IOL Calculation After Myopic Corneal Refractive Surgery, Story of A Problem and Resume of Its Solutions

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After more than 60 years from the first intraocular lens (IOL) introduction, cataract phacoemulsification with IOL implant has become the most performed surgical procedure in medicine all over the world. From the first steps to our time, many improvements have been observed. Rate of intra operative complications and post-operative infections remarkably decreased; improvements of the surgical techniques, of the surgical equipment and devices allowed surgeons to provide always better results to the patients. If 15 years ago, surgeons accurately evaluate the opportunity to perform phacoemulsification in patients, waiting for a significant decrease of the best corrected visual acuity (BCVA), today patients strongly ask for surgery even with a little impairment of the visual acuity [1]. Current techniques, drugs and device make this surgical procedure very often to be very satisfying both for patients and for surgeons but these results have made patients always more demanding, particularly about visual acuity without spectacles. Today patients accept the idea to use spectacles for far vision always with more dissatisfaction. This is the reason, more accurate formulas have been developed to precisely calculate IOL power, in order to reach emmetropia as often as possible [1]. Every formula works using some ocular morphological parameters: corneal curvature, axial length, and anterior chamber depth. It is easy to imagine that improving the accuracy in measuring these parameters, allow the formulas to be more accurate. A very strong improvement in this field has been observed after the introduction of laser interference biometry (LIB) in eye visit practice after the diffusion of the IOL Master (Zeiss, Germany). This device, just from the first versions, allowed physicians to perform very accurate evaluation of corneal curvature, axial length and anterior chamber depth, with higher reliability of Javal keratometer and easier than ultrasound biometry. After IOL Master, other devices with similar way of working have been developed, always trying to reach more precision in IOL calculation.

Another kind of surgery that have had an huge diffusion, in last 30 years, is refractive surgery. After some not excellent results with the corneal incisional surgery, the use of excimer laser (with both techniques: PRK and LASIK) has provided effective and stable results with great satisfaction both of patients and of surgeons. In this field too, technology advances allow always better results with enlargement of inclusion criteria for the surgery and the consequently increase of the patients that undergone laser refractive surgery [2]. The problem started after that the first patients who underwent refractive surgery had to face cataract one. In these cases, the ones that had PRK or LASIK for myopia obtained a hyperopic, and sometimes a very high one, refraction after cataract surgery and IOL implant. These results were even more disappointing in patients that previously underwent surgery to not use spectacles [3].

How this could be possible? Researchers largely studied this complication, many causes have been supposed and many solution purposed. Today we can say that the causes of the lack of accuracy of IOL calculation in these kind of patients are: (1) the inability to calculate the exact anterior corneal curvature by current available devices, (2) an invalidate keratometric index due to a change of relationship between the anterior and the posterior corneal surface, (3) an unreliable prediction of the effective lens position (ELP) calculated by the corneal curvature [4].

In my opinion, the first one is the most important one. In fact, the last developed instruments to measure corneal power too are lacking precision after myopic refractive surgery, in particular to overestimation of this parameter that lead to an underestimation of corneal power if used with the formulas used to calculate IOL power in routine cases.

To overcome this problem, many new formulas, methods and correcting factors have been purposed. The first one to obtain reliable results has been described by Eiferman and Holladay in the 1989 the "Clinical History Method" based on the knowledge of the preoperative keratometry, refraction and post refractive surgery refraction, this method was the gold standard for long time [5]. One of the problem of this method was the needing of data of the eye before refractive surgery.

Because sometimes many years occurred between the two events (refractive and cataract surgeries), it was not so simple to find the data required by the Clinical History Method. This is one of the reason of the research of new methods and formulas to solve this problem.

Even if new diagnostic device able to evaluate corneal curvature in different ways have been introduced, no one showed to be reliable after myopic refractive surgery: overestimation of corneal power has been always observed with the last developed ones too. Specific correcting factor to apply to specific devices have been suggested by researchers to improve reliability of them [6,7].

Many other methods requiring knowledge of pre-refractive surgery data have been purposed, [8] but in the last years method that do not need these data become available, the first one has been purposed by Rosa., *et al.* [9] Reliability of this last family of formulas has been proved to be comparable or superior to the to the ones requiring knowledge of parameters of the eye before refractive surgery [10].

Reviewing the international literature about this topic is possible to read many solutions to this problem, usually this means that the real one has not yet been obtained [10].

Often is very hard to compare the different papers published because of a lack of standardized methodology. Populations of the studies may be very different and statistical methods used to evaluate the results too, to include only one eye of patients should be better to reduce the inner correlations between even organs, otherwise a compensation statistical method should be used. Moreover, when results are evaluated, usually mean of the refractive error after cataract surgery was used but this could lead a compensation between hyperopic and myopic refractions, so it should be more reliable to use the median of absolute error, after converting the negative refractions in positive ones, in order to understand the real distance from emmetropia. About this aspect, should be always important to highlight that if two methods provide same absolute error from emmetropia, the one with a prevalence of myopic refractions should be preferred because of the much more compliance pseudophakic patients have for myopic defect compared to the hyperopic one. Usually studies published are multicenter one, so different IOL with different constant were used, to compare them is due to take in consideration the differences in constant to not bias the results. Moreover, the different IOL used during surgery will take place at different effective lens positions (ELP), making even more difficult to compare the results obtained. Another aspect of the difficulties of accurately evaluating reliability of a purposed method, and to compare them, is that physicians rarely have IOL power that should provide the actual emmetropia. When a IOL power calculation is performed and target refraction is emmetropia, but I could be every refraction, it is very hard to observe a power value that the formula suggest to reach exactly the target. Usually we have to choose between two of the closest values. In routine cases and in clinical practice, of course this is not a big problem. Otherwise when we want to accurately compare results coming out from different formulas, it is needed to take in account the residual refractive error due to the power range of the IOLs. This is possible, knowing the stabilized refraction after cataract surgery and the power of the implanted IOL, according to Feiz., *et al*. a variation of 1 D in the IOL power is providing a 0.7 D variation in the manifest refraction, so to know the power of the IOL that should have provided actual emmetropia in one case it is needed to add 70% of the residual refraction to the power of the implanted IOL [11].

This procedure should delete the bias of the limitation of IOL power range available.

Today it is possible to read many formulas that try to solve this problem and some of them provide very good results, as it is possible to read in published papers [10]. It is important to pay so much attention to the new formulas purposed but even more to the papers that

verify their reliability. In overall medical literature, it is possible to find many methods with very strong theoretical basis that failed in be safe and effective in clinical practice. Because every cataract surgeon has to handle a patient and his expectations, it is very important to use formulas with effective refractive results verified on large series of patients and not just supposed on fancy theoretical basis.

Among proved to be reliable methods and formulas, it is important to choose the one more suitable for the needing of the case we are facing, some of them work only with data coming from specific diagnostic device moreover some are providing better results in eyes with specific characteristics, such as axial length ranges.

The definitive formula for the IOL power calculation after myopic refractive surgery that would be universally adopted should be reliable, accurate in calculating the residual refraction, easy to apply, without limitations related to devices to use and/or needing of parameters often hard to recover and available in much more (optical or ultrasound) biometers possible.

Analyzing the current options available, it seems we are pretty close to this ideal formulas and it is easy to imagine that researchers will develop it very soon.

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