

The Incidence of Refractive Errors with Subsequent Selection of Corrective Aids

Beneš P.^{1,4}, Synek S.², Petrová S.², Sokolová Šidlová J.¹, Forýtková L.³, Holoubková Z.⁴

SUMMARY

The Incidence of Refractive Errors with Subsequent Selection of Corrective Aids

This study follows the occurrence of refractive errors in population and the possible selection of the appropriate type of corrective aids. Objective measurement and subsequent determination of the subjective refraction of the eye is an essential act in optometric practice. The file represented by 615 patients (1230 eyes) is divided according to the refractive error of myopia, hyperopia and as a control group are listed emetropic clients. The results of objective and subjective values of refraction are compared and statistically processed.

Methods: The study included 615 respondents. To determine the objective refraction the autorefraktometer with Placido disc was used and the values of spherical and astigmatic correction components, including the axis were recorded. These measurements were subsequently verified and tested subjectively using the trial lenses and the projection optotype to the normal investigative distance of 5 meters. After this the appropriate corrective aids were then recommended.

Results: Group I consists of 123 men and 195 women with myopia (n = 635) of clients with an average age $39 \pm 18,9$ years. Objective refraction – sphere: $-2,57 \pm 2,46$ D, cylinder: $-1,1 \pm 1,01$ D, axis of: $100^\circ \pm 53,16^\circ$. Subjective results are as follows - the value of sphere: $-2,28 \pm 2,33$ D, cylinder $-0,63 \pm 0,80$ D, axis of: $99,8^\circ \pm 56,64^\circ$. Group II is represented hyperopic clients and consists of 67 men and 107 women (n = 348). The average age is $58,84 \pm 16,73$ years. Objective refraction has values - sphere: $+2,81 \pm 2,21$ D, cylinder: $-1,0 \pm 0,94$ D; axis $95^\circ \pm 45,4^\circ$. Subsequent determination of subjective refraction has the following results - sphere: $+2,28 \pm 2,06$ D; cylinder: $-0,49 \pm 0,85$ D, axis of: $95,9^\circ \pm 46,4^\circ$. Group III consists from emetropes whose final minimum visual acuity was $V_{min} = 1,0$ (5/5) or better. Overall, this control group is represented 52 males and 71 females (n = 247). The average age was $43 \pm 18,73$ years. Objective refraction - sphere: $+0,32 \pm 0,45$ D; cylinder: $-0,51 \pm 0,28$ D, axis of: $94,7^\circ \pm 57,5^\circ$.

Discussion: Values of objective refraction take higher values than the subsequent execution of the subjective examination of the refractive error and recommendation of the appropriate type of corrective aids. This all is in examined groups and in the individual components of refractive errors. It also confirmed the hypothesis that the population outweighs with-the-rule astigmatism, the deployment of resources according to the literature ranges from $90^\circ \pm 10^\circ$.

Conclusion: The values observed correction of refractive errors are then derived also offer the most common prescription ranges and products for the correction of given ametropia. In the selection and design corrective aids, we are often limited. Our task is then to manufacture high quality, functional and aesthetic corrective aids, you need to connect knowledge from the fields of optics, optometry and ophthalmology. Faster visual rehabilitation simplifies clients' rapid return to everyday life.

Key words: refractive error, objective refraction, subjective refraction, glasses, contact lenses, population

Čes. a slov. Oftal., 68, 2012, No. 1, p. 11–16

INTRODUCTION

Refractive errors are represented in the population by short-sightedness, long-sightedness and astigmatism. The state in which the optical system of the eye does not manifest any refractive error is called emet-

ropy. A special position is attributed to presbyopia, which is caused by a physiological deterioration of the flexibility of the ocular lens, but is not a refractive error from a physiological perspective [1, 7].

It is necessary to correct a refractive error or ametropia, especially if it causes asthenopic complaints. Unfor-

tunately, even in today's excessively technical age it is possible to encounter workplaces where insufficient time is devoted to this fundamental eye examination. According to the health indication and condition of the client it is then possible to select from the individual types of corrective aids. These in particular are represented

First author:

Mgr. Pavel Beneš

Department of Ophthalmology and Optometry, St. Anne's University Hospital, Masaryk University, Brno
Pekařská 53
656 91 Brno
e-mail: optika.rubin@seznam.cz

Table 1. Comparison of values of objective and subjective refraction

Group	Objective sphere (D)	Cylinder (D)	Angle (°)	Subjective sphere (D)	Cylinder (D)	Angle (°)
I. myopia	-2.57±2.46	-1.1±1.01	100°±53.16°	-2.28±2.33	-0.63±0.80	99.8°±56.64°
II. hypermetropia	+2.81±2.21	-1.0±0.94	95°±45.4°	+2.28±2.06	-0.49±0.85	95.9°±46.4°
III. emetropy	+0.32±0.45	-0.51±0.28	94.7°±57.5°	-	-	-

by glasses and contact lenses. The glasses frames serve not only as the holder of the lenses of the eyeglasses, but also as a fashion accessory. It is possible to choose from a large quantity of plastic or metal frames. Frames made from natural materials such as wood or horn can have a striking and innovative effect.

Glasses lenses offer a wide range of possibilities especially in the optical properties of the materials used, but it is also possible to improve these properties in a combination with thin layers. This primarily concerns anti-reflective finish, which provides the wearer with greater visual comfort in comparison with regular glasses lenses by eliminating undesirable reflections, and thus providing the eye with more visual information. Optical image errors can then be alleviated by selecting lenses with a higher refraction index or in a version with an aspheric surface [1, 2].

Contact lenses provide users primarily with the advantages of an unlimited field of vision, which in the case of eyeglasses is restricted by the shape of the frames. For more active and sports oriented clients, contact lenses are of irreplaceable value. They are more comfortable, ensure stable vision and are safer than would be the case upon performing the same activities with glasses. Here also there is a relatively wide range of materials and versions available. Above all, upon correction of high values of refractive errors they are again the preferred option in comparison with glasses. In addition to correction of the actual error, they also play a role in strengthening the individuality and social integration of the client. Regular checks of the anterior segment and correct care for contact lenses then ensure success upon wearing these corrective aids. Each wearer of contact lenses must have reserve glasses available for the case of interruption of their use. A significant position is occupied by surgical refractive procedures on the cornea and cataract surgery. The

new crosslinking method of reinforcing the cornea reduces the invasiveness of these highly specialised procedures [4, 5, 8].

METHOD

615 clients, thus 1230 eyes, were included in a randomised trial, where they were divided into three groups. The first two were represented by refractive errors representing myopia and hypermetropia. A group of emetropic clients were chosen as the third, control group.

The aim was to conduct an objective measurement of the refractive condition of the eye. For this purpose an auto refractor-keratometer with a Placid disc (KR 8100P, Topcon, Japan) was used. The determined values were then subjectively tested using anatomical testing frames and a set of glasses lenses (Occlus). The determination of vision was conducted at the standard testing distance of 5m, using a projection optotype (ACP-8, Topcon, Japan). The results of the measurement were recorded and then statistically processed using the program Statistica 9, CZ-Czech single user version by the StatSoft® company, which is available to students and employees of Masaryk university. A suitable type of corrective aid was then recommended for each client. In the majority of cases, the glasses were produced stating the advantages of the latest types of glasses lenses and technological procedures in their processing for the given correction and specific error. A large degree

of emphasis was also placed on the aesthetic aspect, i.e. functional and attractive glasses. Upon selection of contact lenses, keratometry was also measured during objective measurement of refraction on the above-stated instrument, and topography of the anterior surface of the cornea was conducted. On the basis of the determined parameters a suitable type of spherical, toric or progressive contact lens was then applied.

Clients who manifested signs of any procedure on the cornea, blepharitis, purulent conjunctivitis or other eye disorder were not included in the study.

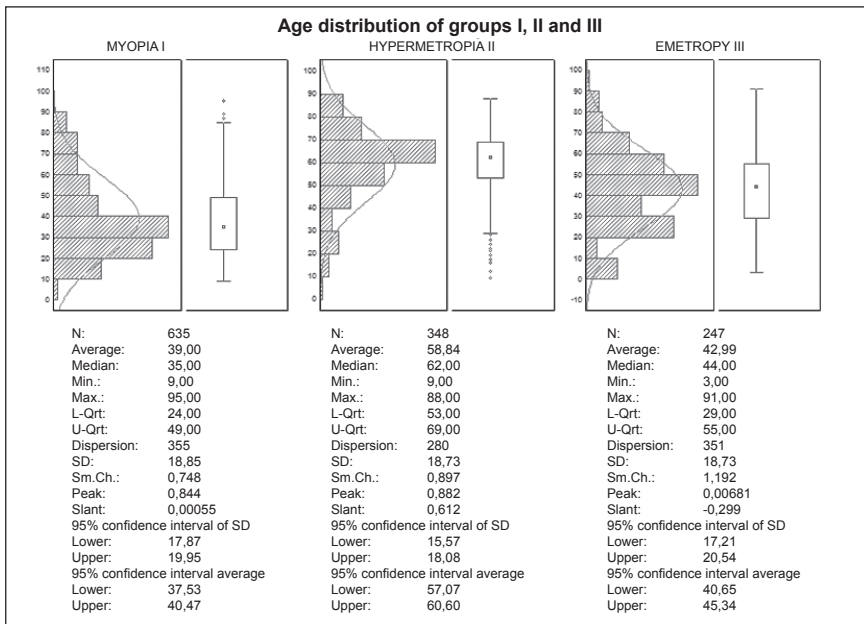
RESULTS

Group I is composed of 318 myopic clients, 123 men and 195 women (n = 635) with an average age of 39 ± 18.9 years (min. 9 years, max. 95 years; median 35 years), graph 1. Values of objective refraction – sphere: -2.57 ± 2.46 D (min. -0.25 D, max. -20.5 D; median -2.0 D), graph 2, cylinder: -1.1 ± 1.01 D (min. -0.25 D, max. -7.25 D; median -0.75 D), angle 100° ± 53.16° (min. 0°, max. 180°; median 97.5°).

Following a subjective examination the results were as follows – value of sphere: - 2.28 ± 2.33 D (min. 0.0 D, max. -18.0 D; median -1.75 D), cylinder: -0.63 ± 0.80 D (min. 0.0 D, max. -4.5 D; median -0.5 D), angle: 99.8° ± 56.64° (min. 0°, max. 180°; median 95°), see table 1. It is already clear upon first view that the subjective refraction values are lower than the determined objective refraction values. The correction

Table 2. Incidence of corneal astigmatism in given sample of population

Group	Direct ast. (number of eyes)	Indirect ast. (number of eyes)	Oblique ast. (number of eyes)	No ast. (number of eyes)
I. myopia	278	59	285	13
II. hypermetropia	113	42	182	11
III. emetropy	113	15	111	8
total	504	116	578	32



Graph 1. Age distribution of groups I-III ($p < 0.05$)

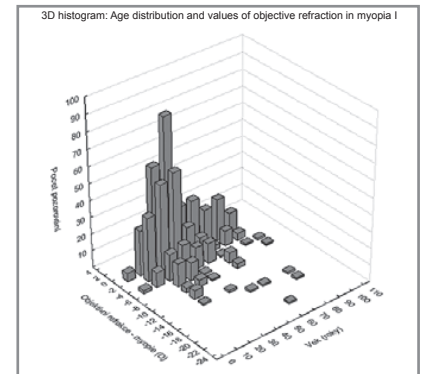
of astigmatism is a further step in stipulating the resulting correction. According to the literature direct corneal astigmatism occurs most commonly in the population, there are 278 eyes in this group, indirect astigmatism was present in 59 eyes and oblique astigmatism was determined in 285 eyes. 13 eyes manifested a purely spherical shape of the anterior surface of the cornea, as shown in table 2. Myopia is the most widely represented refractive error in the population. The offer of glasses lenses designated for correction of this error is also very wide. It is possible to choose from a basic version of material to special slimline products, where emphasis is placed primarily on the resulting aesthetic effect within the glasses frames. Contact lenses are popular corrective aids for the correction of myopia. In our case it was possible upon correction to fully cover the determined subjective refraction values.

Group II is represented by hypermetropic clients, and consists of 67 men and 107 women ($n = 348$) with an average age of 58.84 ± 16.73 years (min. 9 years, max. 88 years; median 62 years), graph 1. Objective refraction measured by instrument shows values of – sphere: $+2.81 \pm 2.21$ D (min. 0.0 D, max. $+19.0$ D; median 2.38 D), graph 3, cylinder: -1.0 ± 0.94 D (min. -0.25 D, max. -5.75 D; median -0.75 D), angle $95^\circ \pm 45.4^\circ$ (min. 0° , max. 180° ; median 92°). The sub-

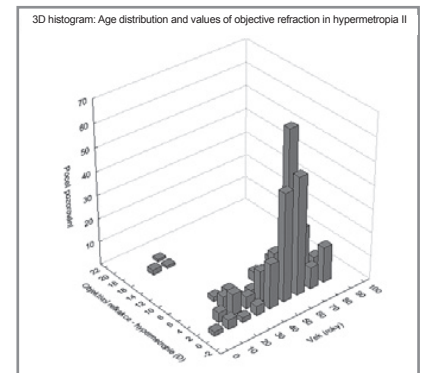
sequent determination of subjective refraction has the following results – sphere: $+2.28 \pm 2.06$ D (min. 0.0 D, max. $+17.0$ D; median $+1.75$ D), cylinder: -0.49 ± 0.85 D (min. 0.0 D, max. -5.0 D; median 0 D), angle: $95.9^\circ \pm 46.4^\circ$ (min. 0° , max. 180° ; median 90°), see table 1.

Direct corneal astigmatism was measured in 113 eyes, indirect was present in 42 eyes and oblique astigmatism occurred in 182 eyes. A spherical shape of the anterior surface was determined in 11 eyes, see table 2. Here also there is confirmation of the fact that the values of measured objective refraction on the auto refractor-keratometer are higher than the subjectively verified values. In the case of correction by glasses, in the case of hypermetropia we are partially limited by technological possibilities, and the use of aspheric lenses was shown to be the best option. These lenses reduce the optical image error (spherical aberration, distortion) and provide the user with better vision primarily in the periphery of the glasses lens. Also upon correction using contact lenses we are restricted in the case of hypermetropia by the offer and range of dioptric scopes, especially at higher values of refraction error and combinations with a higher value of correction cylinder.

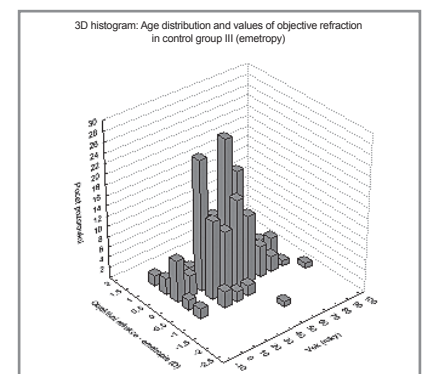
Group III consists of emetropic clients, i.e. clients who did not require any corrective aid and whose resulting subjective vision was at least $V_{min}=1.0$ (5/5) or better. In



Graph 2. Distribution of myopia in given age group ($p < 0.05$)



Graph 3. Distribution of hypermetropia in given age group ($p < 0.05$)



Graph 4. Distribution in control group III (emetropia) and in given age group ($p < 0.05$)

total this group was represented by 52 men and 71 women ($n=247$). The average age is 42.99 ± 18.73 years (min. 3 years, max. 91 years; median 44 years), graph 1. Objective refraction in this group was determined at – sphere: $+0.32 \pm 0.45$ D (min. -1.75 D, max. $+1.5$ D; median $+0.25$ D), cylinder: -0.51 ± 0.28 D (min. -0.25 D, max. -2.25 D; median -0.5 D), angle $94.7^\circ \pm 57.5^\circ$ (min. 0° , max. 180° ; median 93.5°), as shown in table 1 and graph 4. Direct corneal astigmatism was

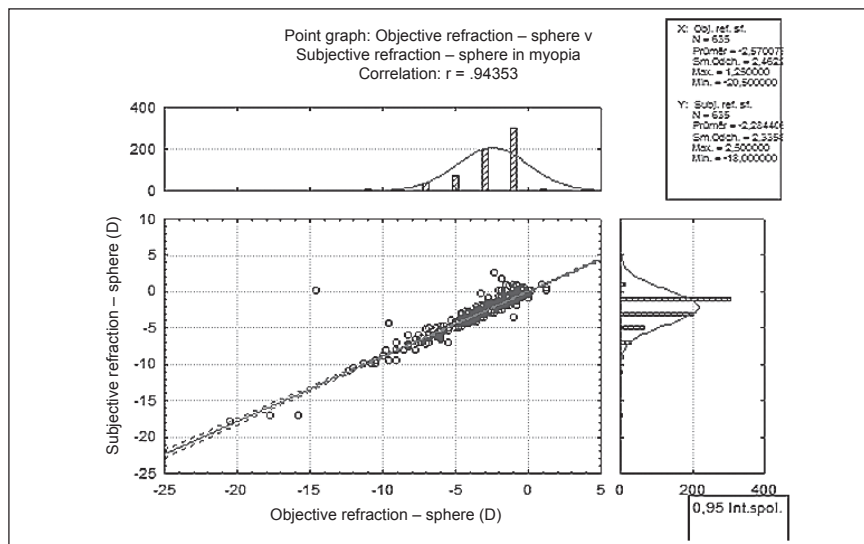
measured in 113 eyes, indirect in 15 eyes and oblique astigmatism was present in 111 eyes. A purely spherical shape of the anterior surface was determined in 8 eyes, see table 2. A subjective refraction test then demonstrated that the clients did not require correction with glasses or contact lenses. In this group also we encounter the possibility of wearing glasses, primarily as a fashion accessory. From the offer of contact lenses clients choose coloured lenses, which have a cosmetic effect.

DISCUSSION

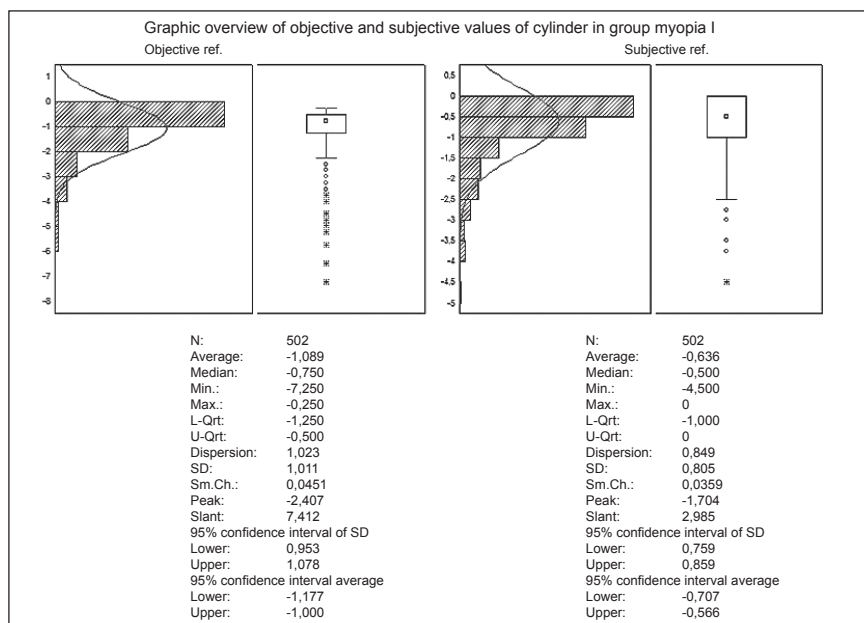
From the conducted measurements it is possible to draw a number of conclusions. According to the results presented in table 1 it is evident that the objective refraction values are higher than the subsequent performance of subjective examination of the given correction. This was the case in all examined groups and individual components of refractive errors. The average value in myopia is in sphere -2.5 D objectively, whereas subjectively this value is lower than -2.25 D, graph 5. Also the objectively measured value of the cylinder is -1.0 D in group 1, whereas subjectively it is within the range of -0.5 D to -0.75 D, graph 6. However the angle of the corrective cylinder is approximately the same in both cases, which amongst other factors illustrates the relatively high degree of precision of the chosen measuring instrument.

The situation is similar in group II. The determined objective refraction values are higher, i.e. the spherical component shows +2.75 D, whereas subjectively this is +2.25 D, graph 7. This is evident also in the higher objective values of cylinder -1.0 D, in comparison with a subjective value of less than -0.5 D of the correction cylinder, graph 8. In the case of the angle of the correction cylinder, both values are again virtually identical. The hypothesis that the correction of direct astigmatism, whose distribution according to literary sources is within the range of $90^\circ \pm 10^\circ$, predominates within the population, is also confirmed. [3-5]

The control group (group III) consisted of clients who subjectively did not require correction by glasses or contact lenses and whose natural vision was at least 1.0 (5/5) or better. These respondents most



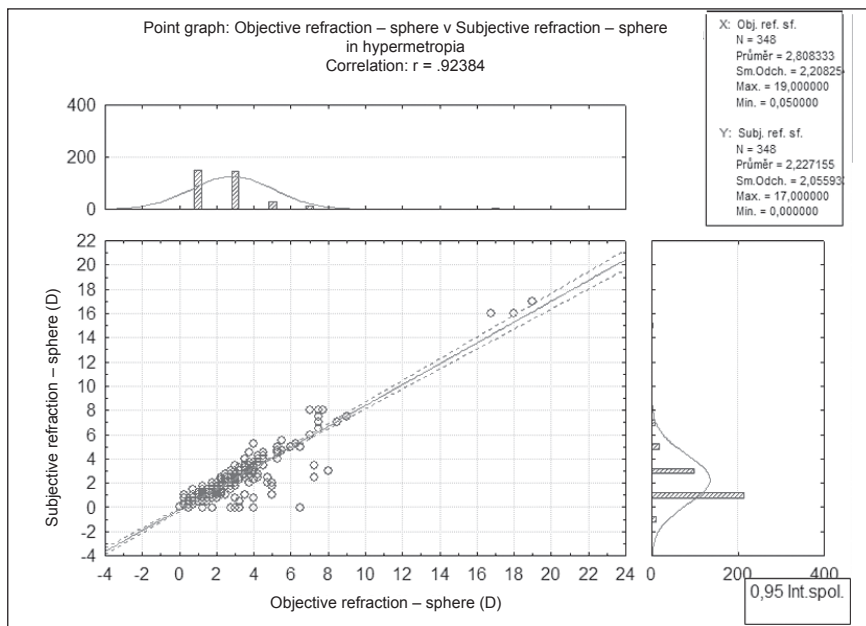
Graph 5. Comparison of objective and subjective values in spherical component (D) in myopia



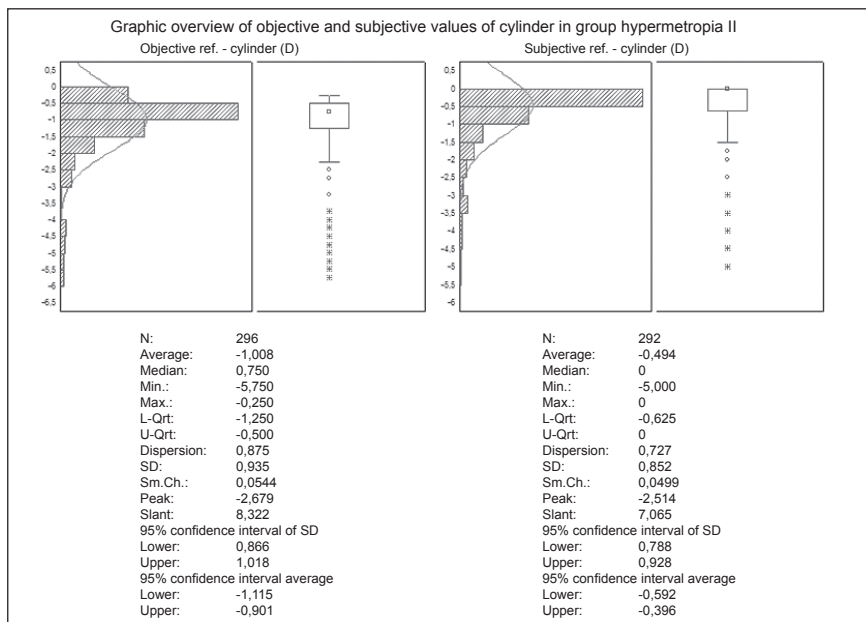
Graph 6. Comparison of objective and subjective values of cylinder (D) in myopia

frequently requested non-dioptic sunglasses, and also included those who used cosmetic coloured contact lenses. Unfortunately, in practice opticians do not only encounter such low values of the refractive condition of the eye. A combination of surfaces of glasses lenses with a higher astigmatism frequently results in an aesthetically poor appearance of the glasses as a corrective aid. As a result it is suitable to utilise software animation of the most state-of-the-art centring systems, which offer the option of visualisation of the specific product of the glasses lens, the parameters of centring into the selected frames and the values of

the maximal thicknesses in order to attain the required result [3-5]. For integration of the information and for a general assessment of the anterior segment of the eye, topography of the cornea was also performed on each subject using the above-named instrument. This enabled us to eliminate any potential pathological states and take into account the proportion of corneal astigmatism to general astigmatism. The software also automatically evaluated keratoconus screening. However, if we compare the value of the correction cylinder with the value of corneal astigmatism, as is evident from table 2, we find that



Graph 7. Comparison of objective and subjective values of spherical component (D) in hypermetropia II



Graph 8. Comparison of objective and subjective values of cylinder (D) in hypermetropia II

according to the measurement in our sample of the population, oblique corneal astigmatism predominates over direct astigmatism [7, 8].

CONCLUSION

From the determined values of correction of refractive errors we can concur with the manufacturers of glasses and contact lenses who state similar resulting measurements in their studies. This then forms the basis for their offer of ranges of optical strengths and products for correction of the given refractive error. However, we are frequently limited in the selection and design of a corrective aid. Although this applies for infrequently occurring refractive error values, in the case of correction of clients with high ametropia the selection is generally limited. Our aim is then to provide a quality, functional and aesthetic version of corrective aids. In this field also it is necessary to beware of the advertising and marketing tricks of certain vendors and retail chains, which do not always present true information. These relate to regular and special types of corrective aids, about which the client is not sufficiently instructed in advance.

In more complicated cases this concerns not only mere correction of the actual refractive error. These days, glasses are no longer a handicap, but rather as well as correcting the refractive error also complement the client's image. An important role in the correction of refractive error is also currently played by refractive surgery, and correct choice of method eases rapid rehabilitation of sight and return of the client to everyday life.

LITERATURE

- Beneš, P., Petrová, S. a Holoubková, Z.: Optická praktika. Elportál [online]. 1. vyd. Brno: Masarykova univerzita, vyd. 4. 10. 2010 [cit. 2010-10-04]. Dostupné z WWW: <<http://is.muni.cz/el-portal/?id=901008>>. ISSN 1802-128X.
- Beneš, P.: Lepší vizus díky asférické ploše. Česká oční optika. Praha: EXPO DATA, spol. s.r.o, 2011, 52(2), s.74–76, 3 s. ISSN 1211-233X.
- Efron, N.: Contact lens practice. 2nd edition. China: Butterworth Heinemann Elsevier, 2010. ISBN 978-0-7506-8869-7.
- Chen, M. J., Liu, Y.T., Tsai, C. C., Chen, Y. C., Chou, C. K., Lee, S. M.: Relationship between central corneal thickness, refractive error, corneal curvature, anterior chamber depth and axial length. Journal of the Chinese Medical Association, 2009, 72(3), pp. 133-137. ISSN 1726-4901.
- Kamiya, K., Shimizu, K. and Ohmoto, F.: Effect of aging on corneal biomechanical parameters using the ocular response analyzer. Journal of Refractive Surgery, 2009, 25(10), pp. 888-893. ISSN 1081-597X.
- Kolín, J. a kol.: Oftalmologie praktické ho lékaře. 1. vydání. Praha: Univerzita Karlova, 1994. ISBN 80-7066-861-X.
- Remon, L., Benlloch, J., Furlan, W.D.: Corneal and Refractive Astigmatism in Adults: A Power Vector Analysis. Optometry and Vision Science. 2009, 86(10), pp. 1182-1186. ISSN 1040-5488.
- Touzeau, O., Borderie, V., Loison, K., Allouch, C., Scheer, S., Chastang, P., Laroche, L.: Correlation between corneal topography and subjective refraction in idiopathic and surgery-induced astigmatism. Journal Francais d'Ophthalmologie, 2001, 24(2). ISSN 0181-5512.