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PREVALENCE OF MYOPIC SHIFTS AMONG PATIENTS SEEKING CATARACT SURGERY

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Abstract Modern cataract surgery by phacoemulsification is a widely accepted procedure with a rapid recov ery time. The prescription of specific intraocular lens, implanted during surgery, makes it possible to anticipate whether the patient will need reading glasses after the procedure. The present study analyses a sample of cataract surgery patients to show the frequency of myopic shifts related to nuclear opacity, which can result in clear near vision before surgery. A non-selected sample of consecutive patients who underwent elective cataract surgery in a private clinic was studied retrospectively. The myopic shift in refraction was assessed by comparing the old prescription with the spectacle correction at the time of interviewing.The mean age of the 229 subjects studied was 71.5 ± 10.4 years (109, 47.6%, males). A myopic shift in refraction, defined as at least – 0.5 diopters, was present in 37.1% of subjects (95% CI: 30.8%-43.4%). The mean change in refraction in these subjects was -2.52 ± 1.52 diopters. The percentage of subjects who had developed a myopic shift was significantly greater in those who presented greater nuclear opalescence. There were also differences in the mean myopic shift by refractive group, with the emmetropes having the greatest myopic shift. In this study of patients seeking cataract surgery in a clinical setting, more than one third had myopic shifts in refraction. This must be taken into account in order that patients maintain the benefit of clear near vision after surgery.

Key words: cataract, myopic shift

Resumen ***Prevalencia de cambios miópicos en pacientes con catarata***. La cirugía moderna de facoemulsificación del cristalino tiene una recuperación muy rápida. La elección correcta del lente intraocular que se coloca en la cirugía permite, muchas veces, anticipar si el paciente va a precisar anteojos luego de la cirugía. Este estudio analiza una muestra de pacientes con catarata, mostrando la frecuencia relativa de cambios miópicos que permiten a los pacientes ver de cerca sin lentes antes de la cirugía. Se estudiaron retrospectivamente una serie de pacientes consecutivos que realizaron cirugía electiva de catarata. El cambio refractivo miópico fue documentado comparando las prescripciones antiguas con la medición subjetiva al momento del estudio. Los sujetos fueron agrupados de acuerdo a la presencia o ausencia de cambios miópicos, y se estudiaron las proporciones con respecto a su grado de opacidad nuclear. La edad promedio de los 229 sujetos estudiados fue de 71.5 ± 10.4 años, 109 (47.6%) varones. Se halló un cambio miópico, definido como un cambio mayor de – 0.5 dioptrías, en 85 (37.1%, IC95%: 30.8-43.4%). El porcentaje de sujetos con cambio miópico fue significativamente mayor en aquellos que tenían mayor opacidad nuclear al tiempo del examen. En este estudio de pacientes no seleccionados que buscaban realizar cirugía de catarata, más de un tercio tuvo cambios miópicos en la refracción. Si el paciente lograba ver bien de cerca antes de la cirugía, esto debería ser tenido en cuenta a la hora de elegir un correcto lente intraocular para que el sujeto no pierda este beneficio de la catarata.

Palabras clave: catarata, cambios miópicos

Almost all subjects aged ≥ 50 have presbyopia (the need for near vision glasses), and more than half have hyperopia, a distance vision complaint that needs to be corrected with positive glasses or contact lenses. Subjects with mild myopia are an exception, since they need glasses for distance vision but can see clearly from close even at an older age. Thus, according to their refractive status, elderly persons require glasses either for distance vision, near vision or both. With increasing life expectancies, many people now face blurred vision produced by cataract, the opacification of the naturally ageing crystalline lens. Furthermore, the development of cataract may bring about a refractive change with ageing. The prescription of the appropriate intraocular lens in cataract surgery is therefore an opportunity to eliminate the need for spectacles.

The progression of visual loss in most cataract patients is slow, especially in the case of nuclear cataract, when it can be measured over a period of years. On the other hand, patients with posterior subcapsular cataract usually experience rapid and progressive impairment of vision, in many cases occurring over a period of a few months.

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In both cases, the surgical procedure is elective and not urgent, and the patient must be informed of all possible outcomes and complications.

Since the work of Brown in 1987, nuclear cataract has been related to myopic shifts in refraction in the clinic[1]. When these myopic shifts appear, emmetropes may gain near vision and hyperopes may no longer require their distance vision lenses. Recent cross-sectional and prospective population based studies of refractive error have addressed this topic[2-20]. These studies have shown that after age 70, cataract is significantly associated with an increased prevalence of myopia and with a myopic shift in mean refractive error of the studied populations. Yet, these studies have not reported the proportion of subjects who undergo this cataract-related myopic shift to see how frequent it is in the clinic. Although there have been several clinical studies of cataract and their risk factors [1, 1-27] only one has reported a 50% prevalence of this cataract-associated myopic shift[28]. The present study analyses a clinical sample of patients who underwent cataract surgery in a private practice setting to show the prevalence of this myopic shift and its associations with refractive error.

Materials and Methods

This study was performed at the San Luis Medical Center in Buenos Aires City. It consisted of a retrospective analysis of the records and protocols of consecutive patients who underwent cataract surgery during the years 2005-2007. Subjects gave written informed consent and the Ethics Committee of the Argentine Counsel of Ophthalmology was consulted for approval. The tenets of the Declaration of Helsinki were followed. Ophthalmologic tests performed before surgery included present subjective refractions and best corrected visual acuity measured with a Snellen optotype projector (Topcon ACP-5D, Topcon, Japan). Previous refractions were studied by measurement of the subject's old spectacles or were taken from clinical records when available. The ocular exam continued with the measurement of ocular pressure and the subjects were dilated with one drop of 1 % tropicamide solution. After 20 minutes, the anterior segment was studied grading the cataract according to the photographs of the international LOCS III grading system[26]. Nuclear, posterior subcapsular and anterior cortical cataracts were graded by one ophthalmologist (RI) comparing the actual slit lamp image with the photographs of the mentioned grading system. Then, keratometry was measured with an auto-refractor (Topcon KR3000, Topcon, USA) and biometry with a contact probe (Ocuscan, Alcon, USA) and all data registered in the protocol.

The eye with the worst best corrected visual acuity was used for the analysis. Age was treated as a continuous variable. The refraction previous to the myopic shift caused by cataract was used for defining refractive groups. Myopia was defined as a spherical equivalent (SE) of less than – 0.50 diopters, hyperopia as a SE of greater than + 0.50 diopters, and the remainder were considered emmetropes. Anisometropia was defined as an SE difference between the right and left eyes of more than 1.0 diopter. Nuclear cataract was classified in six grades of increasing opalescence following the photographs of the LOCS III system, and a cut point between low or high amounts of opacity was established at grade 4. Cortical and subcapsular cataracts were classified as present or absent. If a subject had a change in refraction of 0.50 diopters or more from their old prescription he was classified as having a myopic shift; if not he was considered to have stable refraction.

The proportion of subjects with or without myopic shifts were studied according to the different refractive groups and cataract types. For these proportions, chi square analyses were performed. As age was a normally distributed numeric variable, an analysis of differences in age for each refractive group was assessed by ANOVA with Scheffe post hoc tests. Non-parametric tests were used in the analysis of mean refractive error, a variable in which normality could not be confirmed. All p values were considered statistically significant at $p < 0.05$. Data analyses were performed with statistical software (SPSS version 15.0, SPSS Inc., Chicago, IL, USA).

Results

During the study period 293 clinical records of cataract patients were available. The actual studied sample consisted of the worst eye of 229 subjects (78.2%). Twenty-two subjects were excluded because one of their eyes had already been operated on and it was thus not possible to determine the worst eye, 15 subjects that had became myopic because of cataract were excluded due to incomplete data on previous refraction, 11 were excluded due to incomplete protocols, 4 due to white mature cataracts, 3 due to dense cataracts with hands movement visual acuity, 4 because they had previously undergone refractive surgery, and the remainder due to pathologies such as a blind eye due to glaucoma or a history of retinal detachment surgery.

The mean age of the studied sample was 71.5 ± 10.4 years, and 47.6% were men.

There were 60 myopic subjects, 38 emmetropes and 131 hyperopes; the percentage of those with high myopia (> -6 diopters) was 6.1%. The mean decimal visual acuity of the worst eye was 0.29 ± 0.15. Anisometropia greater than 1 diopter was present in 31/229 (13.5%) of the refractions previous to the myopic shift, and in 62/229 (27.1%) of the actual refractions after the myopic shift.

The percentage of subjects with each type of cataract are presented in Table 1. Nuclear opacity grade 5 or more was present in 114 subjects (49.8%). Of these, 83 (36.3%) had nuclear opacity grade 5 or more with no other type of cataract and 27 (11.8%) had nuclear opacity associated with posterior subcapsular cataract. There were only 2 subjects with grade 5 or more nuclear opacity who had simultaneous anterior cortical and posterior subcapsular cataract. There were 36 (15.7%) subjects with low nuclear opacity (NO grade 2 or 3), but of these 25 had posterior subcapsular cataract and 8 had anterior cortical cataract. The nuclear opacity grading was symmetrical in 63.8% of cases.

The mean age of high myopic subjects was younger than that of the other refractive groups (63.7 ± 11.2 years)

but these differences were not significant (for example, high myopes *vs.* emmetropes, ANOVA, p = 0.783). A myopic shift in refraction of – 0.50 diopters or more had occurred in 85/229 (37.1%, CI 95: 30.8-43.4%) of the worst eyes. The mean change in refraction for the whole sample was – 0.94 ± 1.5 diopters, and the mean change in refraction for subjects with a myopic shift was – 2.52 ± 1.52 diopters. The distribution of myopic shifts is shown in Fig. 1.

There were differences in the mean myopic shift by refractive group (Table 2), with the emmetropes having the greatest myopic shift. The differences in myopic shift between myopes and emmetropes (p = 0.004) or hyperopes (p = 0.025) were significant (Mann-Whitney Test). Accordingly, the myopic subjects had a significantly lower percentage of myopic shifts than the other refractive groups (Table 3, Chi Square 8.32, p = 0.004). There were no significant differences in the percentage of subjects with myopic shifts between sexes (Chi Square 4.53, p = 0.5) or between older and younger subjects (Chi Square 0.478, p = 0.48). There were no differences between refractive groups in the severity of nuclear cataract (p = 0.1) nor in the presence of posterior subcapsular cataract (p = 0.37).

There was a significant difference in the percentage of subjects with a myopic shift according to nuclear opalescence, with those having greater nuclear opalescence showing a greater percentage of myopic shifts (Table 4, Chi Square 16.14, p < 0.001). Subjects who had posterior subcapsular cataract had a significantly lower percentage of myopic shifts than those who did not (Table 4, Chi Square 9.07, p = 0.003). In this sample, an inverse relation was found between the presence of posterior subcapsular cataract and greater nuclear opacity (Chi Square 19.38, p < 0.001).

TABLE 1.– *Percentage of subjects with the different types of cataract (N:229)*

	N	%
Nuclear cataract		
up to grade 4	115	50.2
grade 5 or more	114	49.8
Posterior subcapsular		
Absence	138	60.3
Presence	91	39.7
Anterior cortical		
Absence	198	86.5
Presence	31	13.5

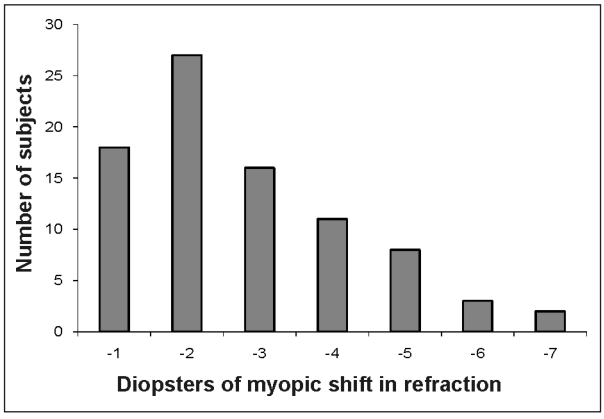

Fig. 1.– Histogram showing the distribution of the myopic shifts in refraction

Discussion

Modern cataract surgery, performed by phacoemulsificacion with a small incision (usually less than 3 mm) has a very rapid recovery time and a low incidence of complications. Complete recovery is usually achieved within few hours after surgery and the patients are able to continue with their usual tasks. Foldable monofocal intraocular lenses (IOLs) allow correction of either distance or near vision, while multifocal IOLs allow simultaneous correction of distance and near vision with a small decrease in the quality of vision. Before surgery, the patient and surgeon should discuss the benefits of the different types of IOLs and decide which lens will be used during surgery. Careful preoperative studies, such as keratometry and biometry, allow precise calculation of postoperative residual refractive error. Some patients prefer not to use glasses after surgery, while for others requiring eyewear is not a concern. Many myopic subjects are happy reading without glasses and would like to continue doing so after surgery.

TABLE 2.– *Mean myopic shift for refractive groups (diopters ± SD)*

Myopic	– 0.60	± 1.36
Emmetropic	– 1.47	± 1.90
Hyperopic	– 0.94	± 1.45
SD: Standard deviation		

TABLE 3.– *Percentage of subjects with myopic shifts according refractive groups*

	Myopic n = 60 %	Emmetropic n = 38 %	Hyperopic n = 131 %
with myopic shift	21.7	50.0	40.5
no myopic shift	78.3	50.0	59.5

TABLE 4.– *Percentage of subjects with nuclear opalescence (NO) and posterior subcapsular cataract (PSC) according to myopic shifts*

		With myopic shift	No myopic shift
NO up to grade 4	n = 115	24.3%	75.7%
NO grade 5 or more	n = 114	50.0%	50.0%
Without PSC	n = 138	44.9%	55.1%
With PSC	n = 91	25.3%	74.7%

Myopic shifts in refraction are thus important in clinical ophthalmological practice as they represent a benefit for many patients who experience this "second sight". With the myopic shifts produced by cataract many presbyopic subjects recover their near vision without glasses, and are happy with this change in their vision. Subjects undergoing cataract surgery with monofocal lenses may lose this benefit, and it is important that they be advised of this to avoid postoperative complaints. Brown established that there was an association between cataract and myopic shifts in refraction[1]. He showed, retrospectively, that it was not the myopia that predisposed to cataract but that it was the cataract that predisposed to a myopic shift. He also showed that this myopic shift was related to nuclear cataract and not to cortical or posterior subcapsular cataracts. At the time of Brown's study, the modern grading systems of lens opacity were not available, so he could not investigate the possibility of a relation between the amount of opacity and the myopic shift as has been done in the present study.

Many cross-sectional and prospective population studies of refractive error in adults[2-20] have shown nuclear opacity to be related to myopic shifts in refraction or to an increasing prevalence of myopia in the ageing population. One, the Tanjong Pagar Survey in Singapore[11] even showed that nuclear cataract was associated with myopia but not with any specific biometric component. A previous study in a clinical sample of cataract surgery patients showed that nuclear opacity was related to a myopic shift in refraction while posterior subcapsular cataract was no [28]. This study was performed in a similar but smaller clinical sample than the present study, and reported myopic shifts in relation to nuclear opacity in 50% of subjects. Interestingly, in both studies this myopic shift was not present in all patients with nuclear cataract, and its causes remain unclear. If we had included the 15 subjects who were missing data on their myopic shifts, the prevalence of myopic shifts reported here would have increased to 40%, a figure similar to that found in the previous study[28].

Population studies using different lens opacity grading systems (graded from clear lenses to dense cataracts) have compared subjects without clinical cataract to those with clinical cataract with arbitrary cut points for defining the presence of significant nuclear opacity. These population-based studies confirmed that nuclear cataract was associated with myopic shifts in refraction. In the present clinical study of cataract patients, the sample was split into two even groups, one that had cataracts with a moderate amount of nuclear opacity (up to grade 4) and the other with high nuclear opacity (grade 5 or more). In both, greater nuclear opalescence was related to a greater prevalence of myopic shifts.

One interesting difference in the present study with respect to population studies is the fact that an inverse relation was found between the presence of posterior subcapsular cataract and greater nuclear opalescence. This may be due to the fact that a clinical sample was used in the present study. Typically, cataract patients complain of low visual acuity in one or both eyes. It is conceivable that posterior subcapsular cataract causes patients to seek medical assistance earlier due to the large vision impairment, and before considerable nuclear opacity has developed. In comparison, patients who develop nuclear cataract alone could seek assistance later with fewer vision complaints. It is thus possible that a clinical sample induces a segregation of the subjects with these two different types of cataract.

The Blue Mountains Eye Study reported a mean myopic change of – 0.96 diopters after 10 years of follow up in subjects with nuclear cataract grades 4 or 5 at baseline[19]. Although the present study was not prospective, a similar average myopic shift of – 0.91 diopters was found in eyes with cataract. But when only eyes with myopic shifts were considered, the mean myopic shift was greater than two diopters. These amounts of myopic shift can be seen in clinical practice, and are responsible for the "second sight" observed in emmetropes and can cause moderate hyperopes to abandon their distance vision lenses[29-30].

In the present study, the analysis made according to refractive groups revealed that myopic shifts were not very common amongst myopic subjects. Also, a significantly less intense myopic shift was observed in myopic subjects compared to that seen in emmetropes or hyperopes and is reported here for the first time. It is difficult to explain

these findings. Perhaps the lens in myopic subjects is less prone to change with ageing. During the presbyopic years, myopic eyes have been shown to have more stable refractions than emmetropic or hyperopic eyes[31]. In the present sample, the greatest amount of mean myopic shift was developed in emmetropes (– 1.47 diopters).

It is possible that this myopìc shift is related to an increase in the refractive index of the lens nucleus. The stiffness of the lens nucleus has been shown to increase with age and with nuclear but not cortical cataract[32]. It is well known by ophthalmic surgeons that the color and opalescence of the nucleus predicts the intraoperative stiffness that will be found during cataract phacoemulsification surgery. The refractive index is not related to stiffness but depends on the protein concentration and water content in the lens[33]. Yet it is unknown why some nuclear cataract subjects have a myopic shift while in others, refraction remains stable. A recent study found that the total water content in the center of lenses with advanced nuclear cataract was slightly lower than in normal lenses[3], and that this could perhaps alter the refractive index of the lens with cataract. Further research is needed to answer these questions.

In conclusion, this study of a clinical sample of patients seeking cataract surgery has shown that about 40% have myopic shifts in refraction at the time of surgery. These shifts are more frequent and of greater magnitude in emmetropes and hyperopes than in myopes. Greater nuclear opacities are related to these myopic shifts. Posterior subcapsular cataract was not related to these myopic shifts and was inversely related to nuclear opalescence in this clinical sample. This may be because posterior subcapsular cataract produces rapid impairment of vision before the nuclear cataract is established. It is possible that subjects seeking surgery for posterior subcapsular cataract have milder nuclear opacities in a clinical setting. These findings may have importance for ophthalmic surgeons planning cataract surgery, as suggesting the appropriate intraocular lens for a patient will enable them to avoid complaints caused by the loss of near vision after surgery.

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Conflict of interests: All authors declare no conflict of interest towards the subject matter of this paper.

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LA TAPA

Zulema Maza. ***La vertiente***, 1995

Técnica mixta. 180 x 150 cm. Cortesía de la Comisión Nacional de Energía Atómica, Predio TANDAR, Centro Atómico Constituyentes. Presidente de la Comisión Organizadora de la Exposición Permanente: Dr. A.J.G.Maroto.

Participó en numerosas muestras individuales y colectivas tanto en el país como en el exterior, y en bienales internacionales. Entre éstas figuran las siguientes: Museo Nacional de Bellas Artes, Museo de Arte Contemporáneo de Chile, Museo de las Artes de Guadalajara (México), Museo Sofía Imbert (Caracas), Centro Cultural Borges, G. Regard (Ginebra*), Palais de Glace*, *S. de la Jeune Peinture* (Paris) y otras. Premios seleccionados: Beca Miró (España), Mención Instalación (Congreso Internacional de Críticos de Arte), Experiencias (Asociación Críticos de Arte), Primer Premio Nacional Manuel Belgrano, Primer Premio Miró, Beca para las Artes UNESCO, Nominé, y Diploma Konex de Artes Plásticas[1].

[1]*Comisión Nacional de Energía Atómica. Artistas Plásticos con la CIENCIA, 103.* Centro Atómico Constituyentes, Predio Tandar, Buenos Aires, 1999; p 107