Piggy - Back lenses in keratoconus

J.H.C. Kok, M.D., Ph. D., C. Van Mil, O.D.(*)

Abstract

Intolerance to rigid contact lenses in keratoconus may occur as a result of epithelial pathology or a sub-optimal fitting. The application of a soft lens as a bandage lens makes it possible to tolerate a rigid lens upon it. This study gives the results of 40 eyes in 26 patients who were consecutively fitted with a new aspheric combination lens. Thirty-five eyes (87.5%) showed no disconfort, acceptable wearing time and visual acuity. Four of these eyes showed an improvement of the corneal condition, eliminating the need for a further piggy-back wearing system. Failures were found in 5 eyes (12.5%) due to: giant papillary conjunctivitis (2 eyes); severe keratonocus (1 eye); difficulty in lens hadling and lack of motivation (2 eyes). The successful use of an aspheric piggy-back combination lens in rigid lens-intolerant keratoconus may preclude early surgical theraphy.

Introduction

An irregular topography of the cornea in keratoconus may require the application of a rigid contact lens for optical correction. The advent of high gas-permeable lens material in combination with an aspheric lens design has been of great benefit for the keratoconus patient (1,2,3). The new lenses are more comfortable and have less complications than the low oxygen-transmissible spheric lenses used until recently. The curvature of an aspheric lens runs more parallel to the corneal topography in keratoconus than a spherical lens.

(*)Cornea and Contact Lens Unit. Departament of Ophtalmolog of the Academic Medical Center, Amsterdam.
Corresponding author:
Jan H.C. Kok.Cornea and Contact Lens Unit. Departament of Ophtalmology Academic Medical Center. University of Amsterdam
Meibergdreef 9. 1105 AZ Amsterdam-ZO. The Netherlands

This increases the surface contact between the cornea and the lens, which provides a stable and well centered lens (1,2,3). Intolerance to rigid aspheric contact lenses, however, may still occur in keratoconus as a result of sub-optimal fitting, corneal sensitivity and epithelial defects. The piggy-back lens design or combination lens is the name given to the technique of fitting a rigid lens on top of a soft lens which acts as a bandage lens, that increases comfort and adds protection to the apex of the cone. Westerhout (4) reported the first use and advantages of a combination of a soft and a rigid lens. Dificulties encountered with this combination lens included poor centration of the rigid lens and gross corneal edema. Many lenses would slip onto the sclera or pop out of the eye (5). Even if the corneal lens was manufactured from (low) gas permeable material there was always a risk of localized corneal hypoxia (6,7). Corneal neovascularization has been another cause why most of these lens systems had to be discontinued (8). Until now, the fitting procedure consisted of an initial application of a hydrophilic lens of medium to low water content. The keratometer readings were taken and a rigid lens was selected by trial and error. This study reports a simplified fitting procedure of a new aspheric piggy-back lens. Keratoconus patients experiencing severe discomfort from their aspheric rigid lenses were fit with a high water containing soft lens and the original rigid lens was placed on top of it.

Only high oxygen transmissible materials were used for both the soft and the rigid lens in order to supply the minimal amount of oxygen required by the cornea (9). Almost 90% of the cases were successfully fitted with the new piggy-back lens system.

Material and methods

Twenty six consecutive keratoconus patiens (40 eyes), who were intolerant of their aspheric high gas-permeable rigid lens were included in this study. 15 patients were male and 11 were female. The mean age was 35.9 years (s.d. 9.1 years, range 18 - 55 years).

Forty eyes were graded according to the Amsler (10) classification, using corneal radius, as modified by Muckenhirn (11), (Table 1). This classification adds a value for corneal eccentricity (E) to the Amsler classification (Table I). Two kind of lens materials, Quantum and Bosten Equa, of comparable high gas permeability, were used for the production of the rigid lenses. All lenses were manufactured by the same company. Quantum lenses were fitted in 29 eyes (72.5%) and Bosten Equa lenses in 11 eyes (27.5%). The specification of the rigid lens materials are given in (Table II). The computer-aided technique for fitting rigid aspheric lenses in keratoconus has been described elsewhere (1,2). All rigid lenses were manufactured by Hecht (Germany) using the Ascon Kc 20 Hecht

Amsler classification of corneas in keratoconus according to Amsler, modified by Muckenhirn.

Grade	Radius (mm)	Eccentricity	Patients (n)
I	> 7.50	< 0.80	8
II	6.50-7.50	0.80-1.20	14
III	5.80-7.50	1.20-1.50	10
IV	< 5.80	> 1.50	8

Table II
Properties of Quantum and Boston Equa rigid contact lens materiales.

QUANTUM 92	
Material	Fluoro-silicon copolymer (siflufocon A)
Dk	92 x 10^{-11}according to Fatt
Refractive index	1.34
Wetting angle	24_0 (captive bubble technique)
BOSTON EQUA	
Material	Fluoro Carbon/Acrylate copolymer
Dk	71 x 10-11 according to FattTable II
Refractive index	1.44
Wetting angle	30_0 (captive bubble technique)

lens desing. The lens has a central spherical optic zone, which is fixed at 20°, while the base curve is changed. The high eccentricity, or rapid rate of peripheral flattening, of the lens is reached within 20 - 30°to align with the topography of the cornea. The maximum eccentricity is limited to 0.9 to minimize loss of visual acuaty from spherical aberration. The parameters of the lenses used in this study were: base curves: 6.00 - 8. 10 mm; diameters: 8.0 - 9.6 mm; and eccentricities: 0.6 - 0.9. The determination of the best soft bandage lens fit was performed by trial and error until good centration was achieved. Mobility of the lens was considered optimal when movement at each blink measured at least one to two millimeters. The specifications of the soft lens are given in (Table III). To create the combination lens, the aspheric rigid lens is placed upon the soft contact lens. Thus no further adjustment of the rigid lens is carried out. The piggy-back lens fitting is considered optimal

Table III
Specifications of soft bandag lens

LUNELLE ES 70	
Material	Polymethyl-methacrylatepolyvinyl-pyrrolidone copolymer
Dk	35 x 10-11 according to Fatt
Refractive index	1.38
Base curve radius	8.0, 8.30, 8.60, 8.90, 9.20 mm.
Total diameter	13.0, 14.0 mm.
Lens hydratation	70%
Center thickness	0.15 mm.

when both th rigit and the soft lens move independently at each blink. In case of a painful corneal erosion, the advice was given to only remove the rigid lens at night and to leave the soft lens in on an extended wear basis, as a bandage lens, until the epithelium was healed. Gentamicin sulfat 0.5% eyedrops were prescribed as a prophylactic medication. Then, a daily wear shedulce of the soft lens was advised again. Where necessary, blue-tinted soft lenses were fitted to overcome the difficulty exprienced with lens handling due to poor vision without lenses. The rigid lenses were cleaned with Boston lens cleaner and stored in Boston conditioner solution. For the soft lenses the Soft tab cleaning and disinfecting, preservative free system, was used. The maximum wearing time of the rigid lens was compared with the wearing time of the piggy-back system. The best visual acuity with the rigid lens was compared with the vision with the piggy-back system, using a Snellen chart.

Contact lenses related complications, including epithelial defects, epithelial edema, corneal swelling and giant papillary conjunctivitis was recorded by slitlamp examination by two independent investigators, before and after the start of the piggy-back wear.

Results

Rigid contact lens intolerance in keratoconus may be encountered in mild and severe keratoconus. The grade of keratoconus in our study was recorded as follows: 8 (20%) eyes Grade I, 14 (35%) eyes Grade II, 10 (25%) Grade III, and 8 (20%) eyes Grade IV.

The main reason for discontinuation of the wearing of the rigid lens was absolute intolerance (8 yes, 20%). A «foreign-body» sensation was recorded in 12 eyes (30%). A maximal wearing time of 12 hours was found for 4 eyes (10%), 9 hours for 12 eyes (30%), 6 hours for 4 eyes (10%). To improve the comfort of the rigid lens a soft bandage lens was used to create the piggy-back lens. The selection of the base curve radius of the soft lens was performed by trial and error. In 24 eyes (60%) a base curve radius of 8.90 mm was fitted (table V). In 6 eyes (15%) of 3 patients, a blue tinted soft lens was used to facilitate lens handling. The mean follow up time of the wearing of the piggy-back lens was 7.8 months, s.d. 3.9 months (range 1-14 months). Two placido photographs demonstrate the smoothing out effect of the soft lens on the irregularities of the corneal surface. The greatest disturbance of the ring pattern correlates with the apex of the cone, which is decentered downwards and sidewards. Smoothing out of these irregularities is shown in, by a more regular pattern of rings.

Table V
Selection of base curve radius of soft lens versus Amsler classification of corneas (number of eyes)

	Amsler classification				
Total	Grade I	Grade II	Grade II	Grade IV	
Base Curve Radius bandage lens (mm)					
8.00	0	1	0	0	1
8. 30	0	2	0	0	2
8.60	0	1	5	2	8
8.90	5	9	4	6	24
9.20	3	1	1	0	5
Total	8	14	10	8	40

Thirty two eyes (80%) fitted with the piggy back system experienced an unrestricted wearing time, without a foreign-body sensation. One eye was absolutely intolerant for the piggy-back lens and another patient could only keep the lens in the eye for three hours at a time. Two eyes had a maximal wearing period of 6 hours, 2 eyes of 9 hours and 2 eyes of 12 hours. The most important goal in fitting the combination lens in keratoconus is the optical correction of the keratoconus, since spectacle correction is inadequate due to the irregular topography. In 15 (37.5%) applications of the piggy-back lens an improvement of the visual acuity was recorded compared with the rigid lens alone. In 18 eyes (45%) there was no alteration of visual acuity with the piggy back-lens and in 7 eyes (17.5%) the vision decreased. However, this deterioration of visual acuity during the study was never the reason to discontinue lens wear. Complications before and after wearing the piggy-back lens are shown in (Table IV).

Table iV
Number of complications before and after the wearing of the piggy-back lens

Complication	Before		After	
Staining	15/40	37.5%	4/40	10%
Erosion	6/40	15%	2/40	5%
Epithelial edema	2/40	5%	0/40	0%
Bullae	1/40	2.5%	0/40	0%
Micro-cysts	1/40	2.5%	0/40	0%
Giant papillary Conjunctivitis	1/40	2.5%	6/40	15%

Staining and erosions of the cornea (21 eyes, 52.5%) before the wearing of the piggy-back system were mainly related to mechanical problems of the fitting and fragility of the epithelium. A reduction of these complications (6 eyes, 15%) was found after fitting the piggy-back lens. In four eyes the epithelial defects improved to such an extent with the piggy-back lens that there was no further need for the bandage lens, and the rigid lens alone was tolerated again. Giant papillary conjunctivitis as a side effect of the wearing of the piggy back lens was observed in six eyes (15%). For two of these eyes the giant papillary conjunctivitis was a reason to discontinue lens war. In five (12.5%) eyes of three patients the piggy-back lens was not successful. The reason was giant papillary conjunctivitis in two eyes of one patient, which did not respond to medication (Topical corticosteroid and Lomudal). Intolerance to the piggy-back lens was found in one eye with severe kratoconus Grade IV. One patient (two eyes) had difficulty with lens handling and stopped due to lack of motivation. Quantum was the first high, gas-transmissible, rigid contact lens material on the market in Europe, followed by Boston Equa. No notable differences were found as regards gas permeability, deposit formation lens breakage.

Discussion

In this study we report our successful experience with a new piggy-back wearing system for the correction of visual acuity in keratonocus patients, who were intolerant to rigid contact lens wear. The improvement of the corneal condition in four eyes (10%) was such that the piggy-back lens was no longer needed. The healing of epithelial erosions by the use of the bandage lens may have contributed to improvement of visual acuity in some cases. However, the progress of the disease in the course of the study, resulting in progressive scarring, is held responsible for the deterioration of the visual acuity for some other patients. The decline of the visual acuity was never a reason to discontinue piggy-back lens wear.

The important advantage of the fitting technique used in our study is that in the case of rigid lens intolerance only. a soft bandage lens has to be fitted to create the piggy-back lens; no further adjustment is necessary for the rigid aspheric lens, saving a lot of time and expense. After the corneal condition has improved due to the healing effect of the bandage lens, the rigid lens may be worn without the bandage lens, without changing the rigid lens parameters. This also gives the possibility of wearing the piggy-back lens on an interrupted time schedule. Using the bandage lenses on an extended wear basis in case of an epithelial defect renders the potential danger of corneal infection. In this case additional antibiotic treatment is mandatory and a switch to dailey wear should be made as soon as possible, usually after 24-48 hours. The advantages of the bandage effect of a soft lens, which may improve the comfort of the rigid lens, have long been apparent. This is confirmed by the results of our study, showing an improvement in wearing time without a foreign body sensation for the piggy-back lens and an improvement of the corneal condition (Table IV). The decentration of the rigid lens on top of the soft lens and the oxygen shortage under the piggy-back lens have limited the use of the piggy-back lens in the past (5,6,7).

The improvement of the centration and movement of the rigid lens in our study is based on two factors. The center thickness of the high-water, zero-power, soft bandage lens is 0.15 millimeter. This lens smoothes out the surface irregularities of the corneal contour, as can well be demonstrated by placido ring photographs. The soft lens acts as a glider for the rigid lens. The upper eyelid can pick up the rigid lens easir, because less friction is present between the soft lens and the rigid lens as compared to the interaction between rigid lens and the bare cornea. As a result of rapid flattening to the periphery of the aspheric rigid lens desing, such lenses run more parallel with the topography of a keratoconus than is the case with spherical lenses. This phenomenon may augment the adhering forces between the cornea and the lens. It may be held responsible for the fact that no lenses were lost or decentered. These two factors ensure that the piggy-back lens adheres to the cornea and that the rigid and soft lens move independently. This is of great importance in supplying enough oxygen to the cornea under the piggy-back lens (6,7). For the same reason our piggy-back lens is favored to other combination lenses, which have the rigid lens fixed, without any movement, in the central position by a ridge in the soft lens (5,12,13). Oxigen shortage of the cornea may result from the use of these lenses. There is a growing list of literature, which indicates that refitting contact lenses in rigid lens-intolerant keratoconus patients may postpone surgical intervention (1,2,14). This study describes a safe, simple technique with low costs and a high success rate to treat keratoconic patients who cannot tolerate rigid contact lenses. This technique may postpone surgical intervention even further for this group of patients.

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