from cataract surgery.

Implants and refractive surgery

Vision with a bifocal lens implant will be good for both distance and near if the corneal shape is spherical post-operatively, and the biometric calculation is correct. Such a result is only achieved by careful control of the corneal shape during and after surgery. During the operation the shape of the cornea is checked and suture tensions adjusted. Post-operatively, further keratometric measurements are made and errors may often be corrected simply by cutting sutures that are too tight.

If however there is still residual astigmatism after this stage, further surgical intervention can be used to correct this by performing relaxing incisions in the cornea of the type used in radial keratotomy. To make these incisions the corneal thickness is measured with an ultrasonic pachymeter and the blade of the diamond knife adjusted with a micrometer to achieve a near full thickness incision without perforating the cornea. The length and position of the incisions is calculated according to the refractive error. Such refractive techniques may even be used at the time of the original surgery, particularly if there is pre-existing astigmatism which requires correction (*Ref 7*).

Good refractive results take extra time and effort to achieve consistently, but with increased awareness of the new benefits available for patients, demand for bi-focal lens implantation combined with these keratorefractive techniques will no doubt increase.

Day case surgery

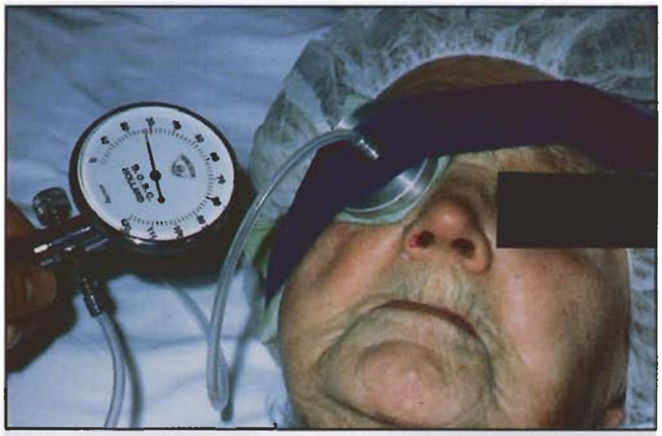
In parallel with the development of

Figure 8

Facial block (O'Brien technique) gives relaxation of the orbicularis oculi.

Figure 9

Controlled pressure on the orbital contents pre-operatively gives a soft eye and helps minimize the risk of complications such as rupture of the posterior lens capsule.



improved lens implants there have been advances in virtually every aspect of the instrumentation used for cataract surgery. Many small changes have brought about a revolution in the quality of the results that can be achieved. Two of the most important have been the introduction of operating microscopes and improvements in suture materials. Modern operating microscopes offer co-axial illumination with magnification of up to 40 times. With 150 micron monofilament sutures, this means that watertight and stable closure of the incision is now the norm. Thus the patient no longer has to endure 10 days' strict post-operative bed rest with pads on both eyes, and can opt for day-case surgery (*Figure* 6, previous page) (*Ref 8*). Restriction of post-operative activities is no longer required, and even post-operative padding of the eye is no longer necessary (*Ref 9*). The patient is required only to protect the eye from direct trauma by wearing a plastic eye shield at night for a few weeks after the operation.

Local anaesthesia

Most patients requiring cataract surgery are elderly and often have other systemic diseases such as diabetes and ischaemic heart disease. For such patients day case surgery is preferably carried out under local anaesthesia. The effectiveness of the local blocks has been improved with the introduction of bupivacane (Marcaine, Astra Pharmaceuticals Ltd, King's Langley, Herts) with its longer duration of action than lignocaine (*Ref 10*). This achieves good anaesthesia for the longest cataract operation, and also provides some post-operative analgesia. Two injections are commonly used — one to anaesthetise the eye and inhibit eye movement by blocking the action of the extraocular muscles, and a second injection to relax the eyelids so that the patient does not squeeze the lids. To avoid a rise in intraocular pressure following the anaesthetic injection, controlled pressure is applied to the orbit (*Figures 7* [previous page], *8, 9*).

Conclusion

Over the past 40 years there have been many technical advances in the field of cataract surgery and lens implantation. The early pioneers performed extracapsular lens extraction and placed large implants in the capsular bag. Although there were some spectacular successes, many of the early cases ended in failure. Over the years, methods changed and intracapsular surgery carried out under general anaesthesia was often employed. Methods of performing cataract surgery now seem to have come full circle and the extracapsular technique is once more preferred.

With today's generation of bifocal lens implants, combined with modern kerato-refractive control, the success rate and visual results obtainable in the treatment of cataract are unsurpassed. Post-operative restriction of the patient is no longer required, and day case surgery is becoming increasingly popular. Local anaesthesia is safe and effective and is generally preferred by elderly patients.

Acknowledgements

I should like to thank Mr R Kightley for Figure 1.

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