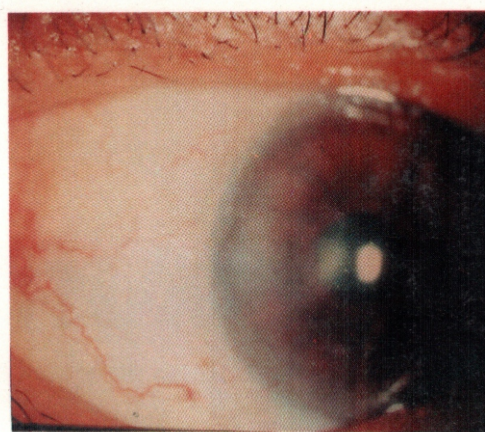
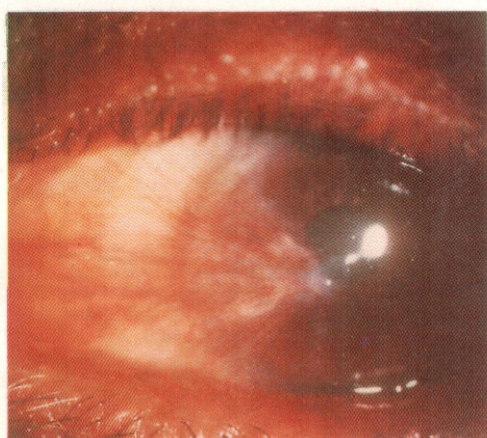


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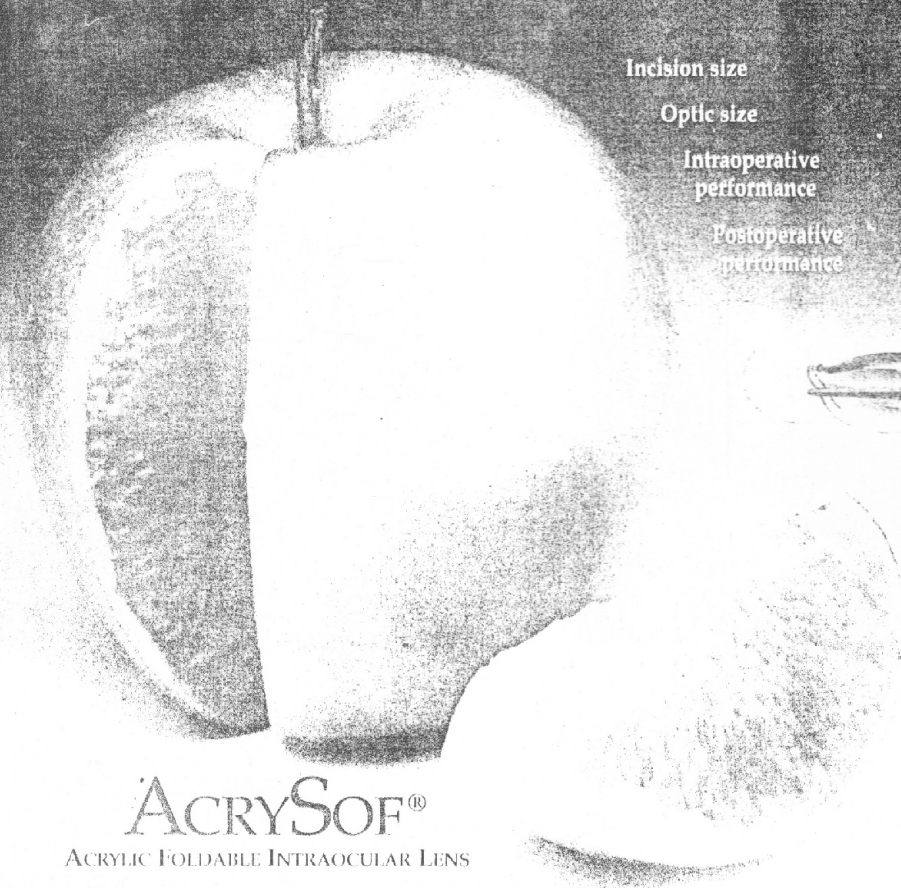


At Page 26 & 27 Figures 1 & 5 Pterygium before and 6 months after excision and limbal stem cell autograft

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Sincerely,

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Editorial

Blindness Statistics for Pakistan

See also pp..... 15-19

To draw up an intelligent and meaningful plan to counter a problem, the exact magnitude of the problem needs to be known. Nothing could be closer to the truth than this in the case of public health plans on national, regional or local levels. But to figure out the exact magnitude of the health problems is easier said than done. Closest one may get in assessing the magnitude of such problems may be by conducting surveys of representative segments of the population and then extrapolating these figures to encompass the total population under consideration. Even that may prove to be a tall order, especially because of the financial constraints. Even these surveys run huge bills to the national exchequer. So much so that so far only seven countries in the world have conducted National Health Surveys. Our country has been fortunate enough to be one of those precious few. Health Survey of Pakistan was conducted between 1990 and 1994 by the Federal Bureau of Statistics of Pakistan in collaboration with the Pakistan Medical Research Council and the National Center for Health Statistics and the National Institute of Health (NIH) of the United States of America.

The figures about blindness and eye-related problems have also been collected in the Health Survey of Pakistan and have recently been released after data analysis. These are discussed in a related article in this issue of the Journal. These facts and figures are quite revealing and ought to be at the finger tips of all ophthalmologists and health care planners of the country. These figures should also be considered vis-a-vis the global figures in order to compare the state of our country's problems with those of the populations elsewhere. [WHO definitions of blindness as visual acuity less than 3/60 (0.05) or counting fingers at 3 meters in the better eye and of low vision as visual acuity of less than 6/18 (0.3) but equal to or better than 3/60 (0.05) in the better eye with the best correction, are universally accepted, and are used here].

According to the Survey, the national prevalence of blindness (in both eyes) is 1.78%¹, amounting to about 2.5 million people. Another 2.5 million are blind in one eye and an additional 5 million are visually handicapped. The corresponding global figures for blindness are 138 million blind and another 100 million with low vision and at risk of becoming blind². The major causes of blindness in Pakistan are cataract, corneal opacities from trachoma and vitamin A deficiency (xerophthalmia), refractive errors and glaucoma, with 1.3 million blind from cataracts alone. Corneal opacities from trachoma and vitamin A deficiency account for 12.6% of blindness nationally, amounting to about 315,000, out of 140 million population. Refractive errors which account mostly for low vision and visual handicap are the third largest cause of preventable/curable blindness in Pakistan, followed by glaucoma as the fourth largest cause of blindness nationwide, accounting for 82,677 cases. Globally, the WHO figures are: 16 million blind from cataracts, 6 million from glaucoma, 5 million from trachoma and 0.3 million from onchocerciasis². Xerophthalmia is the next major cause of global blindness. For lack of uniform definitions, diabetic retinopathy and age-related macular degeneration don't lend themselves to any meaningful assessment of their prevalence.

Trauma is another major cause of unocular blindness. Though no national figures are available, at least its seriousness can be fathomed from a study indicating that 12% of admissions in the eye departments in our North-West Frontier Province are because of ocular trauma³. Global estimates are over one million cases of unocular traumatic blindness. The importance of safety measures, including the use of seat belts in automobiles, protective goggles in workplaces, provision of safe playgrounds and legislative ban on potentially dangerous activities involving fireworks and firecrackers, can not be over-emphasized.

The financial and socioeconomic burden on the nation from blindness can be enormous. Now that an idea about the magnitude of the problem of blindness has been gained from the Health Survey of Pakistan, the national policy makers can draw up sensible plans and take measures to counter them. Ophthalmologists in the country also need to gear their efforts to become prominent players in this field to tackle these problems.

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Jehangir Durrani

Ophthalmic "Pastpourri"

Doctor Franklin's Double Spectacles

The Story of Bifocals

In a series of letters between two old friends, one "rising seventy-five" and the other "rising (perhaps more properly falling) eighty," is preserved the first written account of the use of bifocal spectacles. The younger man was George Whately, a writer on economics and Treasurer of the Foundling Hospital, London. The older man was Benjamin Franklin.

The ensuing few Ophthalmic "Pastpourri" entries from "Our Ophthalmic Heritage" by Charles Snyder taken in sequential continuity make interesting reading.

Jehangir Durrani
MD, FACS, FRC OPHTH

Snyder C. Our Ophthalmic Heritage. Little, Brown and Company. Boston. 1967;pp89-92.

The Prof. Nasim Ahmed Memorial Lecture Agents for Retinal Tamponade

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INTRODUCTION

The purpose of internal retinal tamponade is to close the retinal hole and hold the neuroretina against the retinal pigment epithelium (RPE), thereby preventing accumulation of subretinal fluid (SRF) and promoting permanent RPE-neuroretinal adhesion around the hole.

Rosengren¹ was the first to suggest that the use of a substance inside the eye could be useful in securing retinal re-apposition. He described how the use of air "presses the retrolental exudate out and partly presses the retina against the choroid. The air bubble being in place before the rupture, it serves as a sort of rupture tamponade and thus prevents the formation of new retrolental exudate. In case of this treatment it is very important to place the patient so that the rupture lies upward and the air bubble, according to the force of gravity, thus obturates the rupture."

Rosengren identified the importance of posturing the patient and utilizing this technique attained a success rate of 75% in his small series of patients.

In any discussion on retinal tamponade it should of course be remembered that internal tamponade is an adjunct to and not a substitute for accurate localization of retinal breaks, removal of epiretinal membranes if necessary and the application of cryo or laser therapy.

MATERIALS

Currently 3 main groups of substances are used in internal retinal tamponade. Namely, gases, liquid silicone oils and perfluorocarbon liquids (PCFL).

GASES

The most commonly used gas in retinal surgery is air. Air has the advantage of being free of cost and freely available, though it must of course be filtered to remove contaminants. Its disadvantage is that it is rapidly absorbed, for instance a 2ml bubble will be

gone from the eye in approximately 3 days. Because of the realization that the adhesion provoked by laser or cryotherapy is maximal at approximately 10 days, a search was made to identify gases that could provide tamponade for that period or even longer.

Much of the early work on gases (other than air) was carried out by Norton², Abrams and colleagues³, and Fineberg and colleagues⁴. Sulfur hexafluoride (SF₆) was initially identified as a useful substance and has remained popular. Perfluoropropane (C₃F₈) was also identified and is useful when either longer tamponade is required or where only a small volume of gas can be introduced into the eye. This is because it expands its volume by 4 times.

Why do bubbles of SF₆ or C₃F₈ gas expand within the vitreous cavity and remain there for longer than air bubbles? Abrams and colleagues³ identified 3 stages of gas dynamics after instillation of a bubble of pure inert gas into the eye.

The first stage involves rapid ingress of carbon dioxide, oxygen and nitrogen into the bubble because the bubble contains none of these gases and there is, therefore, a pressure gradient between the capillary bed and the bubble. Oxygen and carbon dioxide equilibrate quickly. Nitrogen and C₃F₈ exchange slowly. Maximum expansion is present when nitrogen diffusion into the bubble is equal to C₃F₈ diffusion out (occurs at about 72 hours for C₃F₈).

In the second stage, C₃F₈ which does not diffuse out easily due to its low solubility is gradually exchanged for nitrogen.

In the third stage the composition of the bubble remains constant and the volume decreases as all the gases diffuse out at a rate proportional to their concentrations. The expansion characteristics of SF₆ and C₃F₈ gases are shown in Table-1.

Table 1: Expansion Characteristics of Two Commonly Used Gases

	Expansion Factor	Time to Max Expansion	Non-Expansile Concentration
SF ₆	2 x	2 days but half the expansion occurs in 6 hours	20%
C ₃ F ₈	4 x	3 days	12%

The length of time that a bubble of gas remains within the eye depends on the concentration of the gas and the volume originally injected (Table-2).

Table 2: Longevity of Different Volumes and Concentrations of Gases after Intraocular Injection

Percentage	Injected Volume	Longevity (Days)
Air	2 ml	4
	4 ml	7
SF ₆ (100%)	0.4 ml	5
	2.0 ml	10
SF ₆ (25%)	4 ml	10-12
C ₃ F ₈ (100%)	0.4 ml	28
C ₃ F ₈ (12%)	4 ml	28 (at least)

Clinical Uses Of Gases

Gases are used clinically in both non-vitrectomised and vitrectomised eyes. In non-vitrectomised eyes they may provide internal tamponade but may also often provide volume replacement and by their nature "smooth the retina out" over the pigment epithelium preventing the fishmouthing phenomenon which occurs in some retinal tears.

In the technique of pneumatic retinopexy popularized by Hilton and Grizzard⁵ a patient with a retinal detachment secondary to a retinal tear in the upper retina is treated as follows. Firstly, cryotherapy

is applied to the hole. This also softens the eye. A volume (either 0.6 ml of SF₆ or 0.3ml of C₃F₈ is injected into the eye. The gas expands, tamponades the hole and the retina goes flat. This technique can be modified by omitting the cryotherapy and applying laser to the retinal break once the retina is flat. This technique has not proved popular in the United Kingdom as we have found the success rate is lower than that claimed (this is thought to be due to the absence of a buckling element providing external support for the retinal break). The pneumatic retinopexy technique has, however, found favour as an adjunct to more conventional surgery where the retinal break has failed to flatten against the pigment epithelium postoperatively. For instance when a scleral buckling operation has been carried out and the retina fails to flatten, the injection of a supplementary small gas bubble can tamponade the tear internally, thereby leading to its closure and flattening of the retina.

The use of air or gas for upper bullous retinal detachments has become popular following the success of this technique described by Stanford and Chignell⁶ and Gilbert and McLeod⁷. The latter authors coined the acronym D-ACE for the sequence which comprised of Drain, Air, Cryotherapy and Explant. In this technique an upper bullous retinal detachment is treated as follows: The SRF is first drained. The air (or air/gas mix) is then injected. The retina is now flat and smoothly applied to the RPE. Cryotherapy (or laser) is performed around the tear. An explant (usually a circumferential tyre) is sutured into position. In practice this is a difficult technique to master because once the gas is injected the retinal tears (even if quite large ones) may become so small and flat as to become almost invisible. The situation becomes even more difficult if multiple gas bubbles form. The injection of a single gas bubble is, therefore, a crucial step in this procedure. To achieve this the following technique may be found useful:

1. Mark the site of prospective gas injection on the sclera 3.5mm from the limbus near a muscle insertion.
2. Don the Indirect Ophthalmoscope (lens not needed).
3. Insert needle (27 gauge) well into the vitreous cavity until the tip is easily seen through the Indirect Ophthalmoscope.
4. Withdraw the needle so only the tip can be seen.
5. Inject gas very rapidly.
6. Withdraw the needle quickly.

If despite this technique multiple bubbles form they can sometimes be persuaded to coalesce by flicking the eye with a finger tip to jar them together.

It is always advisable to mark the apparent position of the retinal hole on the sclera right at the beginning of the procedure before gas injection in case it cannot be seen afterwards. The hole will be most easily seen if there is still a little subretinal fluid under the retina following drainage and gas injection.

Possible complications of this technique include puncture of the lens with a needle tip and retinal incarceration if the SRF drainage site is large or leaks. The simple puncture technique under high pressure using a spatulated 5.0 needle is, therefore, preferred. There is also a considerable danger of excessive cryotherapy being applied since the gas insulates the cryotherapy to within the retina itself. The cryotherapy must, therefore, be meticulously monitored and stopped immediately it is seen with the Indirect Ophthalmoscope.

In the vitrectomised eye the gas is used to flatten the retina by continuous infusion. Subretinal fluid can then be drained via a flute needle utilizing a convenient break (or an iatrogenic hole can be made with a vitrectomy cutter). In this way an almost complete gas fill can be obtained. It is very important that a non-expansile air-gas mix is used under these circumstances, otherwise very high intraocular pressure can be produced postoperatively (20% SF₆ or 12% C₃F₈ is non-expansile).

Posture postoperatively should position the bubble over the retinal break. Posturing, therefore, becomes more important as the bubble gets smaller since a large bubble will tamponade most of the retina. The patient must never lie supine, otherwise a gas cataract will form (this is due to drying of the posterior lens surface and is not specifically a gas toxicity effect).

Nursing staff and explanatory booklets help the patient understand and maintain the posturing in the postoperative period.

Subretinal Gas

Air or gas bubbles have a high surface tension and, therefore, tend to remain within the vitreous cavity when injected. However, air or gas may become subretinal in 3 situations. Firstly, if the retinal breaks are large and bubbles are small; secondly, if the pars plana epithelium is not penetrated

completely by the needle or infusion tip; or thirdly, when the gas is injected under pressure and the retina is rigid due to PVR. Removal of subretinal gas is very difficult because the bubble will float to the highest point in the eye subretinally. A hole can be positioned here too but then of course the gas bubble being buoyant will not "drop" through the hole. We have found heavy liquid injected posteriorly useful in driving the gas bubble out through the retinal break anteriorly.

Ambulatory Fluid/Gas Exchange

It has already been mentioned above that supplementary gas injections can be given in non-vitrectomised eyes utilizing the same technique as used in pneumatic retinopexy. In vitrectomised eyes a supplementary gas injection can be given without the danger of elevation of intraocular pressure by first withdrawing a volume of posterior segment fluid. This can be done simply in an aphakic eye at the slit-lamp by inserting a needle through the peripheral cornea with the syringe angled downwards. Fluid can then be aspirated from the anterior chamber and will trickle to the plunger end of the syringe. Once a volume has been removed an equivalent volume of air/gas mix can be injected. In the phakic eye a long 25 gauge needle is mounted on a 3-way tap, one empty syringe and one syringe containing an air/gas mixture are attached to the other ports. The patient is normally positioned supine. The needle is introduced in the normal way with the operator wearing the indirect ophthalmoscope and holding the 3-way tap and syringe assembly. An assistant then aspirates some fluid from the posterior segment via the empty syringe. The 3-way tap switch is then rotated so that an intraocular gas injection can be given from the other syringe thereby restoring the intraocular volume.

Other Dangers of Injecting Gas into the Eye

In a non-vitrectomised eye injection of even a small bubble into the eye results in a massive increase in the intraocular pressure. In general even a small (0.3 ml) bubble of C₃F₈ will result in pulsation of the central retinal artery and may be even closure of it. It is, therefore, very important to warn the patient that there may be a temporary episode of blindness following gas injection. The operating surgeon should monitor the central retinal artery immediately after gas injection and if central retinal artery perfusion is not restored within 5 minutes consider performing a paracentesis. C₃F₈ is a better gas to use in this "closed eye" situation because a small injected volume (0.3 ml) will expand within approximately 2 days to a

useful size (1.2 ml) which will tamponade more than 90° of the retina. Because SF₆ expands only twice as much, a 0.6ml gas bubble would need to be injected to provide the same effect as a 0.3ml bubble of C₃F₈. A 0.6ml injection of gas will invariably result in closure of the central retinal artery and almost always a paracentesis will, therefore, be required. After gas injection, once central retinal artery perfusion has been restored, expansion of the gas bubble (whether C₃F₈ or SF₆) within the eye is so slow that there is virtually no risk of compromise of the vascular perfusion of the eye thereafter (in other words it is the initial gas injection that is dangerous rather than the subsequent expansion).

In the vitrectomised eye surgeons sometimes worry that the general anaesthetic agent (nitrous oxide) will pass rapidly into the gas bubble leading to expansion and consequent vascular embarrassment. In fact, in practice, although nitrous oxide does diffuse rapidly into the intraocular gas bubble the intraocular gas pressure is under the control of the surgeon at this time, that is to say vitrectomy ports are still open and there is still an infusion line normally attached. The danger then in this situation is not expansion of the gas bubble with vascular occlusion on the operating table, but is in fact the possibility of rapid transfer of nitrous oxide gas out of the intraocular gas bubble back into the circulation once the anaesthetic agent has been discontinued. This could have the effect of leaving the eye with a smaller gas bubble than desired by the surgeon. Some surgeons do ask the anaesthetist to cease giving nitrous oxide 10-15 minutes before the end of the surgery to prevent gas expansion and/or subsequent hypotony. Personal experience over many years indicates that this is not clinically necessary.

Silicone Oil

Liquid silicone was first advocated for use in retinal detachment by Cibis⁸. Thereafter its use declined due to complications, but Scott⁹ championed its use in otherwise inoperable cases. Gradually the use of silicone oil has come back into favour and it remains in use for PVR, giant retinal tears and in retinal detachments with posterior breaks and unrelieved traction. Some surgeons advise its use in other situations where there is a high risk of PVR.

Silicone oils are commonly available in 2 viscosities, 1300 and 5700 centistokes. They have a lower interfacial tension than gases (51 dynes/cm² at 20° C) but similar to that of heavy liquids. The specific gravity of silicone oils is less than that of saline (0.97 grams per ml) and, therefore, they float inside the eye.

In the USA the Silicone Oil Study Group have compared silicone oil with 20% SF₆ gas and 14% C₃F₈ gas in the management of retinal detachment with PVR. In each study there were 2 groups of patients. Group 1 had not undergone previous vitrectomy and group 2 had undergone previous vitrectomy. In the first study^{10,11} silicone oil was found to be superior to SF₆ in both the treatment groups. The second study found a borderline statistically significant advantage of C₃F₈ gas over silicone oil for group 1 eyes in producing retinal re-attachment but no significant benefit with respect to visual results or complications. In group 2 eyes there was no statistically significant difference between C₃F₈ and silicone oil though the prevalence of hypotony was higher in eyes randomized to C₃F₈. Interestingly, in this study complication rates for glaucoma and keratopathy were similar in both gas and silicone filled eyes though it has to be noted that follow-up was relatively short and some complications of silicone oil tend to occur late. Therefore, more advantages to using C₃F₈ may appear in the future. The authors ascribed the better results using C₃F₈ rather than SF₆ gas to the increased longevity of a C₃F₈ bubble in the eye.

Haller and Campochiaro commenting on the silicone oil PVR studies¹² suggested that there may be certain situations where silicone oil is preferred over C₃F₈ gas as follows:

1. Postoperative positioning is more important with gas; therefore, where this is difficult or impossible (e.g. in a child) silicone oil may be better.
2. Postoperative vision is better in silicone-filled than gas-filled eyes. An only eye may, therefore, be better filled with oil,
3. In previously vitrectomised eyes (group-2) there is less postoperative hypotony in silicone-filled eyes than in those filled with gas.
4. Air travel is not possible in gas-filled eyes; therefore, those needing to travel by air soon after surgery may be better served by using oil.
5. Some disease processes, for example CMV retinitis, do better with silicone oil.
6. Some groups, e.g. those with large inferior retinotomies, may do better with oil than with gas.

The injection of silicone oil into an eye through a narrow infusion cannula can be difficult. A mechanical pump or screw syringe can be useful¹³. If very high viscosity oil is used then a Peyman wide

bore needle can be helpful. Whenever oil is injected it is important that the infusion cannula is strong enough, otherwise the tubing may expand and disconnect from the syringe. Silicone oil may be injected into the eye whilst SRF is drained externally or internally. Alternatively a fluid/air or fluid/heavy liquid exchange can be carried out first to flatten the retina. Oil can then be substituted for the air or heavy liquid. Oil used in this way and filling the preretinal space can be used as counter pressure when peeling epiretinal membranes.

Complications of Using Silicone Oil

Silicone oil has a number of complications associated with its use.

Intraoperative Complications

Intraoperative complications of silicone oil injection include the passage of oil subretinally during the injection procedure. This occurs because the surface tension of the oil is quite low. If epiretinal membrane dissection is incomplete then the retinal rigidity exceeds the surface tension of the oil and it passes under the retina. This is usually signalled to the operating surgeon by sudden enlargement of retinal holes. Removal of subretinal oil is difficult and requires oil washout with infusion fluid. Prevention is by adequate membrane dissection. Preliminary air/fluid exchange prior to oil exchange is advisable since if the retina does not flatten under air it will certainly not do so under oil. Occasionally in phakic eye, especially in high myopia, oil will pass through a zonular dehiscence into the anterior chamber during injection and this renders the operative view impossible. The visibility can be restored by removing the crystalline lens and re-establishing continuity between the two oil bubbles; however, this may be undesirable particularly in diabetic eyes. Injection of Healon into the anterior chamber with simultaneous evacuation of oil via another paracentesis re-establishes the view. Healon should be left in situ in the anterior chamber during the following retinal procedure. It is probably best not to remove it at the end of the operation but to pre-empt secondary glaucoma by the use of carbonic anhydrase inhibitors prophylactically¹⁴.

Postoperative Complications

Glaucoma can occur immediately postoperatively. In phakic eyes this can be due to forward shift of the lens/iris diaphragm. In aphakic eyes it is due to pupil block by the anterior face of the oil globule. This can be prevented by an inferior iridotomy¹⁵. Patients should be postured face down

postoperatively. Glaucoma may also arise due to emulsification of silicone oil globules in the eye postoperatively. This occurs with all types of silicone oil though less so in those of higher viscosity^{16,17}. The reason for emulsification is not completely known but it has been pointed out that the problem can be avoided in part by filling the vitreous cavity as completely as possible with oil, so that the bubble becomes immobile and there is less tendency for silicone oil bubbles to break off and emulsify⁹. Surface tension between silicone oil and the aqueous phase tends to keep the two phases separate. Shaking by saccadic or voluntary eye movements without reduction of the surface tension is not sufficient to break the oil bubble into small stable droplets. In order to stabilize oil droplets in an emulsified state, the intervention of a surface active agent is required.

The source for such an agent is not clear. However, blood constituents, particularly red blood cell ghosts, plasma and lymphocytes, phospholipids in membranes and other soluble blood components may play important roles in this process¹⁸.

Typically multiple droplets accumulate in the upper part of the anterior chamber forming an "inverse hypopyon" effect. This can be cosmetically disabling if extensive. These droplets will also occur in the aqueous phase in the posterior segment typically between the retina and oil bubble in the horizontal meridian and below. These oil droplets tend in time to damage the trabecular meshwork leading to elevated intraocular pressure. Removal of oil at this stage may not relieve the glaucoma. Conventional glaucoma operations in these eyes where the conjunctiva is often damaged by previous retinal surgery are often doomed to failure and cyclodestructive procedures are often required. These tiny bubbles will often be present at least to a small degree in most eyes that have silicone oil in situ. They may obscure the view of the posterior pole when the patient is supine, for instance undergoing re-peeling and oil top-up procedures. Viscoelastic can be used to clear them from beneath the central cornea as mentioned above for larger bubbles. In aphakic eyes oil contact with the corneal endothelium leads to calcific band keratopathy and sometimes corneal decompensation. Removal of oil will in some cases prevent progression but may result in retinal re-detachment.

Cataract is a common complication of silicone oil insertion and may in fact be a universal complication. Removal of oil a few weeks after insertion may lower the prevalence of this problem.

Removal of Silicone Oil

Removal of silicone oil is simply accomplished in the phakic eye by establishing a routine saline infusion and then making a pars plana sclerotomy. The oil will then float out on the saline. In the aphakic eye a corneal incision can be made. The timing of removal of silicone oil is much debated. In cases where oil is used as a "tool", for example in giant retinal tears, removal of oil may result in almost immediate retinal re-detachment.

Various studies have shown that in PVR the re-detachment rate may be 33% or more following silicone oil removal¹⁹⁻²¹. The Silicone Oil Study Group found that 85% of oil removed eyes had attached retinas as compared to only 41% of the oil retained eyes. The visual acuity was much better in the group selected for oil removal over the oil retained group. It would appear, therefore, that in general only eyes with the most favourable anatomical and functional status were selected for oil removal. In this series the majority of recurrent retinal detachments occurred within 6 months of oil removal and were especially frequent during the first 3 months. Eyes that had localized retinal detachment prior to oil removal almost always progressed to total retinal detachment once the oil was out²².

Recently it has been suggested that further prophylactic laser therapy should be given prior to oil removal. Laser is applied to the region of the known retinal tears and also to the remainder of the peripheral retina. A pilot study has shown a reduced rate of retinal detachment in patients re-lasered in this way. A larger study would be needed to establish whether this is indeed a helpful treatment.

Retinal Toxicity

It has often been suggested that silicone oil causes retinal toxicity and silicone has indeed been identified intraretinally using transmission electron microscopy and energy-dispersive X-ray analysis²³. Of course the identification of silicone oil within the retinal substance does not necessarily mean that it is toxic.

Perfluorocarbon Liquids (PFCL)

Perfluorocarbon (heavy) liquids were first used in artificial blood substitutes because of their oxygen carrying characteristics. First described as a vitreous substitute by Haidt in 1982²⁴, experimental studies thereafter in animal eyes showed that long-term vitreous replacement with PFCLs was associated with significant retinal toxicity and a foam cell

reaction^{25,26}. PFCLs have, therefore, come to be used not as a long-term tamponade but as an intraoperative tool and short-term tamponade.

The physical characteristics of these liquids are: low viscosity (2-3 centistokes), optical clarity, immiscibility with water and refractive index different from water (1.27-1.31) making the interface visible. Their specific gravity is double that of saline (1.76-2.00). They, therefore, exert a large tamponading force on the retina falling posteriorly onto it and thus allowing retinal unfolding, pre-retinal membrane peeling and at the same time displacing subretinal fluid anteriorly through retinal breaks. Additionally, the high boiling point of PFCLs allows laser treatment to be applied through the liquid to the retina without damage. Much of the clinical work on these substances has been carried out by Chang^{27,28}.

Perfluorotributylamine ($C_{12}F_{27}N$), Perfluorooctane ($C_{18}F_{18}$) and Perfluorodecaline ($C_{10}F_{18}$) have all been used clinically. Theoretically, compounds consisting solely of fluorine and carbon atoms are likely to be more biologically inert. In artificial blood substitutes the systemic retention times of $C_{18}F_{18}$ and $C_{10}F_{18}$ are much lower than for $C_{12}F_{27}N$. Thus residual droplets of the 2 former compounds are likely to absorb more quickly than the latter. Subretinal PFCLs have occurred. We have observed globules for several months without apparent serious consequences. However, where the globule is incarcerated submacularly others have reported macular hole formation. Experimental studies have shown no toxicity from subretinal PFCLs over a 21-day period²⁹. Several observers have commented that the commonly seen globules of PFCLs in the anterior chamber of eyes postoperatively seem to be of no serious importance and seem to excite no inflammatory reaction (nor do they seem to be absorbed over the medium term).

Concurrent Use of Silicone Oil and PFCL Liquids

Because silicone oil does not tamponade the inferior retina postoperatively due to its low specific gravity and consequent buoyancy, re-proliferation of epiretinal membranes on the lower retina can occur.

Theoretically, therefore, a combined fill of silicone oil and PFCL could provide simultaneous inferior and superior retinal tamponade. In practice it has been found that an area of retina in the horizontal meridian is not in contact with either liquid resulting in re-proliferation of epiretinal membranes at this site³⁰. It, therefore, seems that there is still the need for a non-

toxic liquid that can completely fill the vitreous cavity and which possesses the characteristics of both PFCLs and silicone oil. Now that PFCLs are highly refined it may be that they are sufficiently non-toxic to be left within the eye for a more protracted period than originally considered safe. A clinical trial of this treatment modality would be useful.

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"Racquet-shaped" Posterior Capsulotomy Using Neodymium: YAG Laser

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ABSTRACT

A newly developed method of posterior capsulotomy with neodymium: YAG laser was used in a prospective study by us at the Department of Ophthalmology, Dow Medical College & Civil Hospital, Karachi. During the two-year period between May '96 and April '98, Nd: YAG laser posterior capsulotomy was performed on 141 eyes of 125 patients. All the patients achieved adequate opening in the posterior capsule with visual acuity being restored to post-cataract extraction levels in 135 (95.7%) eyes. Complications encountered were few and occurred in 47 (33%) eyes. While all eyes sustained disturbance of the hyaloid face, no intraocular lens implant suffered damage in the visual axial area. Among the complications, 41 (29%) eyes experienced transient rise of intraocular pressure, 20 (14%) eyes showed mild and transient uveal reaction, 4(3%) had clinical cystoid macular oedema and 2 (1.5%) developed retinal detachment.

INTRODUCTION

Posterior capsular opacification (PCO) continues to be a disappointment following extracapsular cataract extraction (ECCE) with or without intraocular lens (IOL) implantation as far as the visual outcome is concerned. It has been reported to occur in from 3.3%¹ and 6%² to upto 50% of adults³⁻⁴ and in almost 100% of children^{5,6} undergoing this type of surgery. Opacification of the posterior capsule occurs due to myofibroblastic transformation of the lens epithelial cells. These cells grow and cause fibrous contraction leading to wrinkling and opacification of the capsule^{7,8}. Opacified posterior capsule hinders the passage of light into the eye reducing the vision and thus needs to be opened up. This can either be done surgically or by using neodymium: YAG laser. Since 1980, YAG laser has been widely used for posterior capsulotomy⁹. The laser beam is usually aimed at the central area of the opacified capsule through an undilated pupil for making an opening in the axial area^{10,11}. We conducted a prospective study, using a method developed by Thorin and Archila¹², in which a large enough, round and central opening is created in the posterior capsule, leaving a "Racquet-shaped" flap suspended in the prehyaloid space, being attached to the capsular bag remnant in the inferior portion of the capsulotomy opening.

Technique

The pupil is dilated widely using tropicamide (1%) and phenylephrine (10%). Nd: YAG laser is

used in Q-switched mode with power setting at around 1.0mj, increasing to 5.0mj depending upon the thickening of the capsule to be incised. A round opening 0.5-1.0mm inside the IOL optic rim is aimed at by incising the capsule starting at either 12 O'clock and moving down in an arcuate fashion on either side or starting at 7 O'clock position and moving in a clockwise manner, leaving a small area of the capsule attached in the most inferior part (at 6 O'clock) (Fig-1), thus shaping a round capsulotomy leaving a "Racquet-shaped" capsular flap, which is attached inferiorly (Fig-2). This flap shrinks and moves posteriorly into the prehyaloid space leaving a big enough clear area in the pupillary zone (Fig-3).

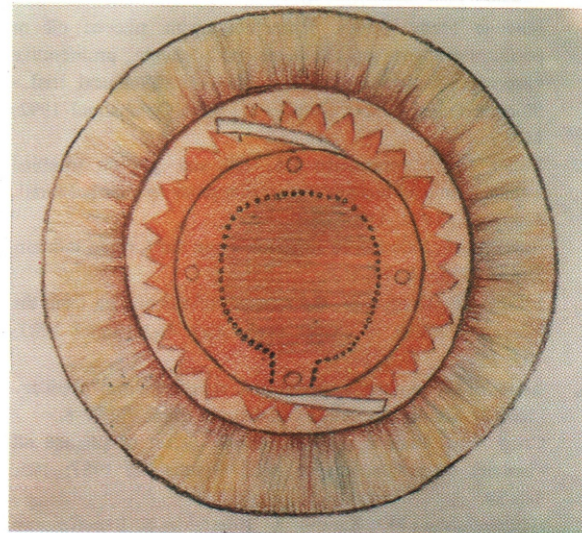


Fig-1: Outline of the "Racquet-shaped" capsulotomy

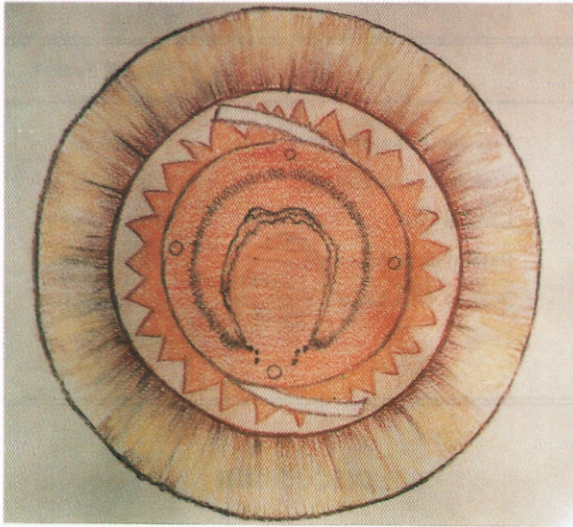


Fig-2: Completed "Racquet-shaped" capsulotomy

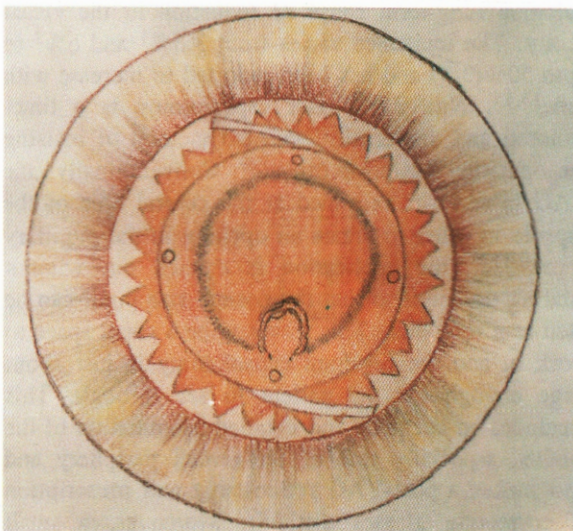


Fig-3: Shrunken capsular flap of the "Racquet-shaped" capsulotomy attached at 6.00 leaving a large enough capsular opening behind the IOL.

Patients and Methods

"Racquet-shaped" posterior capsulotomy using Q-switched Nd: YAG laser (Zeiss) was performed prospectively on 141 eyes of 125 patients at the Department of Ophthalmology, Dow Medical College and Civil Hospital, Karachi during the 2-year period between May '96 and April '98. The patients were selected from those presenting with diminution in visual acuity following ECCE and IOL implantation. Only those patients having a posterior chamber IOL implant and posterior capsular opacification were included in this study. Aphakic eyes and those not

having a posterior chamber IOL were not included. Patients with coexisting problems, e.g. glaucoma, uveitic synechiae, retinal damage, etc, were also excluded. The dates of cataract surgery and post-extraction corrected visual acuity were noted. All procedures were performed by the author under topical anaesthesia using 0.4% benoxinate hydrochloride (Novesine) eye drops. The pupils were maximally dilated using tropicamide 1% and phenylephrine 10%. Post-extraction corrected visual acuity was noted. IOP was measured by applanation method. Abraham's posterior capsulotomy lens was used in all cases. ND:YAG laser (Zeiss) was used in Q-switched mode with the power set at or about 1.0mj. The laser power was increased to a maximum of 5.0mj according to the thickness of the capsule under treatment and its response. The laser beam was focussed by bringing the helium-neon four-dots to a point focus on the posterior capsule. Laser application was started at 7 o'clock position working the way in a clockwise fashion, remaining 0.5-1.0 mm inside the IOL optic rim, to produce a round incision of the capsule finishing at 5 o'clock position, leaving a bridge of attachment between the capsular bag remnant and the "Racquet-shaped" capsular flap. Patients were not prescribed any medication as a rule. Only those requiring antiglaucoma or anti-inflammatory medications were prescribed accordingly, on the first post-YAG visit. The patients were followed-up on day one, day three, at two weeks and whenever necessary thereafter. On each follow-up, corrected visual acuity was recorded, slit-lamp findings were noted regarding any uveal activity and the position of the capsular flap. IOP was measured by applanation method and a detailed fundus examination was carried out. Patients showing signs of uveal reaction and those with rise of IOP of more than 5 mmHg from baseline measurement received appropriate antiglaucoma treatment. The follow-up ranged between a minimum of 4 months to a maximum of 24 months.

Results

Eighty (64%) [89 (63%) eyes] of the patients were males, while 45 (36%) [52 (37%) eyes] were females (Table-1). Their ages ranged between 45 and 85 years (average 58.5 years) (Table-2). The time between cataract surgery and YAG laser capsulotomy ranged between 6 months and 4.5 years, with an average of 2.9 years (Table-3). All treated eyes had a posterior chamber IOL implant in situ. An adequate, round and central opening was achieved in all the eyes. The capsular flap in 4 eyes took longer than usual to fall back in the prehyaloid space. Two

required retreatment with YAG laser. Post-extraction levels of corrected visual acuity were achieved in 135 (95.7%) eyes. Transient rise of IOP was the most common complication (Table-4), occurring in 41(29%) eyes. This, however, settled to baseline levels in all eyes with appropriate antiglaucoma treatment. The antiglaucoma treatment was required for an average period of 2 to 3 weeks only. Twenty (14%) eyes developed mild uveal reaction. This disappeared in due course with topical steroids. Four (3%) eyes developed clinical cystoid macular oedema. This improved with time in 3 eyes but the eventual vision dropped by 2 Snellen lines in one eye. Two (1.5%) eyes developed retinal detachment several weeks after laser treatment requiring further surgery.

Table 1: Sex Distribution.

	No. of Eyes	No. of Patients
Males	89 (63%)	80 (64%)
Females	52 (37%)	45 (36%)
Total	141 (100%)	125 (100%)

Table 2: Age Distribution.

Years	No. of Patients
45-50	05 (04 %)
51-60	43 (34.4%)
61-70	56 (44.8%)
71-80	18 (14.4%)
Over 80	03 (2.4%)
Total	125 (100%)

Table 3: Time Lag Between Extraction and Capsulotomy.

Time Lag	No. of Patients
Upto 12 Months	12 (8.5%)
13-24 Months	56 (39.7%)
25-36 Months	48 (34.0%)
37-54 Months	25 (17.7%)
Total	141 (100%)

Table 4: Complications

	No. of Eyes
Transient rise of IOP	41 (29%)
Transient ant. uveitis	20 (14%)
Clinical CME	04 (2.8%)
Retinal detachment	02 (1.5%)
Repeat YAG Laser	02 (1.5%)
Total	69 (49%)

DISCUSSION

Of all the sight-threatening complications of uncomplicated modern cataract surgery, opacification of the posterior capsule remains the single most common long-term cause of reduction in the visual acuity. The incidence varies from 3.3%¹ and 6%² to upto 50%(3-4) and has been reported to increase with time^{13,15}. Nd: YAG laser capsulotomy is a time-honored and universally accepted method of incising the opacified posterior capsule⁹. Conventionally, the YAG laser beam is aimed at the central area of the capsule in order to create an opening in the pupillary zone¹⁰⁻¹¹. This application is carried out without dilating the pupil so that the normal size pupil can be used as a reference. This leaves quite a small space to work in and the resultant capsulotomy is just about large enough for the patient to see through. This precludes an adequate and detailed examination of the fundus, especially that of the retinal periphery and also makes a post-YAG retinoscopy and prescription of correcting glasses difficult. Moreover, a small capsulotomy opening produces optical problems of diffraction, reduced image intensity and glare¹⁶. The size of a normal pupil varies from 2.0 mm to 5.0 mm in eyes with posterior chamber IOLs, depending upon the amount of light present¹⁷. Capsular openings which are smaller in size than the pupil cause glare due to diffraction caused by opaque portion of the capsule in the pupillary area. These also decrease the intensity and contrast of the retinal image. The use of Nd: YAG laser in the central pupillary area exposes the IOL to unintentional damage^{10,19-21} although techniques have evolved for avoiding damage to IOL implant and this potentially visually disabling complication of Nd: YAG laser posterior capsulotomy²². Yet, the area is so small that the incidence of such damage is as much as 30%^{10,11,23,24}

Nd:YAG laser can cause pitting and even fracture of the IOL^{24,25}. The varied size and shape of the capsulotomy and IOL pitting causes visual disturbance and intolerable glare²⁵. This glare reduces the patient's functional vision significantly²⁶. The author has observed one IOL fractured by YAG laser in the central pupillary area in a 41-year-old female (capsulotomy performed elsewhere), necessitating explantation of the IOL. We used a method of capsulotomy recommended by Thorin and Archila¹² for use only in the eyes with a posterior chamber IOL implant. They termed this method as "Racquet-shaped" capsulotomy, because it leaves a loose "Racquet-shaped" flap of the incised capsule at the end of the procedure, which is attached inferiorly to the capsular bag remnant. This method leaves the axial optic of the IOL virtually untouched by the laser beam. Any peripheral damage that might occur is not visually significant. The shape of the capsulotomy opening is more physiological conforming to the shape of the pupil. Its size is large enough to exceed the size of the patient's normal pupil. This minimizes any post-YAG optical problems. Nd:YAG posterior capsulotomy is not without risks. It is associated with vision-threatening complications of increased IOP¹⁰, cystoid macular edema^{9,27} and retinal detachment^{9,10,19}. It is said to cause a four-fold increase in the risk of retinal detachment²⁸. Our series shows the same complications (Table-4). The visual recovery achieved compares well at 95.7% with 92.2% in a much larger series of 3,711 patients by Bath and Fankhauser⁹. It may be argued that in the "Racquet-shaped" capsulotomy more energy and greater number of shots may be required to achieve the desired result and that the size of the capsulotomy produced is large, which might play a role in increasing the incidence of complications. But the development of post-YAG complications, e.g. raised IOP, cystoid macular edema and retinal detachment have not been found to be related to the number of laser pulses, energy per pulse and total amount of laser energy delivered to the eye^{29,30}. The larger size capsulotomy has its own advantages. It avoids diffraction, allowing the pupil to regulate retinal image intensity and reducing the glare. There is no conclusive evidence in the literature to suggest that the incidence of cystoid macular edema and retinal detachment increases proportionately with the size of the capsulotomy³¹. This procedure is not recommended for incising the opacified capsules in eyes without an IOL implant, as performed by Akhtar³². This is because the larger size opening and hyaloid face disruption might cause the vitreous to herniate through the opening, thus increasing the

possibility of sight-threatening complications in these eye. The presence of an IOL supports the vitreous and keeps it from herniating forwards.

CONCLUSION

The "Racquet-shaped" posterior capsulotomy is simple and practical. It leaves an adequate, round and central opening in the posterior capsule, which is larger than the patient's normal pupil size. It leaves the central optical zone of the IOL undamaged and allows adequate opening for a detailed fundus examination, especially that of the peripheral retina. The capsular flap soon shrinks out of the visual line into the prehyaloid space. We do not recommend this procedure for posterior capsular opacification in eyes without an IOL implant.

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Corrigendum

The article entitled "Macular Hemorrhage: An unusual complication of Nd: YAG laser capsulotomy" in the Journal's Vol 14, Number 3 pp 118-120, was published with authors' names as Abdul Majeed, Tariq Bangash, Waqar Muzaffar, Omar Durrani. The name of the fifth author, Mohammad Daud Khan (Consultant Ophthalmologist, CMH, Peshawar Cantt.) was inadvertently omitted by the authors at the time of submission of the article. This may kindly be added on for appropriate credit.

Editor-in-Chief

Facts About the Status of Blindness in Pakistan

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According to the 1994 WHO estimates around 38 million people are blind worldwide and further 110 million patients with low vision are at risk of becoming blind¹.

The loss of eyesight is one of the most serious misfortunes that can befall a person. Due to lack of epidemiological data, the exact number of blind persons in Pakistan is not known. In 1994 it was estimated to be around 2 million with a further 5 million cases of low vision that are at risk of becoming blind. Thus, the national burden of serious visual impairment was estimated to be 7 million people².

Low vision is defined as visual acuity of less than 6/18 (0.3) but equal to or better than 3/60 (0.05) in the better eye with the best possible correction (visual impairment categories 1 and 2 in ICD-10).

Blindness is visual acuity less than 3/60 or counting fingers at 3 meters.

The estimated national prevalence of blindness is 1.78%, ranging from 1.14% in Sindh, 2.69% in Balochistan, 1.0% in NWFP and 2.17% in Punjab.

The estimates of the prevalence of blindness were prepared on the basis of population-based survey carried out in Pakistan in 1988-90.

Out of 10 blind people, 8 live in the rural areas. In general, more than two-thirds of blindness could be avoided (prevented or treated) if appropriate human, financial and technical resources were made available.

Apart from loss of functional ability and self-esteem, blindness and serious visual impairment have considerable economic implications on the life of the individual, family and society. It leads to loss of productivity and income, and to social dependence which requires rehabilitative and supportive measures. In India and the USA, for example, the costs of

blindness to society are conservatively estimated at US\$ 4.6 and 4.1 billion per year, respectively.

Blindness can occur as the result of a number of communicable, non-communicable and nutritional deficiency diseases, as well as injuries. Depending on the cause, up to 80% of blindness and serious visual loss could be avoided (prevented or treated). The main causes of avoidable blindness and serious visual impairment in Pakistan include cataract, corneal opacities, refractive errors, glaucoma and others.

CATARACT

Cataract accounts for approximately 1.3 million cases of blindness nationwide. In most provinces it accounts for approximately 70% of all blindness.

Cataract results from loss of transparency of the crystalline lens in the eye. When the lens becomes opaque, it impedes light from entering the eye. This condition causes gradual loss of vision and blindness. Cataract can also develop after eye injuries or can even be present at birth for a number of reasons. However, cataracts are largely related to the ageing process.

The older a person, the more chances he has of developing a cataract. The majority of people with cataracts are over 50 years of age. This means that as life expectancy will increase, more people will develop cataract and the number of blind will increase.

Usually, age-related cataract can be treated with a relatively simple operation to remove the opaque lens. Increasingly, even in the developing countries, cataract surgery includes the use of intraocular lens implantation, which, however, requires sophisticated technology and adequately trained personnel. In Pakistan 140,000 cataract surgeries are done annually, while 300,000 need to be done if one is to meet the annual incidence.

While efforts are being made to increase access to intraocular lens implantation through low-cost technology and training of personnel, simple cataract extraction with provision of spectacles is still practiced in the rural areas of the country.

TRACHOMA

Trachoma is one of the oldest infectious diseases known to mankind. In Pakistan corneal opacity accounts for 12.6% of blindness and this is largely due to vitamin A deficiency and trachoma.

Today, the disease is found mainly in poor rural areas of the country. There is lack of proper data on trachoma nationwide. The responsible agent is *Chlamydia trachomatis*--a microorganism resembling both bacteria and viruses--which spreads through contact with eye discharge from the infected person (on towels, handkerchiefs, fingers, etc.) and through eye-seeking flies. *Chlamydia trachomatis* provokes an inflammatory reaction in the eye with formation of follicles in the conjunctiva. After years of repeated infections, the inside of the eyelids may be scarred so severely that the eyelid turns inwards and the eyelashes start rubbing the eyeball. If untreated, this condition leads to blindness.

Trachoma and the related blindness can be prevented through the implementation of "SAFE" strategy, which stands for Surgery for trichiasis (inturned eyelashes), Antibiotics, Facial cleanliness and Environmental improvement which is a combination of community-targeted public health interventions.

Recent field trials of a new and apparently effective drug, azithromycin, have been very encouraging. This long-acting antibiotic, developed and produced by Pfizer International, Inc., has been tested in a number of countries. The initial results look very promising : one dose of azithromycin per year could eliminate the blinding propensity of trachoma. Once its efficacy has been proven, the challenge will be to find the means to make this drug available to all those in need.

GLAUCOMA

Glaucoma is considered to be the fourth largest cause of blindness nationwide and is responsible for an estimated 82,677 cases.

A major difficulty with glaucoma, and the irreversible blindness that it can lead to, is the lack of uniform case definition. The name commonly refers

not to a single disease, but to a group of diseases that have certain common features, including, in particular, cupping and atrophy of the optic nerve head, characteristic visual field loss and often, but not invariably, increased intraocular pressure (IOP).

Early signs of glaucoma are difficult to notice for an individual, except for cases in which pain and blurred vision develop as a result of sudden increase of intraocular pressure. Ideally, therefore, persons over 40 years of age should have regular eye examinations, particularly those with family history of glaucoma.

Glaucoma as such cannot be prevented, but visual loss can be avoided if the disease is detected and treated at an early stage. Awareness and education, aimed at persons at particular risk, facilitate the early detection and treatment of glaucoma.

Apart from cataract, trachoma and glaucoma, vitamin A deficiency, and diabetic retinopathy are leading causes of preventable blindness and visual disability. Eye injuries take their toll of sight, as do degenerative and congenital / hereditary disorders.

VITAMIN A DEFICIENCY

Vitamin A deficiency (xerophthalmia) leads to blindness. It has an association with diarrhea, measles and respiratory infections. Sixty to eighty percent of children becoming blind because of vitamin A deficiency die early from such associated diseases.

Animal food and some orange or yellow fruits are good sources of vitamin A, but they are rarely consumed by poor families. Increasing the consumption of green leafy vegetables can also help prevent vitamin A deficiency.

The three main strategies for the elimination of vitamin A deficiency include supplementation, food fortification, and changes in dietary habits.

The elimination of vitamin A deficiency as a public health problem by the year 2000 is one of the targets of WHO, as noted in its Ninth General Programme of Work (1996 - 2001). Collaboration with UNICEF and other international agencies and nongovernmental organizations is essential for achieving this goal.

DIABETIC RETINOPATHY

Diabetic retinopathy is the leading cause of

blindness and visual disability in adults in economically developed societies. Diabetes is estimated to affect around 120 million people worldwide. In Pakistan data are lacking. But the prevalence ranges from 2-10%. Findings, consistent from study to study, make it possible to suggest that, after 15 years of diabetes, approximately 2% of people become blind, while about 10% develop severe visual disability. Diabetes mellitus is associated with damage to the small blood vessels in the retina resulting in loss of vision.

Furthermore, loss of vision due to certain types of glaucoma and cataract may be more common in people with diabetes than in those without the disease.

Loss of vision and blindness in persons with diabetes can be prevented by early detection and treatment of vision-threatening retinopathy, regular eye examinations and timely intervention with laser treatment, or through surgery in cases of advanced retinopathy. A recent study has demonstrated that good metabolic control can also delay the onset and progression of diabetic retinopathy.

There is evidence that, even in the developed countries, a large proportion of those in need is not receiving such care due to lack of public and professional awareness. In the developing countries, in most of which diabetes is now epidemic, such care is inaccessible to the majority of the population.

INJURIES

Injuries, according to a recent global estimate, may account for well over one million cases of blindness. In addition, they are the most common cause of loss of sight in one eye. In NWFP 12% of admissions in the Eye Departments are because of eye injuries.

Eye injuries may be prevented through increased public awareness about safety measures, such as the use of seat belts in cars, protective goggles, and safe playgrounds for children, as well as through regulations or legislation for such activities as the use and handling of firecrackers. In workplaces, worker education regarding recommended safety measures is extremely important. Another factor is proper and timely eye care, particularly in remote areas of the developing countries. Appropriate treatment after minor trauma will prevent the complications.

Primary Eye Care and Primary Health Care

There are a number of non-preventable causes of

blindness and visual disability, usually in the form of degenerative and congenital/hereditary disorders. Some of these are strongly related to ageing, while others are very rare and are sometimes due to metabolic disorders. In Pakistan consanguineous marriages are very common and hence there is need to set up genetic counseling.

In addition to being public health problems, blindness and visual impairment have important socioeconomic implications. The costs of rehabilitation and care may be the most apparent. Equally important are the indirect costs resulting from the loss of productivity. The quality of personal life is far from satisfactory for the individual and family.

There is a growing trend worldwide to evaluate disease and disability prevention on the basis of costs incurred and benefits accrued. Public health interventions to prevent blindness are particularly revealing in this respect, as cost savings and return on investment accrue because of the avoided rehabilitative costs, on the one hand, and the gains in productivity, on the other.

The Financial Burden of Avoidable Blindness

Accurate data on the total economic and social costs of blindness and severe visual impairment are not available. However, such costs have been shown to be a considerable strain on the national economy.

In 1990, the aggregated cost of blindness to the federal budget in the United States was estimated to be approximately US\$ 4.1 billion. A minimal federal budgetary cost of a person-year of blindness (vision less than 6/60 in the better eye) for a working-age adult was estimated to be US\$ 11,896.

More importantly, it has been estimated that in the USA, if all the avoidable blindness in persons under 20 and working-age adults were prevented, a potential saving of US\$ 1.0 billion per year would accrue to the federal budget.

In a study from India in 1989, a conservative estimate of the aggregated costs of blindness to the national economy, including a minimal subsistence allowance for the blind, amounted to approximately US\$4.6 billion per year.

Social implications

The economic burden of blindness and visual impairment is only part of the study. The blind person and his/her family face important social constraints.

Both directly and indirectly, visual impairment interferes with various activities of daily living. Blind children have to face developmental challenges. In adult life, employment opportunities for the visually disabled are extremely limited and their participation in a host of leisure, community and ritual activities are seriously hampered. In addition, in many societies visual impairment results in a loss of status and self-esteem. These physical and, especially, the psychosocial implications of visual impairment and blindness cannot be accurately quantified in monetary terms. However, they do erode the quality of life of both the affected individuals and their families.

A study in the U.K. indicated that visually disabled people were poorer on average, had lower educational levels, lower employment rates and less satisfying social life than sighted people. These findings probably hold true for all societies.

Prevention

Some examples of cost-effective public health interventions to prevent blindness include:

Cataract Surgery as Part of Primary Health Care

Cataracts are the most common cause of avoidable blindness. Worldwide, there are an estimated 16 million persons who are blind as a result of cataracts. The majority of these people live in the rural areas of economically developing countries. The burden on the country is significant.

In the absence of any preventive measures that can be applied in a public health setting, the only recourse is surgery. Cataract surgery is a highly cost-effective intervention: generally sight is restored after a relatively low-cost operation. The costs of cataract surgery vary depending on the country, the technology used, and whether the surgery involves hospitalization.

With recent trends in making intraocular lenses available at costs as low as US\$ 10, the overall cost of surgery has steadily decreased, and there is a rapidly growing popularity for such surgery even in the developing countries.

A South Asian study revealed that not only did 85% of the men and 58% of the women who regained their sight after cataract surgery return to work, but that there was also a financial return of 1500% of the expenses in the year following surgery.

The cost-effectiveness of cataract surgery has

been demonstrated worldwide. In addition to the restoration of sight, there is an enhancement of the quality of life. Cataract surgery costs have, therefore, been evaluated per quality-adjusted life year (QALY) gained. In comparison with other common public health interventions, cataract surgery has been ranked as one of the most cost-effective means offered to adults in the developing world using available technology.

Diabetic Retinopathy

In many developed countries, diabetic retinopathy is the most common cause of visual loss in the working population. Sight-threatening retinal complications can be effectively prevented by adequate control of diabetes and through periodic ophthalmoscopic examination and laser photocoagulation when required. In many countries, health education programmes aimed at motivating diabetic patients to undergo periodic eye examinations have proven to be cost-effective.

In a study in the USA, the annual cost of welfare benefits per patient with severe visual loss caused by diabetes was estimated to be nearly seven times the cost per patient per year of vision saved. The same study concluded that prevention programmes aimed at improving eye care for diabetic patients not only result in substantial federal budgetary savings but are a highly cost-effective health investment for society.

The economic and social costs of blindness must be considered from the perspective of both the disabled individual and the country as a whole. Many of the same economic and social cost considerations apply to both the developed and the developing countries, although the developing countries have more limited health and social care services and hence lower overall economic resources to bear the burden of avoidable blindness.

In this context, the need for eliminating avoidable blindness should become a public health priority. Sight-saving interventions should be seen as opportunities for investment with a worthwhile return in both humanitarian and economic terms.

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Ophthalmic "Pastpourri"

Infirmities of Old Age

The Story of Bifocals

Franklin wrote his first letter of the series to Whately on August 21, 1784, from his villa at Passy outside Paris. His letter to Whately reads in part:

"Your eyes must continue very good, since you write so small a hand without spectacles. I cannot distinguish a letter, even of large print, but am happy in the invention of double spectacles, which serving for distant objects as well as near ones, make my eyes as useful to me as ever they were. If all the other defects and infirmities were as easily and cheaply remedied, it would be worthwhile for friends to live a great deal longer, but I look upon death as necessary to our constitution as sleep. We shall rise refreshed in the morning".

That the ocular state of the 75-year-old Whately should have interested the 78-year-old Franklin is understandable. For at least 30 years Ben had been troubled by his eyes. He once complained, "...my eyes will now hardly serve me to write by night." His glasses did not always make him happy or allow him to see what he wanted to see. Once he wrote: "I could not find a woman friend...[at the Oratorio in the Foundling Hospital]...though I looked with all the eyes I had, not excepting even those I carried in my pocket." For the warmhearted Franklin not to find a woman friend when he sought her was more than a minor social tragedy for him.

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Phacoemulsification Versus Conventional Extracapsular Surgery: A Study of Early Astigmatism and Complication Rates

SA Haider

ABSTRACT

We conducted a retrospective study into the relative merits of phacoemulsification by corneal and scleral tunnel and conventional extracapsular extraction (ECCE) by ab externo and corneoscleral incisions.

Of 308 consecutive patients 79 underwent conventional extracapsular surgery through corneoscleral incisions and 49 through ab externo approach. 127 patients underwent phacoemulsification through clear corneal approach, while another 53 had scleral tunnels made.

At one week 56% of patients who had scleral pocket phacoemulsification saw 6/12 or better, 43% of those with clear corneal phacoemulsification saw as well. In contrast 40% of patients who had ab externo ECCE were 6/12 or better as compared to 15% who had ECCE by corneoscleral section.

7.2% of phaco patients and 4.6% of ECCE patients had posterior capsular rip.

Overall, the best astigmatic and uncorrected visual results were achieved by scleral pocket phacoemulsification. The results from clear corneal phaco and ab externo ECCE were not significantly different. Although there was higher incidence of posterior capsular rip in patients undergoing phacoemulsification, their uncorrected visual scores (77% equal to or better than 6/12) were still comparable to the patients who had uncomplicated surgery.

INTRODUCTION

It is expected of modern cataract surgery that it would lead to early good uncorrected vision and low astigmatism, while at the same time to have insignificant complication rate. In this study our aim was to compare phacoemulsification by clear corneal as well as scleral pocket incisions with conventional Extracapsular Cataract Extraction (ECCE) by corneoscleral section and ab externo incisions to see how well they came up to expectations.

MATERIALS AND METHODS

308 consecutive patients who underwent cataract surgery by three surgeons of moderate experience were included in this study. Conventional ECCE was performed on eyes that were considered unsuitable for phacoemulsification. The study was retrospective and unselected.

Uncorrected visual acuity and astigmatism were measured at one week, one month, and two months. All refractions were calculated by Topcon autorefractor model RM A7000. To remove observer bias no subjective refractions were performed and all

clinical parameters were measured by an independent observer. All cases had posterior chamber lenses inserted. 5.25mm optic size was used in all cases of uncomplicated phacoemulsification and 6.5mm optic size was used where ECCE was performed or in cases of phacoemulsification where capsular support was inadequate.

RESULTS

We found that the follow-up rate was 83% for the first week, 65% for the first month and 62% for the second month (Table-1). So, in this context we can only compare early results of the two types of surgery. One week and one month and two month uncorrected visual acuity and astigmatic scores are tabulated in Tables 2 and 3. Rates of vitreous loss are tabulated in Table-4.

Briefly, in the postlimbal section ECCE group 40% of patients saw 6/12 or better at one week and 68% had astigmatism of less than 3 diopters cylinder at one week. In the corneal section ECCE group 15% had visual acuity of 6/12 or better and 51% had astigmatism of 3 diopters cylinder or less.

Table 1: Follow-up Rates.

	No. of Operations	One week	One month	Two months
ECCE Corneal	79	61(77%)	49(62%)	61(77%)
ECCE Scleral	49	41(83%)	26(53%)	35(71%)
Phaco Corneal	127	106(83%)	89(70%)	67(52%)
Phaco Scleral	53	49(92%)	38(71%)	28(52%)
Overall	308	257(83%)	202(65%)	191(62%)

Table 2: Visual Acuity of 6/12 or Better.

	At one Week	At one Month	At two Months
ECCE Corneal	15%	10%	21%
ECCE Scleral	40%	26%	34%
Phaco Corneal	43%	45%	49%
Phaco Scleral	56%	58%	56%

Table 3: Cylinder less than 3 diopters.

	At one week	At one month	At two months
ECCE Corneal	51%	48%	52%
ECCE Scleral	68%	75%	60%
Phaco Corneal	55%	48%	85%
Phaco Scleral	89%	88%	100%

In the postlimbal phaco group 56% of patients saw 6/12 or better at one week postoperative and 89% had astigmatism of less than 3 diopters cylinder, whereas in the clear corneal phaco group 43% of patients saw 6/12 or better at one week and 55% had astigmatism of of 3 diopters or less.

Table 4: Rate of Vitreous Loss and its Outcome.

Type of Surgery	Vitreous Loss	VA 6/12 or Better (unaided)
ECCE	4.60%	0%
Phaco	7.2%	77%

Table 5: Cylinder of 5 Diopters or more.

	At one week	At one month	At two months
ECCE Corneal	16/49(32%)	10/44(22%)	14/55(25%)
ECCE Scleral	5/34(14%)	2/20(10%)	4/20(20%)
Phaco Corneal	7/89(8%)	5/68(7%)	2/65(3%)
Phaco Scleral	2/47(4%)	3/39(8%)	0/25(0%)

13(7.2%) patients out of 180 who had phacoemulsification had vitreous loss, while 6 (4.6%) patients out of 128 who underwent ECCE had vitreous loss. Ten out of the 13 patients with vitreous loss during phacoemulsification had visual acuity of 6/12 or better.

DISCUSSION

In the American Academy Meeting in 1937, Greenwood recommended that the term cataract should be avoided as much as possible, since "it strikes terror into the soul of some of the timid ones!" Times have indeed changed. There is a pressing demand from patients that cataract surgery should be safe, convenient, painless and should have the perfect refractive result immediately following surgery. There is disbelief when they are told that they would at least require presbyopic correction.

Phacoemulsification with its small incision is expected to give better refractive result but for most ophthalmologists there is a long learning curve. This retrospective study is an enquiry into the early results and relative complication rates of conventional Extracapsular Cataract Extraction and Phacoemulsification by different routes. In this study only uncorrected visual acuity results are discussed as that is what the patients are interested in.

The problem inherent in a study of this type in our environment is the incomplete follow-up. To avoid selection bias all cases have been included. But due to lack of understanding, distance, involved in follow-up, or other socioeconomic factors, a lot of patients do not complete their follow-up. The highest level of follow-up at two months (77%) was present in the corneal ECCE group. It was only 52% in the Phaco groups (Table-1).

It is expected that patients who are found to have reduced final vision due to unexpected retinal pathologies are evenly spread out according to the law of averages. Therefore, no patients were excluded from this study so as to avoid selection bias.

I chose uncorrected visual acuity of 6/12 or better as a standard as it equates to the driving standard. Cylinder of less than 3 diopters was chosen as most patients can tolerate levels below this in their glasses without too much difficulty.

The results for corneal phacoemulsification were roughly comparable to those of Watson and Sunderraj². In their study 25% of patients saw 6/12 or better, compared to 43% in ours who saw 6/12 or better.

This study is unique in the respect that it compares all surgical modalities of cataract surgery.

The best uncorrected visual acuity and refractive results are achieved, in the two parameters measured, by phacoemulsification through scleral tunnel (Table-2,3). In all follow-up visits more than 50% of patients saw 6/12 or better and 88% or more had cylinders of less than 3 diopters. Four patients in this group had visual outcomes worse than 6/12 due either to diabetic maculopathy or thick posterior capsule.

Much to my surprise the one week visual acuity and refractive results of both clear corneal phacoemulsification (43% 6/12 or better and 55% with cylinders less than 3 D) and scleral ECCE (40% 6/12 or better and 68% with cylinders less than 3) were roughly similar (Table-2,3). Their follow-up rates were also exactly similar at 83%. It appears that a 5.25 mm corneal incision has the same effect as a much larger postlimbal incision.

High cylindrical errors cause a great deal of dissatisfaction among patients. At one week 4% of postlimbal phaco patients, 8% of corneal phaco patients, 14% of postlimbal ECCE patients and 32%

of corneal ECCE patients had cylinders of 5 diopters or more as measured by the autorefractor (Table-5). On this parameter small incision surgery is clearly better. This difference is maintained at one and two months (Table-5).

The rate of vitreous loss was 7.2% with phacoemulsification and 4.6% with ECCE. All eyes had posterior chamber intraocular lenses inserted. In cases of phacoemulsification the incision was enlarged to 6.5mm to insert a sulcus-based lens. There were no cases of clinically apparent cystoid macular oedema. The visual outcome among the two groups was markedly different as 77% of patients who underwent phacoemulsification and had vitreous loss could see 6/12 or better unaided as opposed to 0% for ECCE (Table-4). All patients were better than 6/36 unaided. It can be assumed that vitreous loss in cases of phacoemulsification, when managed properly, though a problem, is hardly a disaster.

CONCLUSION

From this series it appears that with our socioeconomic background maintaining high level of follow-up is difficult.

It also appears that with the incision size of 5.25 mm the best unaided results are achieved by scleral pocket phacoemulsification. However, if the surgeons are not keen to learn phacoemulsification then scleral incision conventional extracapsular surgery is nearly as good as clear corneal phacoemulsification, although an occasional patient may end up having excessively high cylinder.

Phacoemulsification by any route provides a more consistent outcome with less variation in the refractive result.

Though the vitreous loss rate with phacoemulsification was higher, at least in this series, it had no adverse bearing on the uncorrected visual outcome.

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Evaluation of Recurrence Following Pterygium Excision with Limbal Stem Cell Autograft.

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ABSTRACT

Purpose: The Purpose was evaluation of recurrence following pterygium excision with limbal stem cell autograft and to highlight stem cell abnormality in nasal limbal area as an important etiological factor.

Methods: 54 eyes of 54 patients were operated on. Graft was taken from the superior limbal region (donor area) and sutured with 10/0 nylon to the nasal limbal bare area (recipient area) after pterygium excision, with limbal edge of the donor tissue on to the limbal region of the recipient area. Patients were given steroid-antibiotic eye drops postoperatively and followed-up for 6 months.

Results: Patients were grouped into three grades according to the postoperative appearance. Grade-I (no recurrence) was seen in 74.07%, Grade-II (1.5-2.0 mm conjunctivalization of cornea) in 11.11%, and Grade-III (frank recurrence) in 14.8% of total cases.

Conclusion: There is low recurrence rate, insignificant complications, rapid surface healing, minimal corneal scarring and restoration of cosmetically acceptable appearance following stem cell autografting. Definite relationship was seen between age, ultraviolet exposure and recurrence of pterygium.

INTRODUCTION

Pterygium, a wing-shaped fleshy growth has been known to ophthalmologists for thousands of years. It is uncommon in temperate and cold climates but occurs frequently in tropical and subtropical lands. Pterygium interferes with vision by occluding optical axis or by inducing astigmatism. It results in unsightly uncomfortable lump on the ocular surface and also disturbs the cosmesis of individuals. It may be the source of frequent episodes of congestion and grittiness. There is considerable scientific evidence to support the theory that sunlight is the principal etiologic factor in pterygium formation. The cornea and conjunctiva absorb most of the long infrared and short ultraviolet rays that reach the earth from the sun. These rays when absorbed cause tissue damage, the infrared by their thermal action and ultraviolet by their abiotic effects.

Corneal epithelial stem cells are believed to be located in the basal cell layer of the periphery of the cornea, the transition zone between the corneal and conjunctival epithelium and the corneal limbus. Corneal epithelium is regenerated from stem cells

situated at the limbus. Corneal stem cells are essential to maintain the epithelial organization by undergoing continuous turnover throughout adult life.

Stem cells are susceptible to noxious stimuli such as ultraviolet radiations, dry, dusty, windy and sandy environmental conditions. The concept that limbal stem cell dysfunction includes conjunctivalization was first proved by Tseng et al¹ in serial experimental studies and has been further confirmed by impression cytology² in a recent report. Corneal stem cell dysfunction leads to corneal epithelial cell dysfunction. Conjunctival cell invasion leads to decrease in visual acuity by extending onto the cornea across the limbus creating a thin and irregular fibrovascular growth over the cornea.

MATERIALS AND METHODS

This was a hospital-based prospective study. All the patients included in this study were those who presented in the outpatient department (OPD) of Layton Rehmatullah Benevolent Trust (LRBT) Eye Hospital, Lahore.

Selection Criteria

Patients were selected at random from the OPD. Following were the selection criteria:

1. There was no sex discrimination.
2. Age between 20-50 years.
3. No history of eye surgery in the past.
4. No history of glaucoma.
5. No history of serious ocular surface pathology.
6. Pterygium 3-6 mm in extent on an average.

Patients were asked about their occupation (labourers, farmers, welders etc)., duration of exposure, onset of pterygium, ocular symptoms (redness, irritation etc) of the disease, use of turbans or sunglasses, history of any surgery or trauma, history of glaucoma, diabetes and hypertension.

Vision and intraocular pressure (IOP) were checked. Slit-lamp examination was done to check the nature and the extent of the pterygium, any fluorescein staining of the cornea, tear film abnormality, corneal scarring and anterior segment inflammation. Fundus examination was done to look for any vision-threatening lesion, in particular to exclude glaucomatous patients to avoid sacrificing conjunctiva in the useful area (superior limbal region) which may be required for filtration surgery in these patients. Anterior segment photographs were taken preoperatively and on follow-up visits postoperatively.

Indications of Surgery

Indications of surgery in this study were:

- * When the pterygium was progressive
- * When it was 3mm or more in size.
- * When it interfered with vision by occluding the visual axis or inducing irregular corneal astigmatism.
- * When there were repeated episodes of congestion and grittiness.
- * When it was cosmetically disfiguring.

However, patients with regressed, atrophic, avascular, flat lesions which had not progressed for years and were less than 3mm in size were not operated on.

SURGICAL TECHNIQUE AND ANESTHESIA

All patients were operated on under the microscope. Complete sterilization and aseptic measures were observed during surgery.

- * All cases were operated on under local anesthesia using 2% Xylocain.
- * Pterygium excision was done with conventional bare sclera technique.
- * Hemostasis was secured.
- * Lamellar keratectomy was done with Feather blade No. 15.
- * Full-thickness conjunctival autograft of 4 x 5 mm was excised from the superior limbal conjunctival region.
- * Graft was shifted to the nasal bared area and stitched limbus to limbus with 10/0 Nylon.

All cases were given dexachlor (dexamethasone + chloramphenicol) eye drops postoperatively 5 times a day in the first week which later on was phased out and stopped in the sixth week of follow-up.

Follow-up extended over six months, during which patients were checked for evidence of recurrence, integrity of graft and wound healing, cosmetic appearance and visual improvement and any complication.

RESULTS

Fifty-four eyes of 54 patients were included in this study with a mean follow-up period of 6 months. On the basis of postoperative appearance we divided the patients into three grades (Table-1).

Table-1: Results (n = 54)

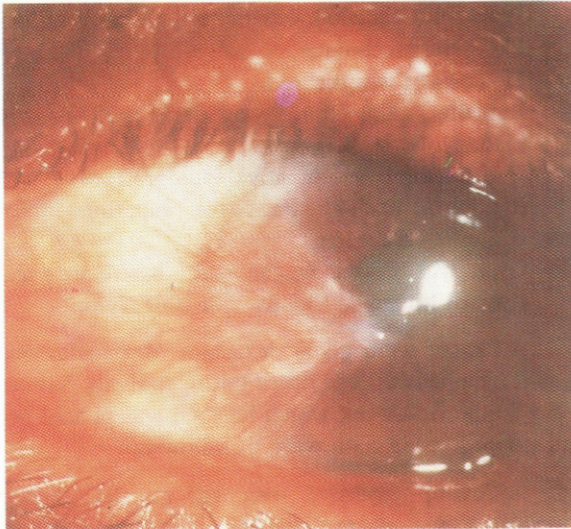
Postoperative Appearance	No. of Patients	Percentage
Grade-I	40	74.07%
Grade-II	06	11.11%
Grade-III	08	14.8%

Grade-I

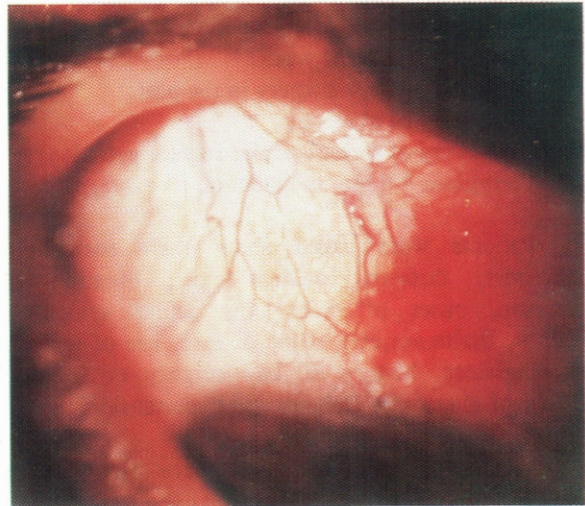
Normal appearance, (No recurrence)--74.07%.

Grade-II

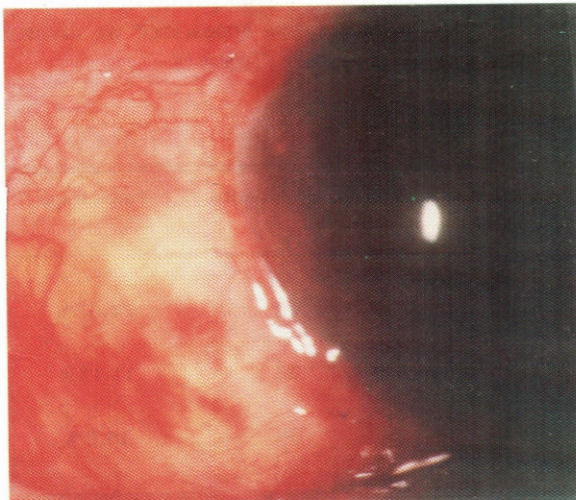
Conjunctivalization of nasal 1.5-2 mm of cornea showing superficial, flat, relatively pale growth noted after 6th week postoperative which remained almost nonprogressive thereafter (appearance cosmetically acceptable to patients and also to the ophthalmologist)--11.11%.



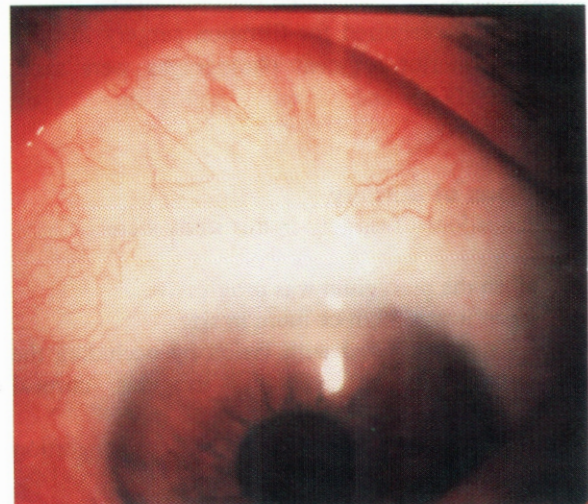
Photograph-1: Preoperative photograph of a 40-year-old patient showing active nasal pterygium approaching visual axis.



Photograph-3: Donor area at 1st week postoperative. Bare scleral area along with episcleral blood vessels and haemorrhage from conjunctival blood vessels are visible.



Photograph-2: Pterygium excision with limbal stem cell autograft at 1st week postoperative, showing clear cornea and stem cell autograft in nasal bulbar area. A few 10/0 nylon sutures can also be seen.



Photograph-4: Donor area at 3 months postoperative shows fibrovascular tissue growth towards limbal area to resurface the bare scleral area.

Grade-III

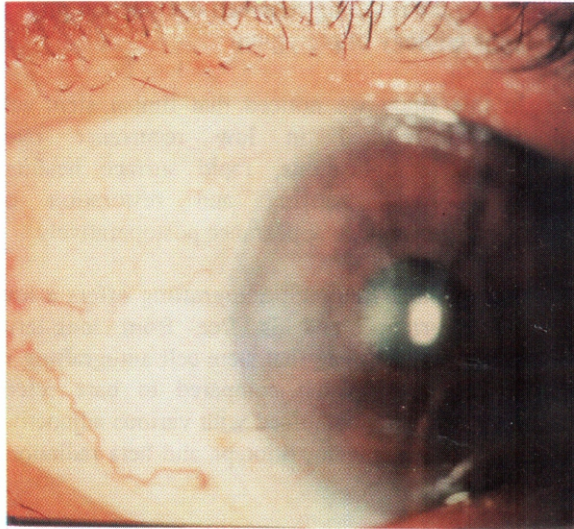
Frank recurrence--14.8%.

COMPLICATIONS

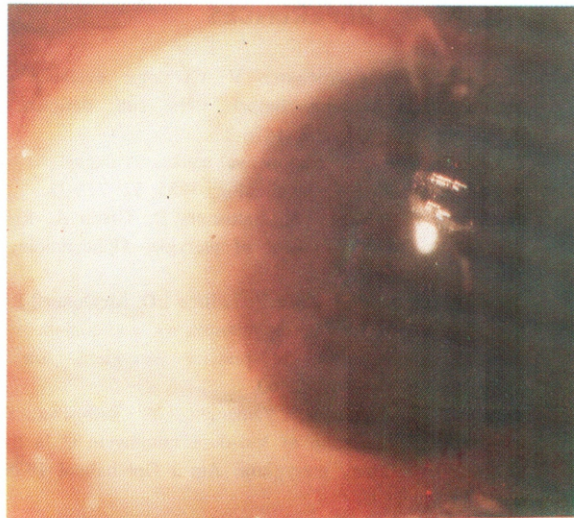
- * No intraoperative complication was observed during the study (Table-2).

- * No undesirable effect was seen at the bared donor area (superior limbal region) which was subsequently covered by regrowth of adjacent tissue during the follow-up. Postoperative complications included dellen formation in 3 patients, cystic graft in 4 patients and filamentary

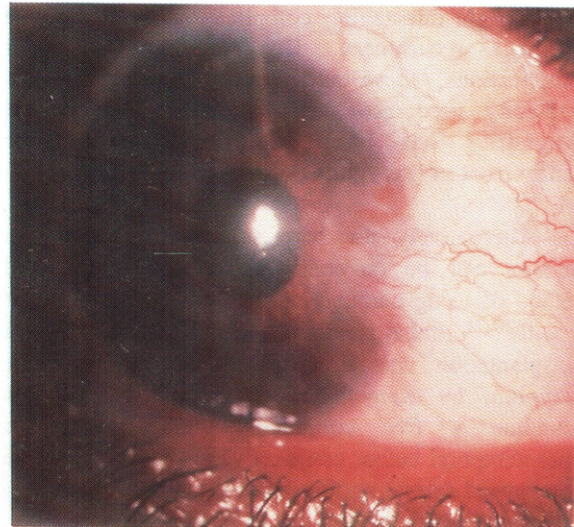
keratitis in 2 patients. We had no complications like hematoma formation, Tenon's granuloma, graft retraction, graft necrosis, extraocular muscle disinsertion or surgically induced corneal astigmatism.



Photograph-5: Postoperative Grade-I appearance at 6-month follow-up after excision of 6mm active pterygium with limbal stem cell autograft in a 50-year-old patient.



Photograph-6: Postoperative. Grade-II appearance at 6-month follow-up after excision of 4mm active pterygium with limbal stem cell autograft in a 40-year-old patient.



Photograph-7: Recurrent pterygium (Grade-III) after pterygium excision with limbal stem cell autograft at 6 months postoperative, in a 30-year-old patient.

Table-2: Complications (n = 54)

Complication	No. of Patients	Percentage
Dellen	3	5.55%
Cystic graft	4	7.40%
Filamentary keratitis	2	3.70%

DISCUSSION

The pterygium is one of the most common corneal disorders in a tropical country such as Pakistan. Exposure to ultraviolet light is presumed to be the most important risk factor³. A wide range of surgical maneuvers for removal of pterygia have been used. However, recurrence after excision has been reported to be as high as 30% to 88%⁴.

In our study most of the patients were from the labour class (road workers, construction workers, farmers) who have to work outside for long periods of time and were extensively exposed to hazardous effects of infrared and ultraviolet radiations present in the sunlight.

Various adjunctive therapies like mitomycin C⁵⁻⁹ thiotepa^{10,11} and beta radiations¹²⁻¹⁴ have been used after pterygium excision in an effort to lower the recurrence rate, but these measures have resulted in serious sight-threatening complications with variable rates of recurrences. Due to high rates of complications, these adjunctive therapies are less frequently used now and, therefore, conjunctival autografting has been widely adopted in the management of pterygium.

Alternatively the bare sclera after pterygium excision can be covered by recently popularized method of using conjunctival autograft without^{4,15-19} or with^{20,21} limbal stem cells. Conjunctival autograft transplantation was described as a treatment for pterygium by Kenyon et al in 1985¹⁵. In this technique a free conjunctival graft from the superotemporal bulbar conjunctiva is used to resurface the exposed scleral surface after pterygium resection. With only a few variations from Kenyon's original report on conjunctival autografting, we performed pterygium excision with limbal stem cell autografting in our patients in which graft was taken from the superior limbal region.

We had low recurrence rates of 25.91% out of which 14.8% showed frank recurrence and 11.11% grade-II appearance (Table-1).

Our study suggested a relationship between age and recurrence of pterygium. Youth is associated with increasing risk of recurrence and as the age advances, chances of recurrence become less and less. Accordingly, our patients who developed recurrences manifested these between six weeks to three months of follow-up.

Some patients developed recurrence despite the fact that they were regular sunglasses wearers, suggesting that use of protective measures can delay but not prevent the recurrence in susceptible population. Of four patients who had their pterygia progress 3-4mm inside the limbus, two developed recurrence after limbal stem cell autografting, which suggests that the nature of the lesion does not influence the postoperative results.

Trachoma, which is very common in our population and is a leading cause of blindness, is responsible for secondary depletion of stem cells as reported by some studies. Our twelve patients (22.2%) had trachoma between stage II-III and they remained satisfactory in the follow-up period.

However, one of those with advanced trachoma ended up with Grade II appearance.

In our study the use of limbal stem cell autograft after pterygium excision was based on the hypothesis that there is focal dysfunction of stem cells in the nasal limbal area secondary to exposure to ionizing infrared and ultraviolet radiations present in the sunlight, so the resulting stem cell dysfunction plays a role in the etiology of pterygium.

In this study we noticed that limbal stem cell autografting resulted in low recurrence rate, insignificant complications, rapid surface healing, minimal corneal scarring and restoration of cosmetically acceptable appearance postoperatively.

Since limbal stem cell autografting offers a low rate of recurrence and is free from long-term complications, it appears that stem cell autografting is a safer alternative when compared to bare sclera excision or excision combined with various adjunctive therapies like mitomycin, thiotepa and beta radiations etc.

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Ophthalmic "Pastpourri"

The Problems and Their Solution

The Story of Bifocals

More than six months passed before Franklin answered Whately. When, on May 23, 1785, he did, he wrote:

"By Mr. Dollond's saying that my double spectacles can only serve particular eyes, I doubt he has not been rightly informed of their construction. I imagine it will be found pretty generally true that the same convexity of glass through which a man sees clearest and best at the distance proper for reading, is not the best for greater distances. I therefore had formerly two pairs of spectacles which I shifted occasionally, as in travelling I sometimes read, and often wanted to regard the prospects. Finding this change troublesome, and not always sufficiently ready, I had the glasses cut, and half of each kind associated in the same cricle. By this means, as I wear my spectacles constantly, I have only to move my eyes up or down, as I want to see distinctly far or near, the proper glasses being always ready. This I find more particularly convenient since my being in France, the glasses that serve me best at the table to see what I eat not being the best to see the faces of those on the other side of the table who speak to me; and when one's ears are not well accustomed to the sounds of a language, a sight of the movements in the features of him that speaks helps to explain, so that I understand French better by the help of my spectacles".

Franklin included in his letter a sketch of his bifocals. He represented each lens as being divided into two equal parts held together simply by a heavy-duty frame. The upper segment of each lens he labeled as the "Least convex for distant objects" and the lower segment he labeled as the "Most convex for reading."

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