ARTIFICIAL PSEUDOPHAKIA*

LONG-TERM RESULTS OBTAINED WITH THE PUPILLARY LENS (IRIS CLIP LENS) IN THE FIRST TWENTY CASES OF UNILATERAL APHAKIA

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THE term "artificial pseudophakia" has been proposed for the condition of an aphakic eye with an artificial lens implant (Binkhorst, 1959d). This paper describes the long-term results obtained with the pupillary lens (iris clip lens) which was the subject of a previous communication (Binkhorst, 1962).

The pupillary lens was developed during the year 1957, and 87 implantations have so far been performed. The first twenty cases, which have been followed-up for at least 2 post-operative years, are described below. Later

TABLE
PARTICULARS OF

1	2	3		4	5				6
Case No.	Type of Cataract	Visual Acuity of Aphakic Eye (corrected)	Correction of Aphakic Eye	Visual Acuity of Pseudophakic Eye (corrected)				Correction of Pseudophakic Eye	
				½ year	1 year	1½ year	2 years		
1	Senile	6/6	+ 12 D sph., + 2.5 D cyl., axis 180°	6/12	6/9	6/9	6/9	- 1 D sph., + 4 D cyl., axis 20°	
2	Senile	6/9	+ 12 D sph.	6/18	6/12	6/12	6/12	- 1 D sph., + 1.5 cyl., axis 90°	
3	Traumatic	6/4.5	+ 11 D sph., + 2.5 D cyl., axis 165°	6/4.5	6/4.5	6/9	6/18	+ 1.5 D cyl., axis 140°	
4	Senile	6/6	+ 10 D sph., + 1.5 D cyl., axis 180°	6/6	6/6	6/6	6/6	- 0.25 D sph., + 0.75 D cyl., axis 50°	
5	Unknown	6/6	+ 13 D sph., + 1 D cyl., axis 60°	6/4.5	6/4.5	6/4.5	6/4.5	+ 1.5 D cyl., axis 85°	
6	Senile	6/6	+ 10 D sph., + 4 D cyl., axis 165°	6/9	6/9	6/9	6/12	- 0.5 D sph., - 2.5 D cyl., axis 45°	
7	Senile	6/9	+ 12.5 D sph.	6/9	6/9	6/9	6/9	+ 1.5 D sph., + 1 D cyl., axis 55°	
8	Senile	6/6	+ 12 D sph., + 2 D cyl., axis 180°	6/6	6/6	6/6	6/9	- 3 D sph.	
9	Unknown	6/4.5	+ 12.5 D sph., + 1 D cyl., axis 175°	6/9	6/9	6/9	6/9	- 0.5 D sph., + 2.5 D cyl., axis 135°	
10	Senile	6/9	+ 13 D sph., + 1.5 D cyl., axis 180°	6/9	6/9	6/9	6/9	+ 1.5 D cyl., axis 180°	
11	Senile	6/12	+ 11 D sph., + 3 D cyl., axis 170°	6/9	6/9	6/9	6/9	- 1 D sph., + 3.5 D cyl., axis 155°	
12	Senile	6/6	+ 11 D sph., + 3 D cyl., axis 180°	6/6	6/6	6/9	6/9	- 2 D sph., + 4.5 D cyl., axis 10°	
13	Radiation	6/6	+ 12 D sph., + 1.5 D cyl., axis 170°	6/6	6/6	6/4.5	6/4.5	- 0.5 D sph., - 0.5 D cyl., axis 115°	
14	Senile	6/9	+ 14 D sph.	6/4.5	6/4.5	6/4.5	6/4.5	- 0.5 D sph., - 0.5 D cyl., axis 110°	
15	Senile	6/9	+ 13 D sph., + 2.5 D cyl., axis 15°	6/9	6/9	6/9	6/9	+ 1.5 D sph.	
16	Cyclitic	6/9	+ 12 D sph.	6/18	6/9	6/9	6/9	- 2 D sph.	
17	Senile	6/6	+ 9 D sph., + 1.5 D cyl., axis 20°	6/6	6/6	6/9	6/9	0.5 D sph., - 3.5 D cyl., axis 130°	
18	Unknown	6/12	+ 11 D sph., + 1 D cyl., axis 165°	6/12	6/12	6/12	6/12	2.5 D sph., - 1 D cyl., axis 75°	
19	Unknown	6/9	+ 12 D sph.	6/4.5	6/4.5	6/4.5	6/4.5	- 0.5 D sph., - 1.5 D cyl., axis 15°	
20	Senile	6/12	+ 10 D sph., + 3.5 D cyl., axis 5°	6/6	6/6	6/6	6/6	- 1 D sph., + 3 D cyl., axis 5°	

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cases, observed for less than 2 years, also seem to confirm the conclusions drawn in this article. The twenty cases included eleven male and nine female patients, whose ages varied from 55 to 81 years (Table).

The aetiology of the cataract (col. 2) may be summarized as follows: senile 13, traumatic 1, radiation 1, cyclitic 1, unknown 4.

In all patients an intracapsular lens extraction had been performed from 3 to 18 months before the lens implantation. Iris surgery was limited to two or three peripheral iridotomies. No complications were seen in cataract surgery itself. In Case 16 (unilateral cataract secondary to uveitis), there was a post-operative relapse of the uveitis which settled down within a few months. In some aphakic eyes the vitreous prolapsed more or less through the pupil into the anterior chamber. The hyaloid membrane was mostly intact, but in some cases ruptured. These events had no influence, however, on the final result. In Case 12 a vitreous strand in connexion with the corneal periphery had remained after the previous implantation of a Dannheim lens,

TWENTY CASES

7	8	9	10	11
Calculated (Spherical) Correction of Pseudophakic Eye	4-dot Test for Far Distance	Bar-reading Test	Operative and Early Post-operative Complications	Long-term Tolerance and Stability
0	Fusion	+	Early post-operative macular lesion	Good
0	Fusion	-	Early post-operative macular lesion	Good
0	Fusion	+	{ Operative endothelial lesion resulting in localized corneal oedema Early post-operative displacement of lens loop	Good
- 1 D sph.	Fusion	-		Good
+ 1 D sph.	Fusion	+		Good
- 2 D sph.	Fusion	-		Good
+ 1.5 D sph.	Fusion	+		Good
- 1 D sph.	{ Simultaneous perception	-		Good
- 0.5 D sph.		+	Operative endothelial lesion resulting in localized corneal oedema	Good
0	Fusion	+		Good
0	Suppression	-		Good
0	Fusion	+		Good
+ 2 D sph.	Fusion	+		Good
0	Fusion	+		Good
0	Fusion	-		Good
0	Fusion	+	Early post-operative relapse of uveitis	Good
- 2 D sph.	Fusion	+	Early post-operative displacement of lens loop	Good
- 2 D sph.	Fusion	-		Good
0	Fusion	+		Good
- 1 D sph.	Fusion	+		Good

which had to be removed after 4 days as it was not well-centred; the vitreous strand was cut at the time of the implantation of the pupillary lens which turned out successfully. In Cases 10, 11, and 16, posterior synechiae of the iris with the hyaloid membrane were present, but could be avoided by the posterior loops of the pupillary lens. Cols 3 and 4 (Table) show the visual acuity and the necessary correction of the aphakic eye.

The dioptric power of the pupillary lens used was not always aimed at achieving emmetropia of the pseudophakic eye; sometimes it was not available, and sometimes it was intended to match the refractive state of the fellow eye. The calculated (spherical) correction of the pseudophakic eye is given in Col. 7, and this may be compared with the actual correction of the pseudophakic eye, in order to check the dioptric effectiveness of the pupillary lens.

Each case was recorded 6, 12, 18, and 24 months post-operatively (Col. 5). In this way eventual late changes could more readily be discovered. Col. 6 shows the required correction, which underwent only minimal changes as time passed. Cols 8 and 9 show the results of simple tests for binocular function. The operative and early post-operative complications are given in Col. 10.

Results

A critical evaluation of the results obtained with the implantation of the pupillary lens in unilateral aphakia should deal with the following points:

- (a) Operative and early post-operative complications;
- (b) Long-term stability and tolerance;
- (c) Functional results (visual acuity and binocular function);
- (d) Special features of artificial pseudophakia with the pupillary lens.

(a) *Operative and Early Post-operative Complications (Col. 10).*—In Cases 1 and 2 oedema with subsequent irreversible changes occurred in the macular area; this may occur in any kind of intra-ocular surgery, though it is more likely in intra-ocular artificial lens surgery, if intense post-operative uveal reaction occurs. After our first series of implantations we learned to avoid unnecessary uveal reaction and macular oedema by rigorous pre- and post-operative treatment with corticosteroids, corticotrophin, and vasoconstriction. In Cases 3 and 9 there had been more than usual manipulation in the anterior chamber and some endothelial trauma during the insertion of the lens; this resulted in a persistent localized corneal oedema, but this, fortunately, did not affect the visual acuity, because it was mainly peripheral. In Case 16 (cyclitic cataract) uveitis occurred post-operatively, but this reaction pattern was to have been expected because the eye had reacted in the same way after the cataract extraction; it later settled down and developed a good level of visual acuity. In Cases 3 and 17 forward displacement of one posterior loop occurred through faulty post-operative care; the loop was easily re-inserted and remained in place afterwards.

(b) *Long-term Stability and Tolerance (Col. 11).*—This depends on late complications, such as displacement of the lens and atrophic, degenerative or inflammatory changes in the eye.

Once the pupillary lens is well in place it remains so. No displacement is likely because of the chosen length of the wire loops and the slight adhesions that form at the pupillary border with the attachments of the posterior loops to the lens body. The lens is automatically centred by the pupil itself. Neither rotation nor tilting of the lens can occur, and even dilatation of the pupil if done carefully will not necessarily affect the stability of the lens.

The pupillary lens is excellently tolerated, the eye being perfectly white and comfortable with normal tension almost from the very beginning, and the slit lamp revealing no sign of irritation. This is not always the case after the implantation of angle-supported lenses. Angle-supports often cause periodical slight irritation, which manifests itself in the transient reddening and tenderness of the eye, accompanied by an aqueous flare and a few cells. Late peripheral or central damage to the corneal endothelium was neither seen nor expected. The lens body and the attached wire-loops lie farther from the corneal endothelium than in the case of the angle-supported lens, as is easily shown by a glass-rod test before the slit lamp. With the angle-supported lens it is easy to bring the lens body or its supports in contact with the central or peripheral corneal endothelium, but with a pupillary lens this is impossible. The pupillary lens solves the problem of preventing late corneal dystrophy, a dramatic and sometimes inevitable complication in angle-supported lenses.

(c) *Functional Results (Visual Acuity and Binocular Function).*—The visual acuity of the pseudophakic eye (Col. 5) is very encouraging, the more so if the advanced age of this group of patients is taken into account. A comparison between the final refractive state (Col. 6) and the calculated refractive state (Col. 7) of the pseudophakic eye demonstrates that slight deviations occur to both sides, but that generally the dioptric power of the pupillary lens was satisfactory.

The excellent visual results are also reflected in the number of cases in which some form of binocular function is restored (Cols 8 and 9). Worth's four-dot test for distance showed the presence of fusion in eighteen out of twenty patients and the bar-reading test was performed by thirteen out of twenty patients. It must be remembered that the lens implantation took place from 1 to 7 years after loss of function in the cataractous eye, and that these results were achieved without any orthoptic training. Also the presence of binocular function before the development of cataract was unknown. In Cases 1 and 14 a definite exotropia was present before the lens implantation, and this disappeared a few days after the implantation. Diplopia was complained of in Cases 5, 16, and 20, but only for a short period after the implantation. No muscle-surgery was carried out.

The positive psychological and social effects of the lens implantation are illustrated by the case histories given below.

(d) Features of Special Interest.

Deformation of Pupil.—The attachments of the posterior loops to the lens body are made to a standard shape. For this reason a narrow pupil will contract itself around the posterior loop attachments so as to render the pupil more or less square, whereas a wider pupil will remain round. Improvement might be achieved by adapting the lens to the individual pupil size.

Cosmetic Effect of Pupillary Lens.—Neither the lens body nor the anterior loops are usually noticeable without magnification, so that the cosmetic effect is very good. A keen observer will sometimes make the remark that “the operated eye is more brilliant than the other”. This observation is based upon the slight tilting movements of the lens in connexion with the iris diaphragm, and the atypical reflex images of the lens surfaces.

Risk of Iris Atrophy.—It is sometimes thought that the fixation of the pupillary lens is done by “clipping” the loops of the lens on to the iris. In fact the iris lies between the loops without any pressure being exerted on it and having only minimal contact with it. So it is not possible for iris atrophy to derive from it, and no adhesions are formed between the lens or the loops and the surface of the iris. The loops merely prevent forward or backward displacement of the lens in abnormal circumstances (as in trauma, dilatation of the pupil, etc.). The actual fixation of the lens in normal circumstances takes place at the four points of attachment of the posterior loops. Slight adhesions are usually formed between the pupillary border and the posterior loop attachments, the remainder of the pupillary border reacting freely to light, as can be readily observed with the slit lamp. In cases with a narrow and rather tightly constricted pupil, shallow impressions can be seen on the pupillary border which do not cause sphincter muscle atrophy.

Phakodonesis.—When the eyeball is moving, the lens to some extent follows any instability of the iris diaphragm with slight tilting movements. As soon as the eye fixes the object of gaze, the lens becomes completely steady, and the patient has hardly any discomfort from it. One patient said that during the first months the reading print “moved”, but later this did not occur. Another patient finds his perception slightly unsteady during the first 5 minutes after awakening in the morning, but not afterwards. None of the other patients had any complaint.

Case Reports

Case 12, a man aged 67, gradually lost the vision in his left eye through the development of mature senile cataract; the right eye retained almost normal vision. As a guard in a recreation-ground the patient was handicapped by the loss of the left visual field.

An intracapsular lens extraction was performed by Dr. Kok-van Alphen of Leiden, in January, 1958, but after this the patient used to close his aphakic eye as “it disturbed the other eye”.

He was referred for the implantation of a pupillary lens in May, 1959. The pseudophakic eye now has a visual acuity of 6/9, and binocular function has been restored, as well as both visual fields (Fig. 1).

FIG. 1.—Appearance in Case 12.

The patient is very proud of the fact that the children in his recreation-ground can no longer get up to mischief at his left side without his being aware of it.

Case 13, a man aged 63, had worked in a bakery for 40 years and had developed a radiation cataract in the left eye. He now works as a hall-porter in a secondary school, and has lost confidence in road traffic.

An intracapsular cataract extraction was performed by Dr. Kok-van Alphen of Leiden, in December, 1958, and the patient then suffered from diplopia. In May, 1959, he was referred for the implantation of a pupillary lens. The pseudophakic eye now has a visual acuity of 6/4.5 and binocular vision has been re-established. The patient feels comfortable in traffic again, even when riding his motor-cycle (Fig. 2).

FIG. 2.—Appearance in Case 13.

Case 15, a man aged 69, developed a predominantly unilateral senile cataract in 1958, the other lens remaining almost clear. As the owner of a garage he was handicapped in his work, as he lost confidence in driving his car with the restricted visual field and lack of depth perception.

The cataractous lens was extracted in March, 1959, and a pupillary lens was implanted in June, 1959. The pseudophakic eye now has a visual acuity of 6/9 and normal visual fields. Fusion is present. The patient is very happy and is able to do his work and drive his car as before (Fig. 3).

FIG. 3.—Appearance in Case 15.

Summary

The term “artificial pseudophakia” is used to describe an aphakic eye with an artificial lens implant, and a series of cases is reviewed in which the pupillary lens (iris clip lens) designed by the author was inserted.

The visual acuity and binocular function in these patients are excellent.

The most striking features of artificial pseudophakia with the pupillary lens are the centering and stability of the lens, and the long-term tolerance of the eye. There were no cases of late displacement of the lens and no late atrophic, degenerative, or inflammatory changes. Late corneal dystrophy, a complication that cannot be excluded in cases of artificial pseudophakia with angle-supported lenses, is not likely to occur with the pupillary lens.

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