One depth of focus channel for presbyopes

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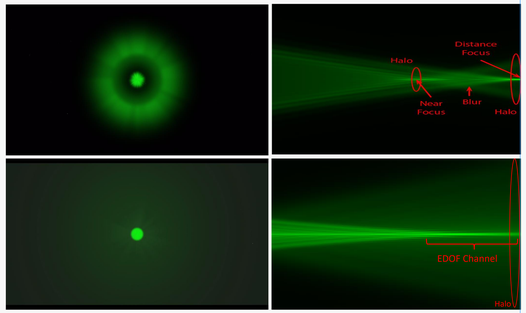
Purpose: Using relative plus power to extend the functional vision range has been a primary method to correct presbyopia. Simultaneous vision lenses are typically limited to +2.00D ADD or less due to visual disturbance that is associated with the ADD power. A contact lens design[1] using catenary optics to maximize the amount of relative plus power with minimal visual disturbance was evaluated for its optical characteristics and visual performance.

Methods: Ray tracing with a model eye was used to characterize VTI's catenary optics to understand the optical profile in relationship to the retina. The modeling results were used to relate to clinical findings of a pilot study[2]. The clinical standard to evaluate the performance of the Extended Depth of Focus (EDOF) class of ophthalmic optics, the Defocus Curve, was determined. The Defocus Curve is a means to evaluate wearer's visual acuity at various viewing distances. The eye chart was placed at distance (0.00D) and the viewing lighting condition kept constant. A series of positive and negative lenses (+2.00 to -4.00D, 0.50D steps) were used to simulate the changing vergences from changing viewing distances. The comparison data (Baseline) was collected from mature presbyopic (≥+2.00D ADD) subjects' Best Distance-Corrected spectacle lenses. The treatment data was collected from the same subjects wearing Neurofocus Optics® technology contact lenses. The extended range of wearer's DOF provided an uninterrupted clear vision from far to closer than 25cm (-4.00D and beyond).[2]

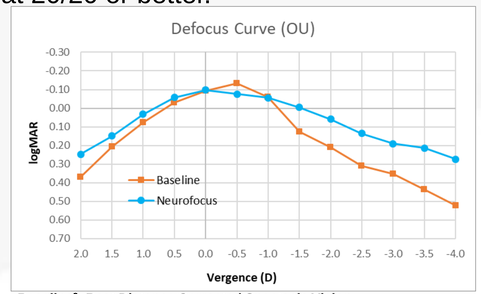
Results: The Catenary[3] surface tends to be spherical-like over a smaller central region but has a much higher level of peripheral steepening when compared to the conic surface. The Catenary optic effectively created a non-interrupted long and skinny EDOF channel. The resulting halo spreads out over greater than ±30 degrees of retina. The intensity of halo per unit area was significantly reduced as the result of the large area of coverage. As there was no abrupt power change, there was no hot spot. These two characteristics could provide easy neuroadaptation and allow the wearer to benefit from the EDOF without suffering from disturbing halos.

Bifocal optics
- Halo and ghosting could be obvious
- Defocus treatment area is limited

Neurofocus Optics® (Catenary)
- Halo evenly spread out, reduced intensity (<20% of +2D)
- Defocus treatment area significantly increased >±30˚



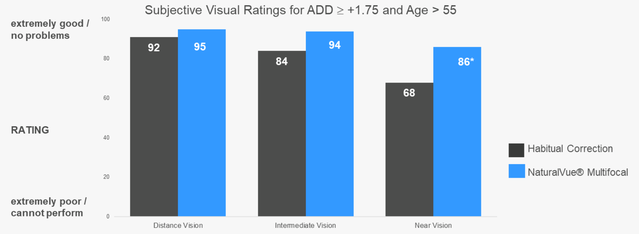
Results: Defocus Curves clinical data from this design show a full range of functional vision (Distance to 30cm) for mature presbyopes (≥+2.00D ADD). Distance and intermediate vision were maintained at 20/20 or better.



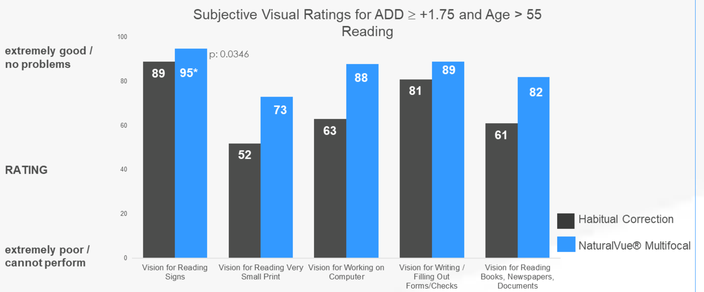
Baseline[2]: Best Distance Corrected Spectacle Vision
Neurofocus improves Intermediate and near vision without significant reduction in distance vision

Results cont'd.:

Near and intermediate vision are improved without a decrease in distance vision.[4]



Near vision is significantly improved, especially for strong reading demands such as for very small print.[4]



*p<0.05, NaturalVue® Multifocal 1 Day contact lenses statistically significantly different vs habitual correction

Conclusions: Contact lenses with catenary optics provide a high magnitude of ADD power with minimal optical disturbance. Clinical data indicated a full range of functional vision without sacrificing distance visual quality even for mature presbyopes.

References:
1. Patents Awarded – MULTIFOCAL OPHTHALMIC LENS WITH INDUCED APERTURE. See https://vtivision.com/about/patents/ for patent numbers.
2. VTI data on file. 2022. n=10. Data collection ongoing.
3. Wikipedia. Accessed November 2022, from https://en.wikipedia.org/wiki/Catenary
4. VTI data on file. 2015. n=59. Data assessed after 1 week of wear.

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