Adjustable focus air lens affords novel solution for presbyopia

Courtesy of Paul A R Meyer MD FRCP

Manual alteration of the separation of the bars from any point adjusts the focal lengths of both lenses, identically.

Cheryl Guttman in Ft. Lauderdale

SPECTACLES created with an adjustable focus air lens are able to provide presbyopic patients with a high resolution, full field of view regardless of focal length, according to innovator Paul A.R. Meyer MD FRCP.

Dr Meyer, consultant medical ophthalmologist, Addenbrooke's Hospital, Cambridge, UK, described the principles of the technology and demonstrated its performance with a prototype system at the annual meeting of the Association for Research in Vision and Ophthalmology.

"Current spectacle lens options for reading vision offer a wide field of view only if they have a single focal plane. Those with multiple focal lengths have either discrete facets for infinity and the near point or, in the case of progressives, small zones for distance and near, joined by a narrow corridor of increasing power. The air lens overcomes the drawbacks of those designs by offering a fully adjustable focal length from infinity to the normal near point, with a wide field of view for any working distance," explained Dr Meyer.

Dual lens system

The air lens design incorporates a novel optical system and actuating mechanism. The optical system consists of two lenses – a plano-concave lens and a plano-convex lens that have identical radii of curvature so that when placed with their curved surfaces in apposition, they nest together perfectly.

The two lenses are pulled apart using the actuating mechanism, and the spherical air gap created between them develops positive power that increases in magnitude in proportion to increasing depth of the cleft. It is because of its continuously variable power that the air lens provides clear focus at any distance.

"Separation of the two lenses creates a spherical air cleft with consecutive divergent and convergent surfaces. Incoming light from an object diverges at the first surface and strikes the second surface further from the optical axis, hence with a greater angle of incidence. Since deviation of a ray at a refractive interface is proportional to its angle of incidence (Snell's Law), light is converged by the second surface more than it has been diverged. As the distance between the surfaces widens, that difference increases and the air lens becomes more powerful." explained Dr Meyer.

The mechanism for achieving lens separation is integrated into a lightweight spectacle frame. It is based on a simple concept, which is often used in engineering applications that require reorientation of moving components.

The activating mechanism uses crossed elements that join two parallel bars from which the lenses are suspended. The crossed elements form an adjustable lattice that can be expanded or shortened to alter the distance between the two lenses in the optical system.

The elements of the lattice are arranged such that force applied at any single point is transmitted to the entire system. Therefore, actuation of the entire system can be achieved by just using the fingertips of a single hand to move the lattice on one side of the spectacles, Dr Meyer explained.

In addition, the system performs precisely to fulfil the need for identical simultaneous adjustment of both sets of lenses.

"In a binocular system, the lenses serving both eyes must be adjustable identically and concurrently. Measurements on our prototype during manual activation from one side found that separation of the two lens pairs differed by less than 0.1 mm over a distance range of 0-15 mm," reported Dr Meyer.

Visually comfortable

Dr Meyer notes that the air lens design also offers other optical advantages. Although the principle planes of the two individual components lie at their spherical surfaces, the principle plane of the lens combination is projected close to the anterior segment of the eye, i.e., at the location where refraction normally occurs.

"As a result, there is maximisation of the available aperture and no image magnification so that the vision provided by this system feels extremely comfortable," Dr Meyer said.

In addition, the parallel orientation of the spherical surfaces minimises the astigmatism that is usually encountered when gazing through a conventional lens at an oblique angle.

Dr Meyer explained that because the air gap is a sphere centred on the axis of rotation of the globe, an individual is always looking through its optical centre regardless of the direction of gaze.

"Avoidance of induced astigmatism as a result of changes in angle of gaze is particularly relevant for these lenses intended to treat presbyopia, considering that the wearer will be converging the eyes to examine near objects," Dr Meyer said.

Patent applications have been submitted to cover the optical system and frame mechanism. Dr Meyer is working with Cambridge Enterprise (who transfer all technology from Addenbrooke's Hospital and Cambridge University) in developing the adjustable focus air lens.

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