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Comparing six multifocal IOLs over six years

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Implanting multifocal IOLs is not only a science. It is an art – an art that goes beyond evaluating only the eyes of the patient to also taking into account the patient's personality and the specific requirements of the patient's occupation. Add to this the challenge of explaining the intricacies of the product to the patient in a way the patient can understand and you have the art of implanting multifocal IOLs.

Deciding which eyes are suitable for a multifocal IOL is the first hurdle to overcome. This is followed by evaluation of the patient's personality. Is this person a good candidate or not? Over the last three decades the science of using multifocals has been greatly developed and expanded by the use of objective scientific methods and means. The more data science can measure, the less art is involved.

The first multifocal IOL that I used was the 3M multifocal in about 1986. In retrospect, this particular lens was ahead of its time, but the art and science of using multifocal IOLs (MF IOLs) was in its infancy. I did not know or understand how to handle the side effects of the product and therefore my flirtation with this particular multifocal was short-lived.

My next venture was with the AMO Array. This was actually a bifocal IOL and was definitely effective, but with side effects. Dr Ivan Marais, then from Johannesburg, was one of the international champions of this IOL and was widely known and respected for his pioneering work with this very effective product. However, the side effects such as disphotopsia, loss of contrast and poor mesopic vision were still very problematic, even more so than in the present day. To the best of my knowledge, Gary Player and Louis Luyt both received AMO Array implants after cataract surgery. Gary Player's name was even used as a marketing tool for this IOL.

Over the years I have used a number of presbyopia-correcting IOLs. This included the 3M MF IOL, AMO Array, Alcon ReStor, Lentis Mplus, Physiol Fine Vision Trifocal, Zeiss AT Lisa Tri as well as the Tecnis Symfony which, according to the manufacturers, is not a true multifocal IOL.

I also used two accommodating IOLs, i.e. the Tetralens and the Crystalens. Both these IOLs provided about 1 dioptre's accommodation but over time this diminished to very little if any. After a few months I decided to discontinue the use of both these IOLs.

Since its introduction into SA I have been a tentative user of the Alcon ReStor IOL but as my results improved our utilisation of this IOL gradually increased. Since 2009 we have been analysing the data and results ontained by using this IOL. In 2012 the study of multifocal IOLs was expanded to include the Lentis Mplus. These studies have now been going on for six years and increased to incorporate six different presbyopia-correcting IOLs.

This article is a summary of my experience.

General principles

As will be repeated, multifocal IOLs are not always truly multifocal. Some of them are actually only bifocal, whereas some are continuous-focus IOLs. These two terms, as well as multifocal IOL and also presbyopia-correcting IOL, will be used interchangeably, endeavouring to be correct in all instances.

Patient selection is most critical when implanting MF IOLs. Many talks have been given and articles published about patient selection because it is so important.

Eye selection is equally important. The eyes must be totally normal except for cataracts. The presence of astigmatism is not a contra-indication but should be rectified to achieve acceptable results. Post-op astigmatism of 1.00D or more is problematic and will not be acceptable for the patient.

Excellent biometry is critical. Post-op spherical equivalent should be between +0.50D and -0.5D. Anything more than this and you will have an unhappy patient. Couple this with a required astigmatism of less than 0.75D and it becomes clear that pre-operative and intra-operative accuracy is of the utmost importance.

Post-operative uncorrected distance visual acuity (UCDVA) is the factor that has the most effect on a patient's satisfaction. If the UCDVA is better than 0.8 in both eyes and 1.0 OU, most patients are happy. They can tolerate other side effects, including average or mediocre

UCNearVA far better than mediocre distance VA.

Side effects such as starburst, glare, scatter and halos at night are annoying and should be explained in detail to the patient before embarking on the implantation of presbyopia-correcting IOLs.

The patient's personality and lifestyle should be taken into consideration when deciding to do MF IOLs.

My dictum is that the patient who wants the MF IOL the most is usually the worst candidate. These people are often perfectionists and have high expectations. The best candidate is the laid back, relaxed type who usually loses or breaks his spectacles and can manage rather well without perfect VA. These people enjoy the freedom the MF IOLs give them without the hassle of glasses and they do not constantly try to see a fly at the opposite side of the opera house!

The worst case for a MF IOL would be the –2.00D myopic astronomical engineer at NASA who constantly works on his computer without glasses and does astronomy and birdwatching for a hobby. Beware, especially if his brother is a lawyer!

This article does not discuss Prelex which is Presbyopic Lensextraction in the absence of cataracts. Prelex is done for the specific reason to treat presbyopia and give the patient spectacle independence. The best candidate for Prelex is a person with the right personality, occupation and hobbies who is hyperopic without significant astigmatism. **Pre-operatively this patient always needs spectacles and after the operation this patient never needs spectacles.** This is a dramatic improvement and these patients are usually very grateful

The different IOLs are summarised in *Figure 1*.

As shown in *Figure 1* the first study was a retrospective study, but since then the other studies have been prospective.

All studies were performed in my private practice in Vanderbijlpark and except for six Zeiss AT Lisa Tri IOLs, all the IOLs were implanted by one surgeon (the author, JDL).

Problems encountered

Doing the surgery was the easy part. Patient selection is always a challenge, but over time you become rather adept at it. Clinical examination and biometry is usually very easy. All the data measured during these examinations go into the patients' clinical files which in our case has become electronic since 2012. My biggest problem was setting up a system of data capturing (from the patients' files) and analysis which is effective and efficient. This presented a learning curve which is still ongoing.

Principles behind the first five multifocal IOLs in our studies *(Figure 2)*

The main reason why multifocal IOLs are effective is because they simultaneously and always create two or more images of the object the patient is looking at. To achieve this, light rays are divided to create different images for different distances.

Therefore, each image has less available light than an image created by a monofocal IOL and this will impact on quality of vision. In bright light (photopic conditions), it is not a problem, but as light decreases, so does visual acuity.

Loss of contrast is also a common side-effect and does increase in poor light, mesopic as well as scotopic conditions. Furthermore, the optical qualities of these IOLs are such that some light is reflected or lost and this decreases the available light even further.

The patient must develop the ability to choose between these images to obtain useful vision. This requires a certain flexibility on the side of the patient. Therefore, patient selection is so very important. If you, as the doctor, misjudge the patient, you will have an unhappy patient even if you measure 6/6 UCVA at all distances.

The Alcon ReStor, the Lentis Mplus from Oculentis and the Hanita Bunnylens multifocal IOLs are actually bifocal IOLs and not true multifocal IOLs. These IOLs do not make adequate provision for intermediate vision at so-called computer distance, about 60 cm. As the MF IOL industry developed and the lenses evolved, some companies produced a trifocal IOL of which the Physiol Fine Vision Trifocal and the Zeiss AT Lisa Tri are included in our series. These trifocal IOLs created a third image for intermediate VA, with good effect.

The following generation of multifocal IOLs came from AMO Tecnis. They claimed to be the first of the next generation presbyopia-correction IOLs, with the Tecnis Symfony IOL. It creates a continuous elongated focus which provides an extended range of vision. This is accompanied by significantly less of the other well-known side effects, such as glare, starburst and halos. This makes for a very good IOL (*Figure 3*).

Figure 2. Principles behind the first five multifocal IOLs

- **Light is divided** between different images
- These multifocal IOLs work on the principle of **simultaneous vision**; one image is in focus while the out-of-focus image is suppressed.
- **Dysphotopsia at night** is usually present: halos, glare and starburst are common. These are caused by the **out-of-focus image**.
- 6-22% **loss of light** occurs.
- Scotopic VA is always reduced due to **division of light and loss of light.**
- Loss of **contrast** occurs. 'Waxy' VA is reported.

Figure 1. The six multifocal IOL studies

Study began	Retro/ Prospective	IOL	Mechanism of action	Bifocal or Trifocal	Total inserted
2009	Retro	Alcon Restor	Diffractive apodised plus refractive	Bifocal	86
2011	Pro	Lentis Mplus Lentis LS 313 MF 30	Refractive	Bifocal	112
2013	Pro	Physical Fine Vision Trifocal	Diffractive apodised	Trifocal	58
2015	Pro	Hanita Bunnylens MF	Diffractive apodised	Bifocal	10
2015	Pro	Zeiss AT Lisa Tri 839MP	Diffractive	Trifocal	14
2015	Pro	Tecnis Symfony extended focus	Diffractive	Extended focus	6

Figure 3. Principles behind the next generation of (MF) presbyopia-correcting IOLs

Tecnis Symfony IOL (from AMO).

- It is the first and currently the only presbyopia-correcting **extended range of vision** IOL.
- Because of the **one elongated focus** it delivers a continuous, full range of high-quality vision.
- The incidence of halos and glare is comparable to that of a monofocal IOL.
- Non-toric as well as toric versions are available.

Figure 4. Alcon Acrysof IQ ReSTOR

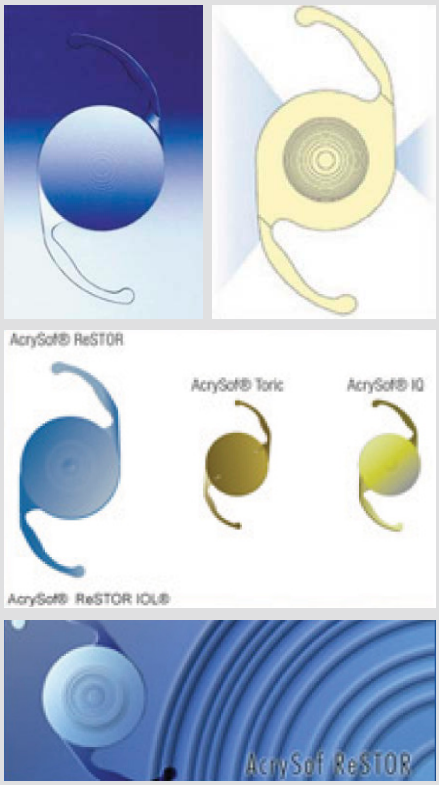


Figure 5. ReSTOR characteristics

- **Bifocal** (not truly multifocal).
- Aspheric. Biconvex: Size 6 x 13 mm.
- One piece hydrophobic acrylic.
- Blue filter.
- **Central diffractive** region of 3.6 mm for near and distance vision when pupil size is normal in bright (photopic) light.
- Apodised. It is defined as a gradual reduction in diffractive step heights.
- A **peripheral refractive** region is dedicated to distance vision. When the pupil dilates in poor light more light is distributed to the distance focal point.

Discussing different MF IOLs

We shall now take a closer look at six multifocal IOLs.

1. Alcon Acrysof IQ ReSTOR IOL (Figure 4)

This is an aspheric, one-piece, hydrophobic, acrylic IOL, 6 mm wide and 13 mm long. As mentioned before, it is actually a bifocal IOL. It has a central diffractive region of 3.6 mm which is apodised. **Apodised is defined as gradual reduction in diffractive step heights.** The central region of the IOL provides near and distance vision when the pupil size is normal such as in photopic light. The periphery of the lens is refractive and is dedicated to distance vision. When the pupil dilates in poor illumination, more light is distributed to the distance focal point (*Figure 5*).

As seen in *Figure 6*, ReSTOR IOLs have been produced with +4D, +3D and +2.5D near additions. The +4D add ReSTOR has been discontinued.

Figure 6. Different ReSTOR IOLs

- Available in **+2.5D, +3D** and **+4D add**.
- +2.5D adds + 2.0D at spectacle plane. Focus at 50 cm. Has 7 steps (rings).
- +3D adds + 2.5D at spectacle plane. Focus at 40 cm. Has 9 steps (rings).
- +4D adds + 3.2D at spectacle plane. Focus at 31 cm. Has 12 steps (rings). More or less obsolete.

From 2008 to 2010 we implanted 86 patients with a +4D add in one eye and a +3D add in the other eye. These were analysed and the results are reported later in this article.

The ReSTOR IOL is easy to insert and unfolds rather slowly which makes it very safe to insert. I use a 2.5 mm clear corneal incision and introduce the injector into the anterior chamber. This IOL can also be inserted through a smaller 2.2 mm incision using the wound assisted technique of which I am not at all a supporter. When using the 2.2 mm incision and the 'wound assisted technique', you do not introduce the cartridge into the AC. **It has been well documented that the incidence of post-operative infection is less when introducing the injector cartridge properly into the AC.** It is also technically easier and more elegant. The difference between post-op astigmatism after a 2.5 mm incision and a 2.2 mm incision is negligible and in my view does not justify the risks and consequences.

Centration of the ReSTOR IOL is good but not perfect and varies between zero and 0.4mm (*Figure 7*).

Figure 7. Comments on the ReSTOR IOLs

- Easy to insert.
- Centres well.
- Slight decentration has no significant effect on patient satisfaction.
- Disphotopsia always present at night but diminishes over time.
- Light: **41% for far; 41% for near: 18% reflected (lost)**.
- **Scotopic VA** is reduced.
- Loss of contrast very common.
- **Excellent distance UCVA OU mandatory**.
- +3.0D add better intermediate and +4 add better for near.
- **+3D/+4D combination** in my series was very effective.

As with all the other MF IOLs, disphotopsia is always present at night, but diminishes over time.

A very important factor is the distribution of light. The design of the ReSTOR optic causes reflection and therefore loss of 18% of light. The rest of the light is divided equally between near and far visual foci. The division and loss of light is the cause of reduced VA in mesopic and scotopic light conditions, for near as well as for distance vision.

Loss of contrast also occurs with the ReSTOR IOL and can be measured and quantified. As with most things, contrast sensitivity varies between patients.

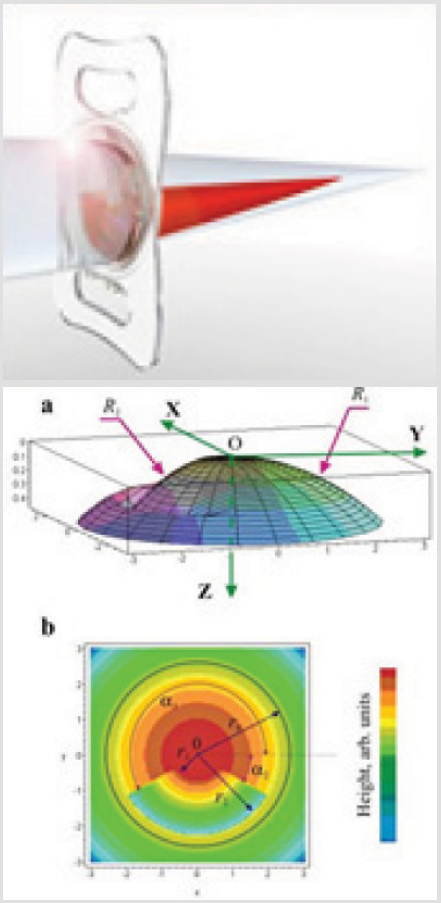
As for all patients with MF IOLs the patient will be rather satisfied if UCVA for distance is good OU (both eyes), preferably for each eye separately, but it is a very important requisite when both eyes are used. Effectively this means at least one eye must be 0.8 (6/7.5) for UCDVA.

Patients tolerate mediocre near UCVA much better than mediocre distance UCVA.

2. Lentis Mplus (LS 313 MF30)

This IOL comes in a plate haptic version as seen in *Figure 8*. This is the model we used. The Mplus is bifocal as seen in the figures and is not concentrically symmetrical for 360° like the other MF IOLs. The distribution of light is 39% for

Figure 8. Lentis Mplus IOL



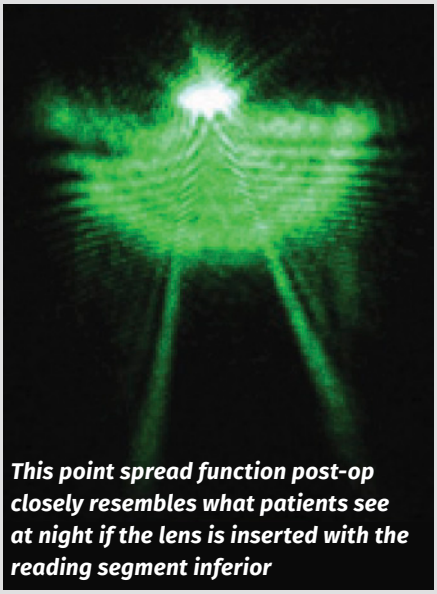
near VA and 55% for distance VA. This corresponds to the two segments of the IOL as seen in *Figure 8*.

This configuration of the IOL eliminates classical halos during night vision as described for most of the other presbyopia-correcting IOLs. Six per cent (6%) of incoming light hits the meridional transitional area between near and far vision segments and is reflected and therefore lost for useful vision (*Figure 9*).

It does, however, create two lines of scatter as can be seen in the point spread function in *Figure 10*. This disphotopsia is nevertheless less problematic than the disphotopsia experienced with IOLs with 360° concentric diffractive or refractive circles.

An interesting alternative is to insert this IOL upside down (superior goes to inferior, not anterior goes to posterior) to cause upward direction of this scatter

Figure 10. The point spread function of the Lentis Mplus IOL



This point spread function post-op closely resembles what patients see at night if the lens is inserted with the reading segment inferior

where it is supposedly less troublesome. I have not done this but it seems to be a good idea.

Like most modern-day IOLs this lens has a 360° square edge to reduce the development of posterior capsular opacification (PCO). The IOL has a hydrophilic inside and a hydrophobic surface.

Insertion of the Lentis Mplus is easy because unfolding is slow and safe. Initially we were instructed to insert the IOL with its reading add inferior but this has now changed. Something far more important has emerged. The distance segment of this IOL MUST be in line with the visual axis.

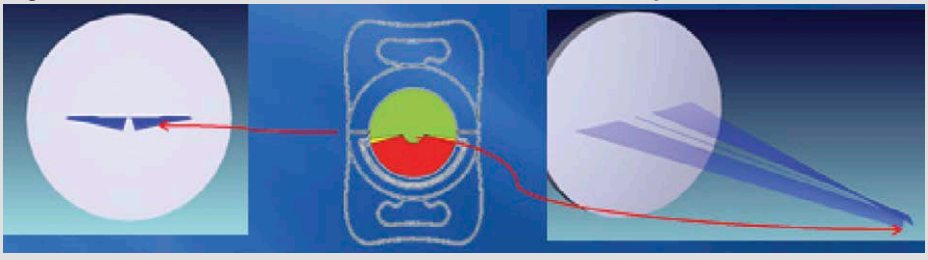
If the near segment of this IOL ends up in front of the visual axis it induces myopia and the patients complain of blurred vision even if they see 6/6 for distance. With autorefraction these eyes also show about –1.50D myopia (but ironically has 6/6 distance VA). **These patients are often unhappy and this phenomenon was the main cause of the four explants in our series of 108 eyes.**

Because of the division of incoming light, about 60% of Lentis Mplus eyes show a reduction in contrast. This is not a constant finding and is also dependent on the refraction, IOL position and illumination. Scotopic and mesopic VA is generally reduced.

In our series the Lentis Mplus IOL provided the best intermediate UCVA, slightly better than the ReSTOR +3D add. If biometry and surgery is good the UCDVA will be excellent.

As with all the other presbyopia-correcting IOLs, the patient is most likely to be satisfied when the UCDVA is 6/6. The opposite is also true. If the patient attains excellent UCNVA but poor UCDVA he will most likely be unhappy with the result.

Figure 9. The meridional transition area of the Lentis Mplus IOL



3. Physiol Fine Vision Trifocal

The name of this lens is an acronym based on its trifocality and its ability to provide **F**ar, **I**ntermediate and **NE**ar (FINE) vision (*Figure 11*).

Figure 11. The PhysIOL Fine Vision Trifocal IOL

The Fine Vision Trifocal is a diffractive trifocal IOL, with 360° concentric diffractive rings. It is 10.75 mm long and has a 6.15 mm optic. The optic is biconvex with an aspheric posterior surface. The haptics are angulated 5° forward and the lens has a 360° square edge all around the optic and even at the haptic junction. The lens is made of a hydrophylic acrylate with a 25% water content and comes in powers ranging from 10D to 30D in 0.5D

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Figure 12. Characteristics of the PhysIOL Fine Vision Trifocal IOL

- **Diffractive Trifocal** IOL.
- 360° diffractive rings.
- Size: 10.75 mm height x 6.15 mm optic.
- Biconvex and aspheric posterior surface.
- Angulation 5°.
- A constant 118.9.
- 360° square edge all around the optic and even at the haptic junction.
- **Hydrophilic** acrylate with 25% water content.
- Power range 10D to 30D in 0.5D steps.

steps. The lens is very soft and easy to insert. Being as soft as it is, it is slightly more prone to tearing of a haptic than the other IOLs. It centres well and without a problem. Slight decentration of less than 0.5 mm has no significant effect on the visual outcomes. The characteristics of this lens are summarised in *Figure 12*.

Trifocality is achieved by combining two sets of diffractive rings. One set creates a focal point for intermediate VA with +1.75D add and the other provides near VA with a +3.50D add. These rings alternate with each other as shown in *Figure 13*.

Our results obtained with the Physiol Fine Vision Trifocal showed excellent UCVA at all distances. Side effects are the usual, i.e. reduced VA in poor light as well as some loss of contrast. Disphotopsia is always present at night but in time this diminishes and patients do not find it very bothersome. The fact that about 15% of light is reflected obviously contributes to the reduced scotopic and mesopic VA as well as loss of contrast. Once again, UCDVA is of the utmost importance. If patients cannot see far they do not appreciate the near vision (*Figure 14*).

Figure 14. Comments on the PhysIOL Fine Vision Trifocal IOL

- Very easy to insert, very soft.
- Centres well.
- Slight decentration has no significant effect on patient satisfaction.
- **Disphotopsia always** present at night but diminishes with time.
- Loss of contrast very common.
- **15% loss of light**.
- **Reduced scotopic VA**.
- **Excellent distance UCVA OU mandatory**.
- Good intermediate and excellent near vision achieved.

4. Hanita Bunnylens multifocal IOL (Figure 15)

This lens is actually one of the bifocal presbyopia-correcting IOLs. The name Bunnylens apparently refers to the shape of the haptics which look like the ears of a bunny. These haptics have a 5° anterior angulation. The IOL is 11 mm long with a 6 mm optic. It is aspheric and has a 360° square edge to reduce posterior capsular opacification (PCO). The IOL is made of hydrophylic acrylate HEMA/EOEMA polymer and has a UV blocker and violet light filter. The refractive index of the lens is 1.46 and the A constant is 118.16.

Figure 15. The Hanita Bunnylens multifocal IOL

The characteristics of the Hanita Bunnylens multifocal IOL is summarised in *Figure 16*.

The apodised diffractive steps are only present in the central 4 mm zone. It creates a +3D add which gives +2.4D add at spectacle plane.

The lens comes in 0.5D increments from +10 to +30D and in 1D increments from +31 to +35 D.

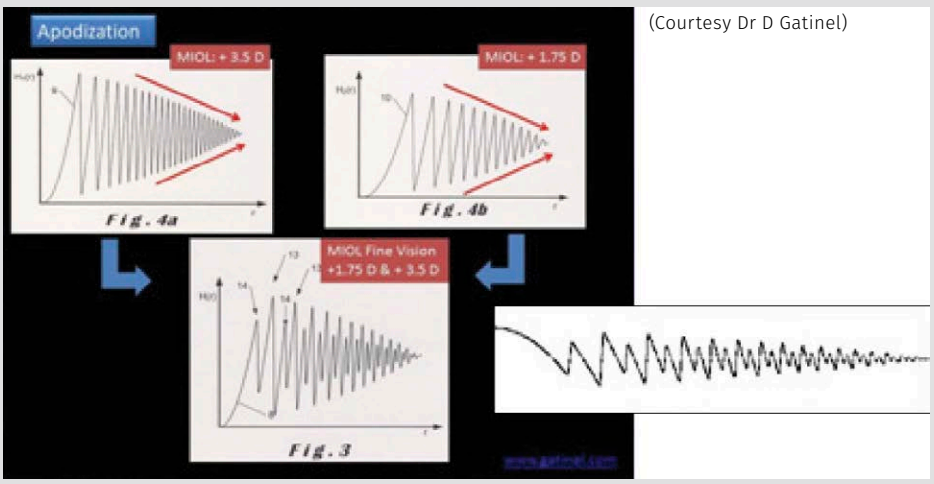
Figure 16. The characteristics of the Hanita Bunnylens multifocal IOL

- **Bifocal diffractive apodised** multifocal.
- Diffractive steps only in central 4 mm zone.
- Aspheric with 360° square edge.
- 6 mm optic; 11 mm length.
- +10D to +30 in 0.5 dioptres; 31-35D in 1 dioptre.
- 5° haptic angulations.
- UV blocker and violet light filter.
- **Hydrophilic acrylic** HEMA/EOEMA copolymer.
- +3D add provides +2.5 dioptre at spectacle plane.
- Refractive index 1.46; A constant 118.16.

Figure 17. Experience with the Hanita Bunnylens multifocal IOL

- Very easy to insert.
- Centres well due to 4 point haptic design.
- Slight decentration has no effect on patient satisfaction.
- Disphotopsia always present at night (and will probably diminish over time).
- Scotopic VA is reduced.
- Loss of contrast also present.
- Light distributions: **65% far; 35% near.** (How much is reflected or losr? – **probably 10 to15%??)**.
- **Excellent distance UCVA OU mandatory**.
- Excellent near and distance VA and good intermediate VA is achieved.

Figure 13. Diffractive characteristics of PhysIOL Fine Vision Trifocal IOL



(Courtesy Dr D Gatinel)

The Hanita MF is easy to insert and centres well due to the four-point haptic design. Slight decentration has no effect on patient satisfaction. Disphotopsia is always present at night but diminishes with time.

Scotopic as well as mesopic VA is reduced. Loss of contrast is comparable to the other IOLs we have studied. Light distribution is 65% for far and 35% for near VA. Loss of light is measured to be between 10% and 15% which means true light distribution of all incoming light is about 58% for far and 32% for near VA.

Our experience with the Hanita Bunnylens multifocal IOL is summarised in *Figure 17*.

Our results showed excellent UCDVA and UCNVA, and, surprisingly enough, also very good intermediate UCVA. Once again, patients are willing to tolerate imperfect NVA as long as the DVA is more than 0.8 OU. This IOL is also the most affordable of the six IOLs and excellent quality and value for money.

5. Zeiss AT Lisa Tri 839 MP *(Figure 18)*

This IOL is also a true trifocal based on diffractive optics. It has +3.3D diffractive rings for near and +1.66D diffractive rings for intermediate VA. Light distribution is 50% for far vision, 20% for intermediate vision and 30% for near vision according to the manufacturers. Other authors state that 12.5% of light is reflected and therefore lost. That leaves approximately 44% for distance, 18% for intermediate and 26% for near vision. In spite of these figures the visual results are good for all distances, but side effects are still present.

Figure 18. Zeiss AT Lisa Tri (Toric) 839 MP IOL

The IOL has a plate haptic design, it is very easy to insert and centres well. Slight decentration of the IOL has no significant effect on the visual outcome.

The characteristics of the Zeiss AT Lisa Tri 839 MP IOL is summarised in *Figure 19*.

As with the other trifocal and bifocal IOLs with 360° concentric circular diffractive or refractive rings, this IOL also causes disphotopsia at night which will diminish over time. These include halos, glare and starburst. Due to division of incoming light, mesopic and scotopic VA is reduced.

Figure 19. Characteristics of the Zeiss AT Lisa Tri 839 IOL

- **Trifocal diffractive** IOL design.
- Plate haptic.
- Has **+3.3D** refractive rings for near VA as well as **+1.66D** diffractive rings for intermediate VA.
- Light distribution is **50% for far; 20% for intermediate and 30%** for near vision. Manufacturers claim that no loss of light occurs. Other authors state that **12.5% of light is reflected**.
- **Contrast sensitivity was very good:** comparable to normal older adults.

Loss of contrast is minimal and is similar to that of the Tecnis Symfony which has virtually no loss of contrast sensitivity. Contrast sensitivity is claimed to be equal to normal adults in the same age group.

UCDVA is a function of many factors and was excellent in our series. It is mandatory to achieve excellent UCDVA to attain patient satisfaction. Near and intermediate UCVA was very good.

An unexpected side-effect of this lens may follow the treatment of PCO. Because the AT Lisa Tri is based on a plate haptic platform, care should be taken not to do a very large YAG posterior capsulotomy to treat PCO. The reason for this is that the plate haptic IOL may not be 100% stable and may dislocate into the vitreous after a very large posterior capsulotomy.

Figure 20. Experience with the Zeiss AT Lisa Tri IOL

- Very easy to insert.
- Centres well.
- Slight decentration has no effect on patient satisfaction.
- Disphotopsia always present at night (and will probably diminish over time).
- **Scotopic VA reduced**.
- **Loss of contrast was minimal:** better than Hanita and similar to Symfony.
- Excellent distance UCVA OU mandatory.
- Very good intermediate and excellent near vision attained.
- BEWARE of large YAG posterior capsulotomy.

Our experience with the Zeiss AT Lisa Tri IOL is summarised in *Figure 20*.

6. Tecnis Symfony presbyopia-correcting lens from AMO

AMO rightfully claims that this lens represents the next generation of presbyopia-correcting IOLs. The Tecnis Symfony merges two complementary technologies to create distance, intermediate and near vision. A proprietary diffractive echelette design feature extends or elongates the range of focus. (Echelette is derived from the French word 'echelle' which means 'ladder') (*Figure 21*).

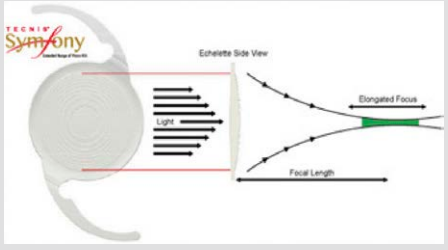
Figure 21. The Technis Symfony from AMO IOL

Principles behind the Tecnis Symfony IOL: It merges two complementary technologies:

- A (proprietary) **diffractive** echelette design feature **extends the range of vision**. (echelette – from French echelle = ladder) Also called extended vision or elongated focus.
- The proprietary **achromatic** technology corrects chromatic aberration. This creates **improved contrast sensitivity**.

The Tecnis Symfony has nine diffractive steps (rings) and creates this elongated or extended focal pattern as seen in *Figure 22*.

Figure 22. The Tecnis Symfony IOL



Light patterns as created by different Tecnis IOLs are shown in *Figure 23*. It is clear that light is divided as with all other multifocal IOLs.

The second technology used by the Symfony is that of achromatic diffractive technology which corrects the chromatic aberration. Chromatic aberration is a result of the different refractive effect of lenses on light with different wavelenghts (or colour).

As can be seen in *Figures 24 and 25*, these two technologies produce a lens

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Figure 23. Comparing the light patterns of different Tecnis IOLs

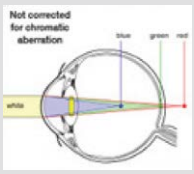
- The novel pattern of light diffraction projected through the **Tecnis Symfony** IOL is compared with the light patterns projected through the **Tecnis monofocal** and **Tecnis multifocal IOLs**.

Symfony

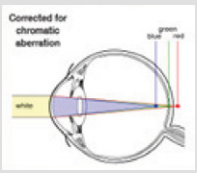
Monofocal

Multifocal

Figures 24 and 25. Achromatic technology corrects chromatic aberration



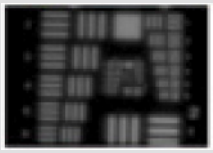
Chromatic aberration: The refractive index of the eye varies with wavelength. Different wavelength (= colours) are focused in different foci. Colours that are out of focus cause blur and loss of contrast. Achromatic diffractive technology corrects this chromatic aberration.

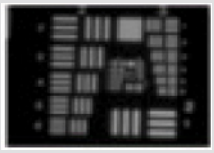


The **pictures** compare an eye with 1.2 dioptre chromatic aberration on the top with an eye with an achromatic IOL on the bottom, which only has 0.14 dioptre of achromatic defocus. The difference is responsible for better contrast sensitivity.

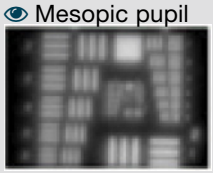
Figure 26. Contrast is better due to correction of longitudinal chromatic aberration.

- LCA 1.2 dioptres (uncorrected)
- LCA 0.14 dioptres (corrected)
- Photopic pupil
- Photopic pupil





- Mesopic pupil
- Mesopic pupil



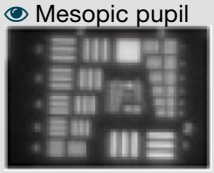
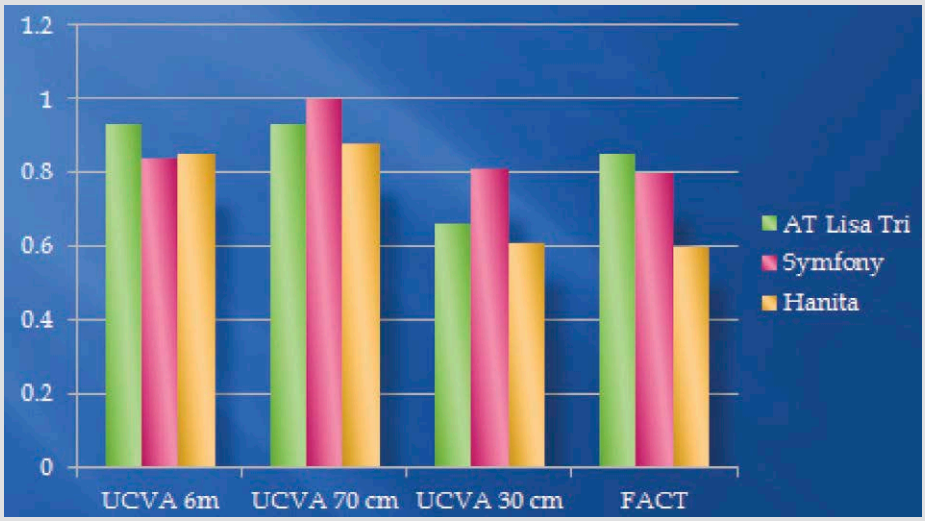


Figure 27. Comparing mean UCVA at different distances as well as contrast sensitivity



with an elongated focal area which creates multifocality as well as achromatic focus which gives very good contrast sensitivity.

The Tecnis Symfony lens is easy to insert and unfolds very slowly which makes it very safe. It centres exceptionally well and is very stable in the capsular bag.

Contrast sensitivity is normal or even better than what is regarded as normal for people over 50 years (*Figure 26*).

Scotopic VA is slightly reduced as with all other multifocal, bifocal or trifocal IOLs.

Disphotopsia is always present, although patients tolerate it well.

Patients often do not mention it until specifically asked about it. The disphotopsia gradually diminishes over time.

In our series decentration of more than 0.5 mm did not occur.

However, within the range of 0–0.5 mm the centration did not have a significant effect on the outcome.

Our patients achieved excellent UCDVA (mean of 0.82) as well as mean UCIVA of 1.0. We were alerted that the near VA might be less perfect but were very satisfied with the UCNVA results. Mean UCNVA was 0.8 which was better than the At Lisa Tri as well as the Hanita MF Bunnylens (*Figure 27*).

Comments on the Technis Symfony IOL are summarised in *Figure 28*.

Summary

As mentioned before, the implantation of multifocal IOLs is as much an art as a science.

Patient selection is of prime importance. This includes ocular features, occupational requirements, as well as personality traits.

A rule of thumb is that the patient must not lose any visual ability which was present before the surgery. Therefore, hyperopic patients are good candidates because pre-operatively they required spectacles for all visual distances, and post-operatively they have a 90% chance of being totally spectacle-independent.

Another perspective to consider is that the patient who is the most driven to have multifocal IOL implants is often a very poor candidate for a multifocal IOL. This person wants perfection and althought MF IOLs are an excellent innovation, it still has side effects which may be troublesome for certain patients.

Patient satisfaction is directly proportional to uncorrected distance VA

Figure 28. Comments on the Tecnis Symfony IOL

- Creative product based on new optical combinations.
- Easy to insert. Unfolds very slowly which is very safe.
- Centres well.
- Slight decentration has no effect on patient satisfaction.
- Disphotopsia is present. My patients reported halos as well as glare but with very little discomfort.
- **Scotopic VA is reduced**.
- **Excellent contrast** sensitivity.
- Division and loss of light does occur.
- **Excellent distance UCVA OU mandatory.**
- Excellent intermediate vision is present.
- Near VA in our small series was very good.

OU. Patients who do not have better than 0.8 uncorrected distance VA will not be happy even if they have good uncorrected near VA.

Whether micro-monovision was targeted or inadvertantly achieved, the results are often excellent with no more side effects than when both eyes achieved emmetropia. The distance OU UCVA is once again the crucial value.

Post-op residual astigmatism should be less than 1.00 dioptre. This astigmatism is the culmination of a number of factors, including pre-op astigmatism, surgical technique, limbal relaxing incisions as well as the possible use of toric IOLs.

The presence of even the slightest PCO will decrease UCVA and increase side effects. Early YAG laser capsulotomy is more important than with monofocal IOLs.

The take-away messages are summarised in *Figure 29*.

Figure 29. Summary

- **Patient selection:** always of prime importance.
- Excellent **distance UCVA OU** is imperative.
- **Micro-monovision** can be very effective.
- **Scotopic VA** is usually reduced.
- **Disphotopsia always present** but may diminish over time.
- **Post-op** astigmatism **must be less** than 1 dioptre.
  - Astigmatism post-op is the result of any of the following:
    - Pre-op astigmatism
    - Surgical technique
    - Limbal relaxing incisions
    - Toric multifocal IOLs
- Even **slight PCO** can reduce VA and increase side effects: Do early YAG.

Scotopic visual acuities are always diminished due to the inherent characteristic of the MF IOL to divide light.

After all is said and done somebody has to be the funder of the surgery.

The cost of these so-called premium lenses is a major factor in patient selection.

If cost was not a factor, we would probably implant MF IOLs in more than 50% of patients' eyes after cataract surgery. Presently this number is between 5% and 10%.

In 2015 we compiled a list of MF IOL prices which varied between R3 695 and R10 231 per MF IOL. These were the Nappi prices and included VAT.

Conclusions

Multifocal IOLs represent excellent technology and definitely have a place in refractive lens surgery, whether for cataracts or clear lens extraction.

If all the criteria as discussed above are met, patients can expect very good results and surgeons can expect high levels of patient satisfaction.

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Comparing six multifocal IOLs over six years

CPD Article **Questions**

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Questions **True** or **false:**

1. The Alcon Restor IOL is apodised. T F
2. The Lentis Mplus IOL is trifocal. T F
3. The Alcon Restor loses or reflects 18% of incoming light. T F
4. The near vision segment of the Lentis Mplus must be in line with the visual axis. T F
5. The Physiol Fine Vision trifocal IOL is a diffractive IOL. T F
6. The Hanita Bunnylens MF is a trifocal IOL. T F
7. The Zeiss AT Lisa Tri is also available in a toric version. T F
8. The Tecnis Symfony is a bifocal IOL. T F
9. Patients with MF IOLs are very insisting on good Uncorrected Near VA (UCNVA). T F
10. All presbyopia-correcting IOLs cause side effects. T F

This is to state that I have participated in the CPD-approved programme and that these are my own answers.

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