Hoffer Formulas

43

Kenneth J. Hoffer

Introduction

This is a personal history of my intraocular lens (IOL) power formula developments since 1974. I had always been fairly good at math and physics in high school and college, and I was driven by the competition I faced starting a new practice in Santa Monica, CA, which had a more than adequate supply of cataract surgeons. My goal was to get the best possible postoperative refraction results to compete in that environment.

In the Spring of 1974, I was planning to do my first IOL and to use a new Kretz 7200MA A-scan immersion ultrasound unit recommended to me by Karl Ossoinig [1] (Iowa City, IA) to measure the axial length (AL) so I could calculate the IOL power (P) that I would need to make the patient emmetropic. To begin, I needed a formula.

The Hoffer-Colenbrander Formula [First Generation]

For advice on a formula to use, I contacted Dr. Cornelius Binkhorst (Terneuzen, Holland) (famous for the Binkhorst 4-loop IOL and leading us to extracapsular implantation with his 2-loop iridocapsular lens). He recommended what he was using, a formula by Prof. MC Colenbrander (Leyden, Holland), which had just been published in the 1973 British Journal of Ophthalmology [2].

When first trying to use his formula, I found it very cumbersome and I needed to convert the formula in three important ways. First, I redefined the parameters of the formula to *A* = axial length (in mm), *K* = average corneal power (in diopters (D)), *C* = anterior chamber depth (in mm), and *P* = IOL power (in D). Secondly, I had to change parts of the formula so that it would be able to accept the axial length (AL) and anterior chamber depth (ACD) in millimeters rather than meters. In the early 70s, we all used a standard 3.5 mm for the ACD for the prepupillary IOLs and 2.95 for all anterior chamber (AC) lenses.

Finally, and most importantly, I added a factor R to the corneal power (K) in the formula; R being the postoperative (PO) spherical equivalent (SE) refractive error in diopters (D) at the corneal plane. I considered that the refractive error could be treated as a contact lens on the cornea, and its value could be algebraically added to the power of the cornea. I then recognized the need to correct R from a vertex distance of 12 mm (in the spectacle plane) to the plane of the cornea (0 mm). Now, the formula could calculate the IOL power for any desired postoperative refractive error instead of just for emmetropia (*R* = 0) (Table 43.1). This became

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Table 43.1 Formulas developed by the author (1974–2020)

1974: Hoffer Emmetropia/Ametropia formula

P = (1336/(AL-ACD-0.05))−(1.336/((1.336/(K + R))−((pACD +0.05/1000)))

Where *R* = Rx/(1–0.012*Rx)

$$P=\frac{1336}{A-C-.05}-\frac{1.336}{\frac{1.336}{K+R}-\frac{C+.05}{1000}}$$

Where *P* = IOL power (D), AL = axial length (mm), ACD = anterior chamber depth (epithelium to the lens, mm), *K* = average K (D), Rx = desired or PO refractive error in glasses (vertex 12 mm), and *R* = refractive error at the corneal plane (both D).

1974: Hoffer Refractive Error formula

$$R=\frac{1.336}{\frac{1.336}{\frac{1336}{A-C-.05}-P}+\frac{c+.05}{1000}}-K$$

R = (1.336/(1.336/(1336/(AL−ACD−0.05)−*P*) + (ACD + 0.05)/1000))−K

Where Rx = R/(1 + 0.012*R)

1974: Hoffer Axial Length formula

AL = 1336/(P + (1.336/((1.336/(K + R))−((ACD + 0.05)/1000)))) + ACD + 0.05

Where *R* = Rx/(1–0.012*Rx)

1974: Hoffer Iseikonia

$$I=\frac{1336}{L-C-.05}-\frac{1.336}{\frac{1.336}{K+S}-\frac{C+.05}{1000}}$$

I = (1336/(L-ACD-0.05))−(1.336/((1.336/(K + S))−((ACD + 0.05)/1000)))

Where *I* = iseikonic IOL power, *A* = axial length, *L* = axial length of the other eye (L-0.657 only if eye is phakic), *K* = corneal power, ACD = anterior chamber depth, *P* = IOL power, Rx = refractive error, *S* = refractive error of other eye.

1978: Hoffer + Axial Length-dependent ELP

Hoffer formula using ACD = 2.92*AL−2.93

1993: Hoffer Q formula [Hoffer Formula using an ELP prediction formula (Q formula) based on AL and Tangent of K]

Hoffer formula but ELP is calculated by the Q formula for ELP below:

ELP = pACD +0.3(AL-23.5) + (tan K)^2 + (0.1 M*(23.5−AL)^2 * (tan(0.1(G-AL)^2))−0.99166

Where M and G are limiters for AL values in the Q formula ONLY.

If AL ≤ 23, *M* = 1 and *G* = 28. If AL > 23, *M* = −1 and *G* = 23.5. If AL > 31, AL = 31. If AL < 18.5, AL = 18.5

MOST IMPORTANT: The above limits *only* apply to the Q formula.

Solving for pACD by back calculation requires a quadratic equation:

$$\mathrm{pACD}=\left[\frac{A+N-\sqrt{(A-N)^2+4\left[\frac{\frac{N-A}{P}}{1336}\right]}}{2}\right]-.05$$

pACD = ((AL + N−SQRT[(AL−N)2 + 4((N−A)/(P/1336))])/2–0.05

where *N* = 1336/(K + R) and *R* = Rx(1–0.12*Rx)

Table 43.1 (continued)

2004: Hoffer H [Holladay 2 formula simplified] In the Holladay 2 formula, an estimated scaling factor (ESF) multiplies the ELP. $\text{Log}(ESF_p) = +1.18 \log(AL_p/23.45) - 0.89 \log(43.81/K_p)^2 + 0.28 \log(CD_p/11.7)^2 - 0.18 \log((ACD + LT)/(ACD_p + LT_p) + 0.21 \log((1\text{-}Rx*[Rx])/400)$ If LT is unknown use: $LT_p = 4 + Age_p/100$. $ELP_p = SF*ESF_p$. The above is the reason for entering the age of the patient. ESF_p = inverse log of $[\log(ESF_p)]$ where $_p$ = patient's value. In the Hoffer H formula, we replaced his standard biometric values with ours and deleted the entry of the patient's preoperative Rx. $\text{Log}(ESF_p) = +1.18 \log(AL_p/23.65) - 0.89 \log(43.81/K_p)^2 + 0.28 \log(CD_p/11.52)^2 - 0.18 \log((3.24 + 4.63)/(ACD_p + LT_p)$ Final ELP = ELP*ESF
2015: Hoffer H-5 [Hoffer H formula using gender and race of patient] We replace the standard biometry values (AL, K, ACD, and LT) in the Hoffer H formula (above) with the averages for the gender and race of the individual patient using the biometric race and gender values of our published study [3].
2020: Hoffer QST See text

what I called the "Hoffer-Colenbrander" formula for several years until Dr. Robert Drews (then President of ASCRS) recommended that I call it simply the Hoffer formula because it really was no longer the Colenbrander formula.

Because of the R factor, the Hoffer formula could now, by back calculation, be used to calculate the PO refractive error resulting from any given IOL power. I also wrote an iseikonic (equal image size in both eyes) formula based on the written recommendations made by Colenbrander in his article (Table 43.1). I tried to publish these formulas but were rejected by all the journals I submitted them so I gave up. At that point in time, respected journals were not interested in publishing anything to do with IOLs. The fact that I was completely unknown did not help either. So, in 1975, I had to start a journal (JCRS) to publish my first paper on lens calculation [4]. Unfortunately, the formulas I had written were not published [5] until 1981, 7 years after they were written, in a less prominent journal that no longer exists (Ophthalmic Surgery).

Adding the First AL-Dependent ACD [Second Generation]

We obtained reasonably good results with the formula for that era, but in 1978, I performed an analysis of the relationship between the AL and the 3-month PO ACD measured by a Haag-Streit optical pachymeter. It was published later in 1983 in a textbook by Jared Emery [6] and in 1984 [7], in a short-lived publication submitted only at the plea of the Chairman of my residency program, Dr. Robert Jampel (the Editor). The results showed a direct relationship (r = 0.67) between the AL and ACD (Fig. 43.1). A regression formula resulted such that the PO ACD could be estimated by first multiplying the AL by 0.292 and then subtracting 2.93 (Table 43.1).

The problem was that this regression formula was only good for that one IOL style I was using. I (or others) would have to repeat this for every other IOL model making it not universally useful for others. This AL-dependent prediction of the ACD was later defined by Holladay as the first second-generation formula. Later, Richard Binkhorst (New York, NY) also took this into

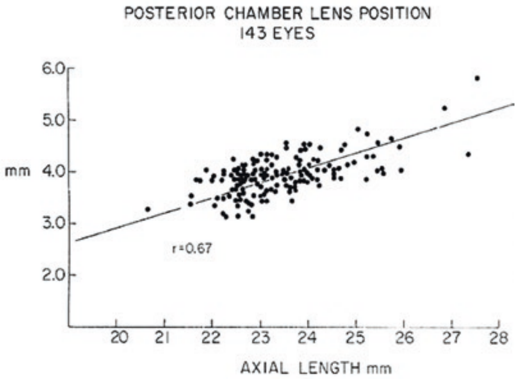


Fig. 43.1 Measurement of the anterior surface of the cornea to the anterior surface of the posterior chamber lens implant (ACD) in relation to the axial length of 143 eyes with a one-piece PMMA posterior chamber lens fixated in the bag, from 1978

consideration but used a different formulation to accomplish it. In 1988, Sanders did the same with the SRK regression formula, calling it the SRK II [8], but by that time it was a little too late for regression formulas.

The Hoffer Q Formula [Third Generation]

In 1988, Holladay [9] introduced the first third-generation formula, which made the predicted ACD dependent on the AL and the K. It made sense to me, as the cornea became steeper (higher K reading) the ACD was deeper. Unfortunately, he used R. Binkhorst's formula for his base instead of the Colenbrander. He used a Fyodorov formula to calculate a predicted corneal height (distance from anterior cornea to iris plane). To get an ACD (or estimated lens position (ELP)), he had to determine the remaining distance from the iris plane to the principle plane of the IOL, a distance he called the surgeon factor (SF). Since this distance could not be measured preoperatively, he calculated it from a series of PO patients and used the average value for future calculations. This required him to solve the quadratic formula for ACD and SF.

After analyzing my results comparing the Hoffer-AL and Holladay formulas, I found the Holladay to be more accurate in a series of 153 eyes (unpublished). I thus planned on using only his formula in the future, but Holladay strongly urged me to update my formula and make it so it could be personalized, for which I have since been incredibly grateful.

So, with a Casio programmable calculator in hand, I worked on an ACD prediction algorithm using the AL and K during our family vacation in Florida. The calculator has memory banks labeled from A to Z, and I started by placing my first iteration of a trial formula in memory bank A. After many iterations [10], it was the memory bank Q that I used to store the final successful ACD trial formula using the tangent of K. I became so accustomed to going to the Q memory bank, I decided to call this ACD prediction method the Q formula, and thus, it became the Hoffer Q formula [11] (Table 43.1). Holladay recommended I call it the Hoffer 2 and come up with a new variable termed the Hoffer ACD factor that would be akin but not equal to his SF. I decided against that for three reasons. First, the base Hoffer formula had not changed since 1974 and therefore should not be referred to as a "Hoffer 2." Secondly, I had changed the calculation of ACD input 10 years earlier (ACD = 2.92AL−2.93) and now was simply changing it again by using the new Q formula. Thirdly, I did not want to create a new IOL-dependent lens constant that would be as alien to most ophthalmologists as the SF was when it was first introduced. The world had three lens constants (ACD, A-con, and SF) and that was enough. I wanted to use a value everyone was familiar with, the ACD, calling it the personalized ACD (or pACD). To solve for ACD and enable personalization, I too had to solve for it using the original base Hoffer formula. This required solving a quadratic equation (Table 43.1). After weeks of frustration trying to do it myself, I finally gave up and it was done for me by Lincoln Chase PhD of the mathematics department at UCLA. Years later, Holladay admitted to me that he had to get a Baylor University math professor to do it for him also. Math is not always easy.

For the Q formula, I did not use the Fyodorov corneal height calculation; instead, I used a tangent of the K. Before publishing the Hoffer Q formula, I needed to perform a study to show that it was superior to the Holladay and SRK/T [12]. I input the surgical data and biometry of 450 eyes in which I had implanted a Jaffe 6-mm one-piece PMMA lens in the capsular bag. This would be the largest uniform series of eyes operated on by one surgeon, using one lens style and the same biometry instruments and surgical technique. The results revealed that the Hoffer Q was statistically equal to the Holladay, but not better. It was statistically superior to the SRK I and II but not the SRK/T even though it appeared to be clinically more accurate.

I decided to analyze the effect of AL on the three theoretic formulas. I started by defining AL ranges as short (<22 mm), normal (22–24.5 mm), medium long (24.5–26 mm), and very long (>26 mm), which are now used by most researchers. My results showed that the Hoffer Q was more accurate than the other two in eyes shorter than 22.0 mm, but because of the small number of short eyes in that range (36), I could not show statistical superiority (which was often noted by Holladay in his presentations). To further verify this result, I asked Dr. James Gills to provide me with biometric data on short eyes and his staff (Myra Cherchio) was able to provide me with data on 830 eyes shorter than 22 mm and a repeat analysis on this series showed Hoffer Q to be statistically more accurate ($p < 0.0001$) than the Holladay and SRK/T formulas in short eyes, which unfortunately I never had time to publish. In 2011, Aristodemou [13] finally published the statistical superiority of the Hoffer Q, but in eyes shorter than 21.0 mm, in his landmark 8,000 eye large study from the UK.

In response to this, in 1996, Holladay developed the Holladay 2 formula (never published), which calculates a scaling factor (ESF) for the estimated lens position (ELP) by using the logarithms of the preoperative AL, K, the corneal diameter (CD), the anterior segment length (ASL) (composed of lens thickness (LT) and ACD), and preoperative refractive error using mean values for those parameters to better predict the postoperative IOL position. I had taken a photograph of the structure of the formula during an ASCRS course he gave where he first described it and stated it would soon be published. Thomas Olsen (Aarhus, Denmark) had proposed the use of most of these same parameters in his Olsen formula [14, 15] a decade earlier. I did not pursue these concepts because I felt it would be difficult to get ophthalmologists to obtain a measurement of ACD, LT, and CD on every routine cataract. Of course, all this changed in 2009, with the introduction of newer optical biometers that are readily able to provide all these parameters.

Interested in comparing this new Holladay 2 formula, in 2000 I published a study [16] using the Holladay IOL Consultant computer program, to compare the Holladay 2 with the Hoffer Q, Holladay 1, and SRK/T formulas in 317 silicone plate-haptic lens cases operated on by me. The results showed the Holladay 2 (H-2) to be equal to but not better than both the Hoffer Q in short eyes and the SRK/T in long eyes. It also showed the Holladay 2 to be far inferior to the Holladay 1 in eyes with ALs between 22 and 26 mm and especially eyes 24.5–26 mm, where the Holladay 1 has always been the absolute best. Thus, the extremes of AL were improved with the H-2, but it sacrificed the accuracy in the middle range, the majority of eyes. In 2019, Holladay 1 and Holladay 2 were upgraded by improvements in the Wang/Koch AL adjustment formulas [17], which have improved their accuracy quite a bit.

I cannot leave out the unfortunate history of the typographical errors that occurred in the original publication of the Hoffer Q formula by the journal. A crucial minus sign was left out, and the example calculation answers were switched. In the erratum that was published later, I made changes to the formula whereby the limitations on ACD were replaced by limitations on the AL but only in the Q part of the formula. Readers thought that the AL limitation was an addition to the ACD limits and used both of them (in the Q formula and the vergence formula). These problems were due to journal typesetting and me. All errors were made clear in a 2007 letter to the editor in JCRS. The worst example of the errors caused was that by Tomey (Japan) in their A-scan ultrasound instrument. They programmed it without a license or contacting me. In 2001, a publication by Oshika et al. [18] (Table 43.2) showed the Hoffer Q to be the worst formula (mean error of +11.44 D) in a small series of microphthalmic eyes where in actuality it was the most accurate (mean error of +2.80 D). Tomey corrected this, issued an erratum, and apologized for the error. Due to the harm it could cause patients, I now ask to have a license signed for commercial use of my trademarked name whereby I can assure it is programmed correctly.

Table 43.2 (**a**) Results found by Oshika, et al. [18] on microphthalmic eyes using the Hoffer Q, Holladay 1, SRK/T, and SRK II formulas (Note: Hoffer Q the worst). (**b**) The corrected real results later produced by Tomey[16Erratum] (after they corrected their mistake) showing the Hoffer Q the best

Formula	ME ± SD	Range
Hoffer Q	**+11.44 ± 0.49**	**+4.08 to +21.70**
Holladay 1	+2.74 ± 4.47	−0.60 to +10.20
SRK II	+11.94 ± 7.07	+4.22 to +21.60
SRK/T	+4.40 ± 4.34	+0.40 to +11.17

Formula	ME ± SD	Range
Hoffer Q	**+2.80 ± 1.83**	**−4.02 to +5.00**
Holladay 1	+3.03 ± 4.23	−0.56 to +10.20
SRK II	+11.94 ± 7.07	+4.22 to +21.60
SRK/T	+4.40 ± 4.34	+0.40 to +11.17

where *ME* mean error, *SD* standard deviation

There have been many new IOL formulas and many studies comparing them over the years, such as the Barrett Universal II, the EVO 2.0, Haigis, Kane, Ladas, Olsen C-factor, Panacea, Pearl GPS, and RBF, all showing improvements over the standard old Hoffer Q/Holladay 1/SRK/T formulas. The Hoffer Q in short eyes has stood the test of time for almost 30 years and most all studies prove the results I first published; the Hoffer Q is not superior in all AL ranges.

The Hoffer H Formula [Fourth Generation]

In 2004, to attempt to improve the Holladay 2 formula, I replaced Holladay's mean biometry values with my previously published ones from 1980 [10, 19] for the average AL, K, ACD, CD, and LT in the algorithms used for the Holladay 2 ESF calculation and omitted the preoperative refraction which I thought could be very error-prone due to changes brought about by the cataract. I called it the Hoffer H formula (H for Holladay) and after testing it against the Hoffer Q/Holladay 1/SRK/T formulas on a large series of eyes, I found that its singular benefit was a real statistical increase in the percentage of eyes within a prediction error of ±0.13 D (21%), ±0.25 D (38%) and ± 0.50 D (64%), but the other parameters were basically the same or less. The results were presented as a poster at the American Academy of Ophthalmology Meeting in 1994 but based on a lack of enthusiasm from colleagues, I never published it or did much more with it.

The Hoffer H-5 Formula [Fifth Generation]

Eleven years later, in 2015, waking up in the middle of the night on a cross-country Amtrak train trip, I came up with an idea that, since there were differences in biometry between genders and various races, it might be better to change those parameters in the Holladay 2 and Hoffer H formulas suited to the gender and race of the individual patient. I made a note and fell back asleep. It was

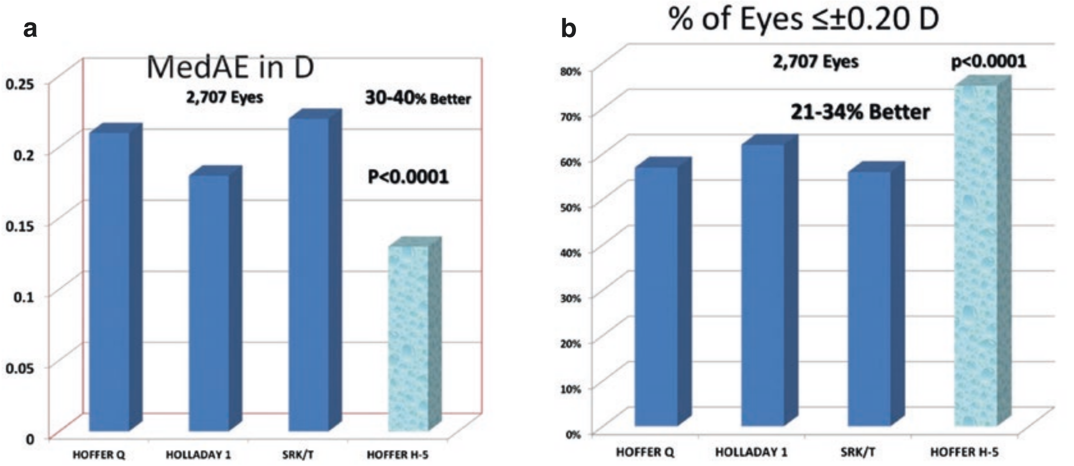


Fig. 43.2 (**a**) Results of MedAEs of the Hoffer H-5 compared to the Hoffer Q, Holladay 1, and SRK/T formulas showing it to be 30–40% statistically better in 2,700 multiracial eyes in 2017. (**b**) A similar comparison of the percentage of eyes within ±0.20 D showing the Hoffer H-5 with 21–34% statistically better in 2,700 eyes

many months later when I discovered the note and set about, with Giacomo Savini (Bologna, Italy), to follow up on it. We first performed a thorough review of the literature regarding the gender and racial differences in biometry and came up with the proper values for them, which were published in 2017 [3]. After an analysis using a large series of 2,700 multiracial eyes from around the world, we found definite statistically significant improvements in accuracy (Figs. 43.2) over the standard Hoffer Q/Holladay 1/SRK/T formulas [20] but were unable to test it against the newer formulas because of the massive task of entering 2,700 eyes individually into each formula's website or program. Not much interest was developed for the new formula by colleagues or industry.

The Hoffer QST Formula 2020 [Using Artificial Intelligence]

After years of frustration that the Hoffer Q formula was limited to reasonable accuracy in normal eyes and better accuracy only in short AL eyes and considering ways to address it, it took the evidence of studies such as by Eom et al. [21] and Melles et al. [22] to point out the effect that the lack of preoperative ACD had on its poor performance in some eyes, but it was the stimulus of a suggestion to improve the Hoffer Q by Tun Kuan Yeo of Singapore, at an IOL Power Club (IPC) annual meeting in St. Pete Beach, FL, in 2018 that stimulated us to finally do something about it. He suggested making alterations to the index of refraction or adding preoperative ACD, which the Haigis formula [23] had made prominent. It was even considered during the formulation of the Q formula but seemed too cumbersome for clinicians to measure ACD in 1993.

With those aims, Dr. Savini and I began a series of alterations to the basic Q formula using those ideas. We were getting remarkably close (but never better) to the accuracy of the newer more accurate formulas. But then, in collaboration with Dr. Leonardo Taroni (Bologna, Italy), we set about investigating the limitations of the Hoffer Q and finding a way to overcome them.

The first limitation that came to our attention was the correlation between the prediction error (PE) and the preoperative ACD. The Hoffer Q tends to overestimate the IOL power in eyes with shallow ACDs (leading to myopic errors) and underestimate it in eyes with deep ACDs (leading to hyperopic errors) (Fig. 43.3). This finding confirms the results of previous studies [21, 22]. The second limitation is the weak performance in eyes longer than 26.0 mm, where the Hoffer Q tends to provide hyperopic outcomes.

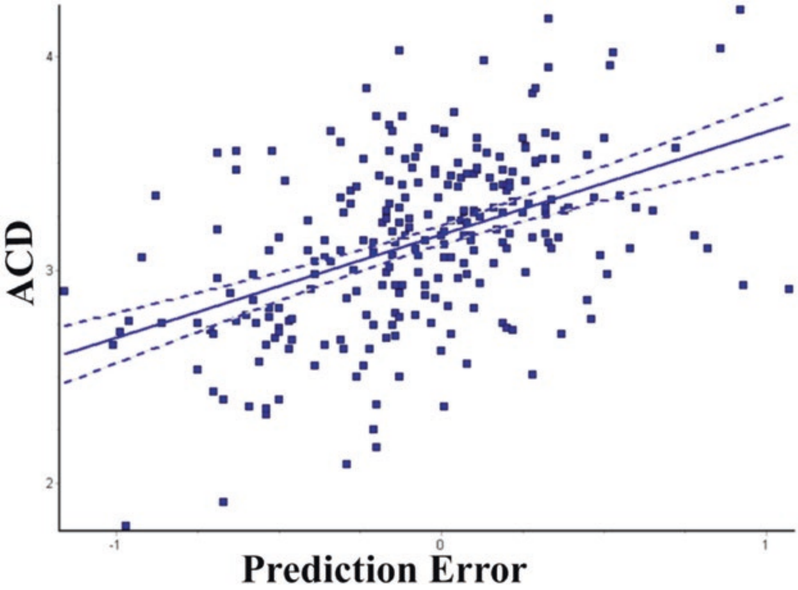
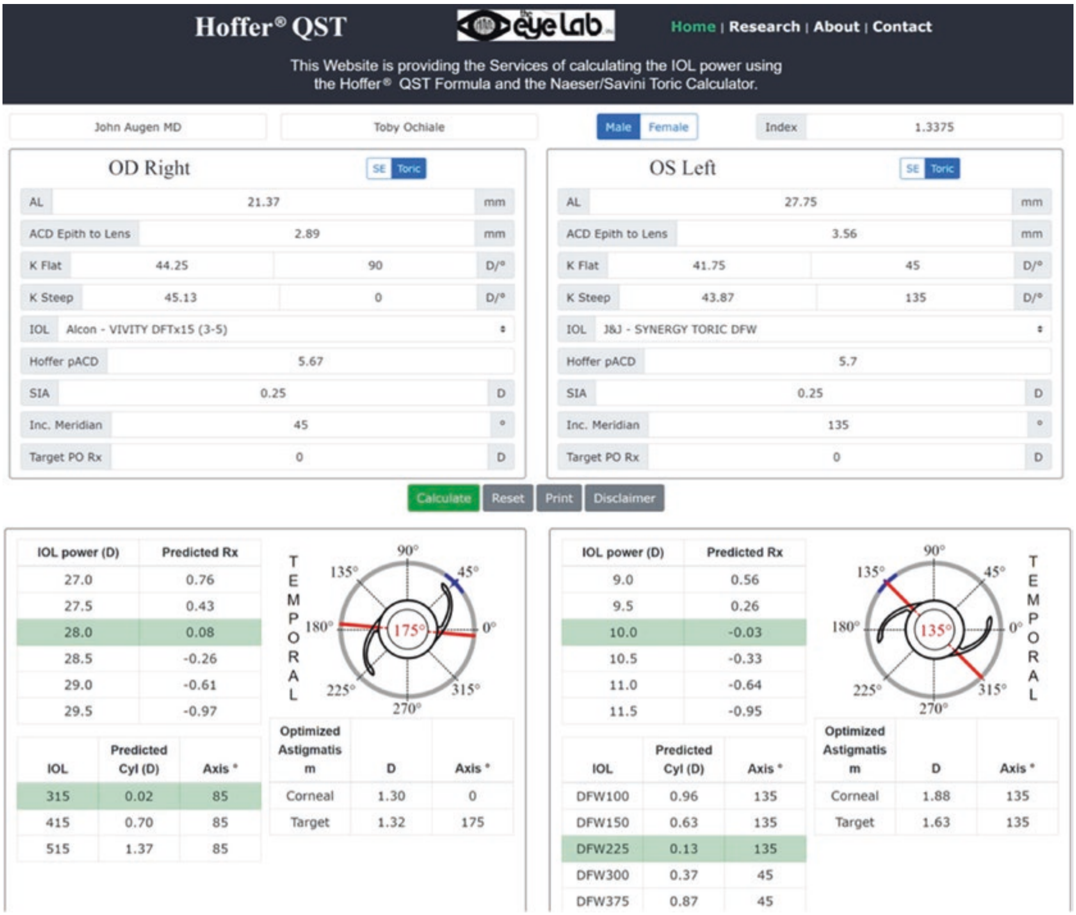


Fig. 43.3 Linear regression ($p < 0.0001$, $r = 0.4552$, r2 = 0.2072) shows that the prediction error (PE) of the Hoffer Q is related to the anterior chamber depth (ACD). Data from 253 eyes implanted with the same IOL after constant optimization. Line: regression; dotted lines: 95% confidence

We started our project of improving the Hoffer Q by using classical statistics such as linear regression and were able to achieve better results than the original formula, but it was not yet possible to reach the accuracy of the newest formulas. We found that the solution was in machine learning, an artificial intelligence that provides us with a nonlinear regression model. The next step was to decide which elements of the original Hoffer Q may deserve updating and we first focused on the effective lens position (ELP), as this is one of the main contributors to errors in IOL power calculation using modern biometry [24, 25]. We collected 537 highly accurately-measured eyes with the same monofocal IOL and zeroed their PE by optimizing the ELP. We subtracted the original Hoffer Q lens constant (pACD) from the optimized ELP giving us a new ELP correcting factor (we called a T-factor) for each eye. Maintaining the same pACD value of the Hoffer Q formula allows us to calculate the new ELP equation using an easily available constant for every single IOL, such as those published on the User Group for Laser Interference Biometry (ULIB, http://ocusoft.de/ulib/c1.htm) or IOLCON (https://iolcon.org) websites. At this point, using machine learning, we created a new model that uses gender and biometric data as input (e.g., AL, ACD, and corneal radius) to calculate the T-factor. Preliminary analyses revealed that other biometric parameters (LT and CD) do not improve ELP prediction, so they were not included in our model.

As a second step, we developed a customized AL adjustment for long eyes following the same method adopted for the T-factor. Briefly, we zeroed the PE of around 200 long eyes (AL > 25.0 mm) optimizing the AL. After determining the AL adjustment from the difference in the original AL and the optimized one, we developed a nonlinear model to estimate it.

Thus, the Hoffer QST has an AL adjustment similar to the Wang-Koch, but superior because (1) it is not dependent only on AL but also uses the input of our model gender and several biometric data (AL, Kavg, ACD, and R) and (2) we use a nonlinear regression model. The Hoffer QST accuracy is maintained over the entire spectrum of ALs and in all IOL models we have tested so far. John Shammas et al. showed its



This Website is providing the Services of calculating the IOL power using the Hoffer® QST Formula and the Naeser/Savini Toric Calculator.

John Augen MD	Toby Ochiale	Male Female	Index 1.3375

OD Right — SE Toric

AL	21.37		mm
ACD Epith to Lens	2.89		mm
K Flat	44.25	90	D/°
K Steep	45.13	0	D/°
IOL	Alcon - VIVITY DFTx15 (3-5)		
Hoffer pACD	5.67		
SIA	0.25		D
Inc. Meridian	45		°
Target PO Rx	0		D

OS Left — SE Toric

AL	27.75		mm
ACD Epith to Lens	3.56		mm
K Flat	41.75	45	D/°
K Steep	43.87	135	D/°
IOL	J&J - SYNERGY TORIC DFW		
Hoffer pACD	5.7		
SIA	0.25		D
Inc. Meridian	135		°
Target PO Rx	0		D

IOL power (D)	Predicted Rx
27.0	0.76
27.5	0.43
28.0	0.08
28.5	-0.26
29.0	-0.61
29.5	-0.97

IOL	Predicted Cyl (D)	Axis °
315	0.02	85
415	0.70	85
515	1.37	85

Optimized Astigmatism	D	Axis °
Corneal	1.30	0
Target	1.32	175

IOL power (D)	Predicted Rx
9.0	0.56
9.5	0.26
10.0	-0.03
10.5	-0.33
11.0	-0.64
11.5	-0.95

IOL	Predicted Cyl (D)	Axis °
DFW100	0.96	135
DFW150	0.63	135
DFW225	0.13	135
DFW300	0.37	45
DFW375	0.87	45

Optimized Astigmatism	D	Axis °
Corneal	1.88	135
Target	1.63	135

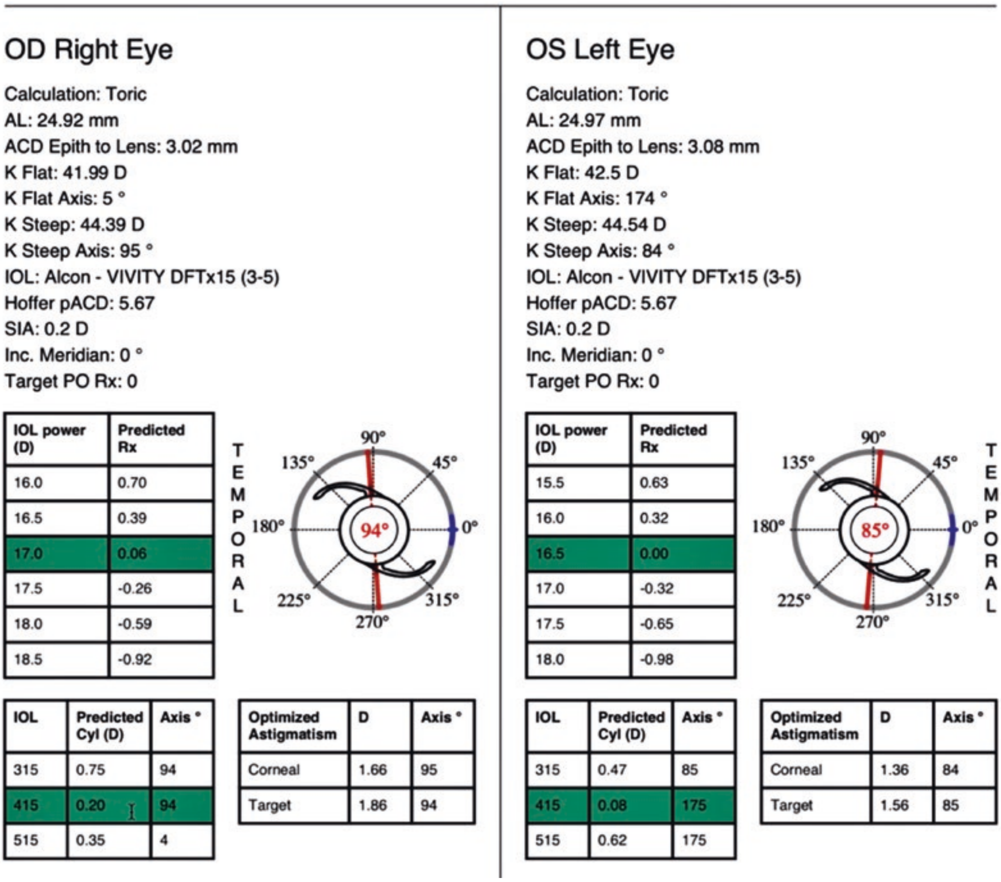
Fig. 43.4 The Hoffer QST website with Naeser/Savini Toric calculation for a short OD and a long OS

accuracy using the Argos biometer [24], which uses a "Sum of Segments" method to measure AL using a specific speed for each part of the eye as developed by David Cooke [26]. This results in an AL slightly different from all the other biometers.

In conclusion, we updated the Hoffer Q formula by means of new algorithms and machine learning generating the new Hoffer QST (Hoffer Q/Savini/Taroni) formula [27].

The Hoffer QST formula calculator is available to be used for free on our website (Figs. 43.4) at www.HofferQST.com (or www.EyeLab.com and www.IOLPower.com), and it includes the accurate Naeser/Savini Toric calculator with a complete printout (Fig. 43.5) for the chart or electronic medical record. It is also available on the new (September 2022) ESCRS IOL Calculator [https://iolcalculator.escrs.org] and will be available on the new Optopol REVO NX Spectral Domain OCT biometer and the Heidelberg Anterion biometer.

We have added a "Research" section (Fig. 43.6) at the top of the home page that allows the user to download specified Excel spreadsheets to be populated with your data, uploaded to the site, and receive multiple simultaneous calculations or Hoffer QST lens constant (pACD)



OD Right Eye

Calculation: Toric
AL: 24.92 mm
ACD Epith to Lens: 3.02 mm
K Flat: 41.99 D
K Flat Axis: 5 °
K Steep: 44.39 D
K Steep Axis: 95 °
IOL: Alcon - VIVITY DFTx15 (3-5)
Hoffer pACD: 5.67
SIA: 0.2 D
Inc. Meridian: 0 °
Target PO Rx: 0

IOL power (D)	Predicted Rx
16.0	0.70
16.5	0.39
17.0	0.06
17.5	-0.26
18.0	-0.59
18.5	-0.92

IOL	Predicted Cyl (D)	Axis °
315	0.75	94
415	0.20	94
515	0.35	4

Optimized Astigmatism	D	Axis °
Corneal	1.66	95
Target	1.86	94

OS Left Eye

Calculation: Toric
AL: 24.97 mm
ACD Epith to Lens: 3.08 mm
K Flat: 42.5 D
K Flat Axis: 174 °
K Steep: 44.54 D
K Steep Axis: 84 °
IOL: Alcon - VIVITY DFTx15 (3-5)
Hoffer pACD: 5.67
SIA: 0.2 D
Inc. Meridian: 0 °
Target PO Rx: 0

IOL power (D)	Predicted Rx
15.5	0.63
16.0	0.32
16.5	0.00
17.0	-0.32
17.5	-0.65
18.0	-0.98

IOL	Predicted Cyl (D)	Axis °
315	0.47	85
415	0.08	175
515	0.62	175

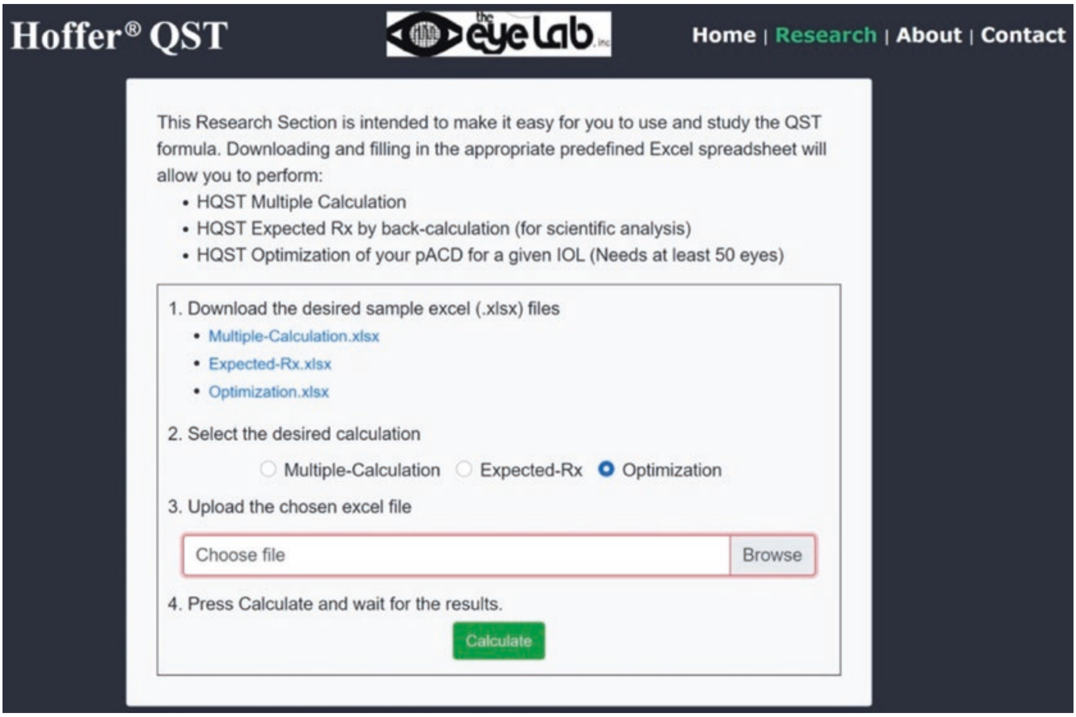
Optimized Astigmatism	D	Axis °
Corneal	1.36	84
Target	1.56	85

Fig. 43.5 Hoffer QST website calculation printout sheet for Toric IOLs

optimization. We are hoping this may stimulate other formula authors to add this to their websites.

Our results show the Hoffer QST to be equal to or better (depending on the parameter measured) than all the latest most accurate formulas available today. Our published clinical results with the formula [27] show that this new version is a definite improvement over the Hoffer Q and will help define its role in today's cataract surgery.

From 1974 to 2024 has been an enjoyable 50 years involved in IOL power formula creation.



This Research Section is intended to make it easy for you to use and study the QST formula. Downloading and filling in the appropriate predefined Excel spreadsheet will allow you to perform:

- HQST Multiple Calculation
- HQST Expected Rx by back-calculation (for scientific analysis)
- HQST Optimization of your pACD for a given IOL (Needs at least 50 eyes)

1. Download the desired sample excel (.xlsx) files
   - Multiple-Calculation.xlsx
   - Expected-Rx.xlsx
   - Optimization.xlsx
2. Select the desired calculation

   ○ Multiple-Calculation ○ Expected-Rx ● Optimization
3. Upload the chosen excel file

   Choose file | Browse
4. Press Calculate and wait for the results.

   Calculate

Fig. 43.6 Hoffer QST Research Page for pACD lens constant optimization and multiple calculations for analyses and formula comparison studies by researchers

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