

The Monovision Approach to Presbyopia

by Dasi Raju

Presbyopia affects an estimated 10.4 billion people globally and, as eye care providers, we are faced with the daily challenge of finding the best solution for our presbyopic patients. There are numerous approaches to treat presbyopia, each has its own benefits and limitations.

Current solutions for presbyopia correction include spectacles, contact lenses or refractive surgery. In the past few decades, with advances in technology, patients have become far more discerning with the type of visual solutions that are presented to them with more and more patients exploring the option of surgical solutions.

Current presbyopic surgical methods include refractive surgery of the cornea or crystalline lens (intraocular femtosecond laser ablation, corneal inlays, presby-lasik techniques and monovision); natural lens replacement with multifocal or monofocal monovision intraocular lens implants; modification of the sclerociliary complex (scleral implants or scleral ablation).

Monovision is a strategy or clinical technique used to compensate for presbyopia. It is aimed at targeting emmetropia on one eye (distance vision) and myopia in the other eye (near vision). The correction of presbyopia using monovision contact lenses was first introduced approximately 50 years ago and reports a mean success rate of 73%, ranging from 59% to 67% in the lower end and increasing to 80% when contact lens intolerance issues are extracted.

In recent years, it is becoming an increasingly popular option in refractive surgery with success rates ranging from 72% to 97.6%.

The key to such a staggering success with Mono Vision is meticulous patient selection and education as not everyone is an ideal candidate.

As Optometrists, one of the foundations of our teachings has been the creation of clear, comfortable binocular vision in patients. Even though monovision challenges this concept, it has gained widespread acceptance due to the success rates.

Monovision creates anisometropia which seems to be well tolerated by those that adapt to this concept. The mechanism that allows monovision to succeed is called inter-ocular blur suppression which happens regionally between corresponding retinal points. This is the ability of the binocular system to partially suppress or compensate for this inter-ocular blur. Schor and Erickson demonstrated that inter-ocular blur suppression in monovision can be inhibited by the presence of strong sighting preference. Such patients with a strong sighting preference would be expected to have increasing difficulty maintaining clear vision at all distances. On the other hand, patients with an absence of sighting preference seem to successfully suppress interocular blur. Individuals presenting with alternating dominance represent the ideal candidates for monovision as they would be expected to experience little difficulty maintaining clear vision as gaze shifts from one distance to the other.

Studies have found that inter-ocular suppression of blur is effective under photopic viewing conditions but that anisometric blur is not suppressed binocularly under high contrast mesopic and scotopic conditions, such as while driving a car at night. During night time driving, the patient sees a large blurry headlight image in the near eye and a smaller clearer image in the distance eye. It is more difficult to suppress the out-of-focus image in the near eye in such a high-contrast situation.

Eye dominance is recognized as one of the important factors in monovision success. Ocular dominance is a tendency to prefer visual input from one eye suggesting that the dominant eye has perceptual processing priority.

Many practitioners feel that the best monovision theory is to correct the dominant sighting eye for distance viewing. Distance vision is more important for spatial-locomotor tasks like walking, running and driving. The non-dominant eye is corrected

for near viewing tasks that do not require visual direction and spatial-locomotor abilities. In a review of the monovision literature, when the dominant eye was corrected for distance vision (conventional monovision), the success rate was higher. The success rate in crossed monovision patients dropped to as low as 50%.

Evans categorised dominance tests as being either sighting, sensory or motor.

Examples of sighting dominance tests are :

The Dolman method : the subject is given a card with a small hole in the middle and instructed to hold it with both hands. The subject is then instructed to view a distant object through the hole with both eyes open. The observer then alternates closing the eyes or slowly draws the opening back to the head to determine which eye is viewing the object (i.e. the dominant eye)

The Miles test: the observer extends both arms, brings both hands together to create a small opening, then with both eyes open views a distant object through the opening. The observer then alternates closing the eyes or slowly draws opening back to the head to determine which eye is viewing the object (i.e. the dominant eye).

The Porta test: the observer extends one arm, then with both eyes open aligns the thumb or index finger with a distant object. The observer then alternates closing the eyes or slowly draws the thumb/finger back to the head to determine which eye is viewing the object (i.e. the dominant eye)

In sensory dominance tests blur suppression appears to be the sensory mechanism by which nearly all people can suppress small amounts of blur. The concept of inter-ocular blur suppression is best explained using the Humphriss Immediate Contact binocular refraction technique where one eye is blurred by approx +0.75 to +1.00D whilst the other eye is refracted. This allows the clinician to refract the eye under binocularly balanced conditions, but without the patient's perception that the blurred

eye interferes with the process. In this method, the patient does not experience retinal rivalry but instead suppresses the blurred image. Evans noted that people differ in their ability to suppress inter-ocular anisometropic blur as some patients can suppress much higher degrees of blur. He also noted that people may also have differing abilities to suppress blur in each eye, and testing the blur suppression in each eye might be a useful method of predicting which eye should be given the distance lens.

Similarly, in the lens fogging technique, the subject fixates a distant object with both eyes open and appropriate correction in place. A +2.00 or +2.50 Dioptre Sphere lens is alternately introduced in front of each eye, which blurs the distant object. The subject is then asked to state in which eye is the blur more noticeable. This is the dominant eye.

Vision encompasses a variety of visual functions including visual acuity and stereo acuity. Binocularity and stereo acuity have been gaining importance due to the increasing demands for three dimensional perception in our daily lives. With the advent of three dimensional entertainment options, and an increasingly competitive world of sports, the precision of appreciating depth is more important than ever before. Several investigators have reported reduced stereopsis in monovision patients indicating that stereopsis is sensitive to induced anisometropia.

McGill and Erickson evaluated near point stereopsis in patients wearing monovision contact lenses and 4 types of simultaneous vision bifocal contact lenses. They found that all presbyopic contact lenses produced a reduction in stereoacuity when compared to the base line. Simultaneous vision bifocal contact lenses provided no significant advantages over monovision in conditions requiring

stereoacuity. Singh and co-authors showed that distance and near stereo-acuity fell significantly with the induction of a monocular myopic shift starting from as little as 1 Dioptre.

However, Wright and co-authors noted that stereo acuity measured with the Worth 4-dot test and the Titmus stereo test is not statistically different in monovision and distance-only patients. This was consistent with Goldberg's questionnaire results from patients undergoing LASIK indicating that any subjective problems or lack of problems with depth perception were independent of whether patients had LASIK monovision or LASIK full distance correction.

Braun et al noted that patients with successful monovision have a smaller reduction in stereoacuity than patients with unsuccessful monovision.

Gutkowski and Cassin found that stereoacuity was reduced only for patients with reading adds above 2.25 D. Wright et al. recommended that the anisometropia induced by photorefractive keratectomy should not exceed 2.0 D. He reported that deficits in stereoacuity were associated with large anisometropia: the worst stereoacuity (800 sec arc for distance and 400 sec arc for near) was reported for a patient with induced anisometropia by photorefractive keratectomy of 3.13 D.

At Optical Express we analysed the outcomes of 102 monovision LASIK patients (204 treatments). The LASIK treatments were done using the VISX S4 Customvue IR with patients having either conventional or iDesign treatments. All flaps were created using the iFS Advanced Intralase Femtosecond laser.

The female: male ratio was 79.2%: 20.8% and ages ranged from 42 years to 76 years with the mean age being 52.8. The pre-operative myopic manifest sphere was -3.74

± 2.03 (-10.00 to -0.25) and the pre-operative hyperopic manifest sphere was $+1.88 \pm 0.67$ (0.75 to 3.75). The manifest cylinder treated was -0.65 ± 0.66 (-3.00 to 0.00). All patients were identified as having monovision as the goal of the treatment.

As part of the pre-operative assessment, the following sequence was used to determine patient acceptability of monovision:

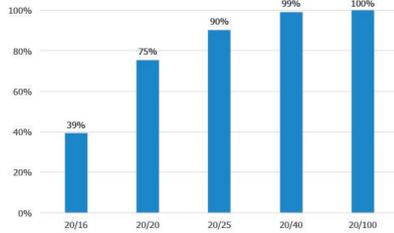
1. Monovision benefits and compromises were discussed with the patient.
2. Ocular Dominance was determined using sighting dominance methods
3. Monovision was demonstrated through the phoropterhead or trial frame, typically placing the distance correction in the dominant eye and distant correction combined with a +1.50DS add in the non-dominant eye.
4. If the patient clearly accepted monovision through the demonstration, no contact lens trial was done.
5. If the patient clearly rejected monovision through the demonstration, an alternative recommendation was discussed with the patient.
6. If the patient was undecided or if the patient had high visual demands for distant or near vision due to their hobbies or occupation a contact lens trial was done using the following approach.
 - a. The appropriate contact lenses was fitted to correct distant vision in the dominant eye and distant vision correction combined with a +1.50DS add in the non-dominant eye.
 - b. When the patient was comfortable with the contact lens, the patient was asked to undertake distance and near visual activities.
 - c. The patient was reassessed after a period of adaptation, typically 30 minutes or longer.
 - d. If the patient clearly accepted monovision, we proceeded with the applicable treatment plan
 - e. If the patient was still unsure if they could accept monovision, the patient was counselled on contact lens use and a follow up appointment was made. If the patient was happy with monovision, we proceeded with the treatment plan.
 - f. If after this multi-step evaluation the patient was still unsure, we discussed alternative options to monovision.
7. The distance eye, the near eye and the target refraction for the near eye in the patient was recorded.

At the 1 year stage, in the distance eye, 90% of patients had an uncorrected distance visual acuity of 20/25 or better, with 99% achieving driving standards vision. (20/40 or better)

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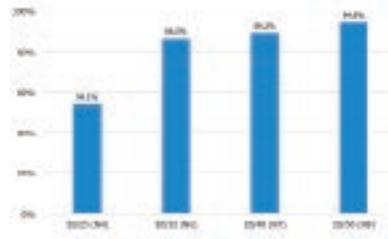
At the 1 year stage, in the distance eye, 90% of patients had an uncorrected distance visual acuity of 20/25 or better, with 99% achieving driving standards vision. (20/40 or better)

Year 1 UCDVA (distance eye)



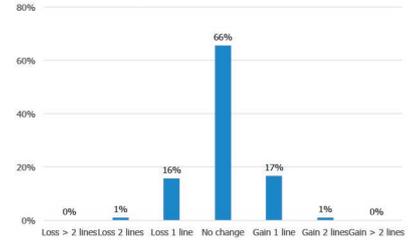
At Year 1, 94.6% were able to read newspaper print (N8 or better).

Year 1 UCNVA (near eye)



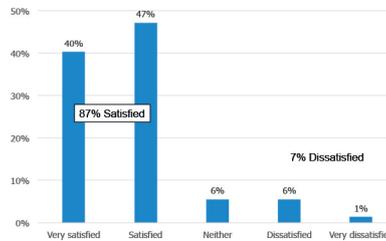
Most patients had either unchanged or better BCDVA with no eyes losing more than 2 lines of vision.

Year 1 Change in BCDVA (distance eye)

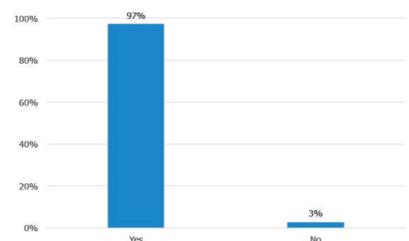


In this analysis, we presented patient satisfaction outcomes at 1 year. Patient satisfaction of subjects attending a 12 month exam was high with 87% reporting being satisfied with the procedure whilst 97% reported they would recommend the procedure. In our experience, most patients that attend for a 1 year follow up are those that experience regression or other issues. Despite this evident bias, the satisfaction was still high.

Satisfaction with Procedure

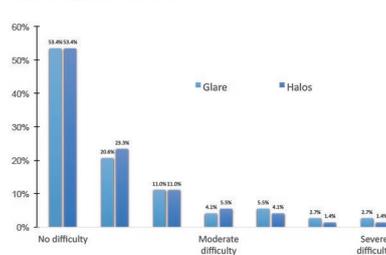


Recommend Procedure

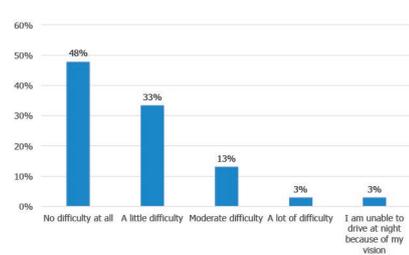


Previous studies have indicated that this inter-ocular suppression of blur is effective under photopic viewing conditions but that anisometropic blur is not suppressed binocularly under high contrast mesopic and scotopic conditions, such as while driving a car at night. During night time driving, it is more difficult to suppress the out-of-focus image in the near eye in such a high-contrast situation. In our analysis, 53.4% of patients had no difficulties with glare and haloes and 48% had no difficulty with night driving. At 1 year, as little as 2.7% and 1.4% of patients experienced severe difficulty with glare and haloes respectively, despite the monovision viewing set-up.

Quality of Vision

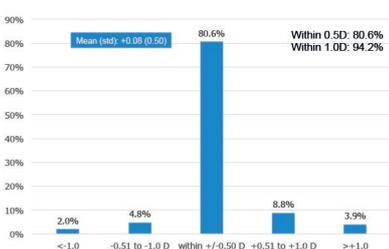


Night Driving



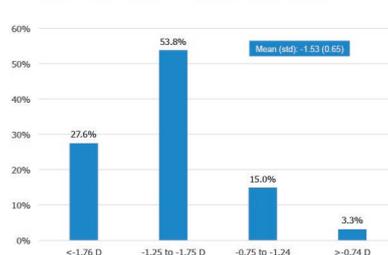
The mean manifest spherical equivalent at 1 year was very close to plano (+0.08D) and 94.2% of eyes aimed for distance vision were within 1 D of emmetropia.

1 Year Manifest MRSE (distance eye)



The mean manifest spherical equivalent at 1 year in the near eye was -1.53D with just over 50% of patients being between -1.25 and -1.75D in the reading eye. During the LASIK treatments we targeted myopia of -1.50 for the reading eye.

1 Year Manifest MRSE (near eye)



The Monovision Approach to Presbyopia

Our study concluded that monovision is a viable option for presbyopic patients who require good distance and near vision. However, it is important to achieve good uncorrected distance visual acuity. Consequently, although we did not examine enhancement rates in this analysis, it is expected that enhancement rates would be higher than bilateral distance-only LASIK treatments.

Patients who understand the limitations of monovision have been shown to adapt better, hence a detailed discussion is mandatory. The patient must receive an explanation of presbyopia and accommodation. Although this is time consuming, it demands effective communication. Goldberg noted that it is important to communicate that monovision is a compromise that does not restore normal physiology, but compensates for the loss of accommodation.

This discussion should include the fact that although monovision aims to reduce dependence on spectacles, there are still instances when a supplementary correction will be needed for sustained or critical distance or near tasks like night driving or concentrated near work. An audit of 114 patients with Lasik monovision by Levinger found that although 90% felt that their main goal had been achieved, 8% used glasses for distance vision and 4% used reading glasses.

Dr. Mickey Gordon calls monovision “walk-around near vision.” It makes you functional for most things, but it's not perfect, and will not restore the ability to focus that patients had in their 20's and 30's.

A brief summary of some of the limitations of monovision is listed below:

- Monovision is inevitably limited by the inability to incorporate an intermediate correction without compromising distance or near vision. This is a potential problem for VDU users.
- Although an ability to suppress is a good thing, this may be causal in the decreased stereo acuity in monovision.
- Contrast sensitivity is reduced with monovision.
- It has the potential to reduce binocular distance visual acuity by 0.5 – 0.8 Snellen lines.
- Ghosting or haloes around lights at night occurs as a consequence of a failure to suppress blur.
- Blurred vision can occur when looking at side mirrors with the near eye.
- In the adaptation period patients can experience eye strain, headaches and feeling imbalanced.
- Visual results must be excellent for monovision to succeed. Patients are very sensitive to even a slight reduction in VA on the distance eye, hence one would expect to have an increase in the enhancement rate with monovision.

Another important factor that needs consideration is the clinic-legal aspect of monovision. Harris and Classe advocated recording informed consent and stressed the importance of giving the patient realistic expectations. Of particular interest is an aircraft accident that appeared to be attributable to a combination of irregular spacing of lights on the runway approach, poor visibility and the wear of monovision. The practitioner that fitted the pilot with monovision argued that he was unaware that he was a pilot, which highlights the need for practitioners to question their patients' vocational requirements and to advise accordingly.

These limitations are important as we can use them to profile the unsuccessful monovision patient.

In profiling the ideal candidate, the following questions can help with the decision to offer patients monovision:

- Do you enjoy activities that require sharp distance vision?
- Do you read for long periods or have a hobby that requires precise near vision?
- Do you drive extensively at night?
- Are you very discriminating with the quality of your vision?
- Do you have an occupation that precludes MV eg high speed sports, pilot, etc.

Following our analysis of monovision patients, at Optical Express we use the following algorithm for monovision selection with the Presbyopic patients.

1. If a patient is unwilling to accept wearing reading glasses after surgery, monovision should be discussed as an alternative to compensate for presbyopia.

2. Assess psychological factors like motivation and persistence.

3. Discuss occupational, lifestyle needs, sports and hobbies.

4. Full discussion of the possible limitations and the possible need for supplementary spectacles. Patient selection and managing expectations on the front end are critical. The most important factor is that freedom from spectacles is a high priority to the patient and they are willing to accept compromises in the overall quality of vision to attain that goal.

Patients must understand that monovision may provide a good functional range of vision for most tasks, however, they may still need spectacles for certain activities like night driving and prolonged reading.

5. A formal Contact Lens trial is not necessary with every patient who wishes to undergo a monovision refractive surgery procedure. An in-clinic simulation supported by the phoropter is sufficient in many cases.

6. Effective communication with the patient after the trial is paramount to ensure the correct decision for surgery.

7. The optimal target for the near eye regardless

of age is -1.25 to -1.75 dioptre sphere.

This can be summarised with the 3D's: discussion, demonstration and documentation. In conclusion, surgical monovision represents a well-established and highly satisfactory method to achieve functional distance and near vision, however, the overall success is dependant on careful patient selection and education as not every patient can adapt to monovision. By applying a refractive surgery approach to monovision, the problems of contact lens intolerance are avoided and an effective optical solution to presbyopia is achieved.

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