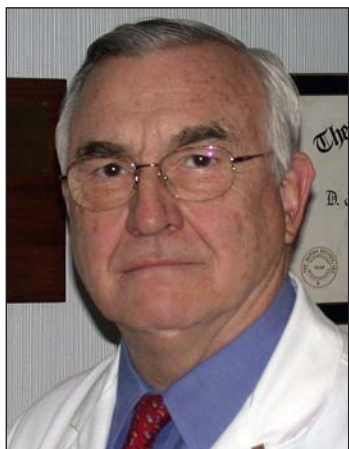


Accommodation and presbyopia debate continues



Jackson Coleman

Cheryl Guttman in Lisbon

THE mechanism of accommodation and the effects of age on that process continue to be subjects of controversy. Delivering the keynote address during a session on accommodation at the XXIII Congress of the ESCRS, D. Jackson Coleman MD told the audience that there is abundant evidence to support the catenary theory.

"The inability to measure some of the components of accommodation has given rise to a number of theories that remain unproven. However, in keeping with the principle of Occam's razor, which states entities should not be multiplied beyond necessity, I propose that the catenary theory is the simplest explanation and therefore the best. The catenary theory accounts for all observable features of accommodation, including the rapid, reproducible changes in lens shape that occur, and relative to other theories, it also allows for much simpler explanations of the effects of accommodative lenses and presbyopia surgery," said Dr Coleman, chairman, department of ophthalmology, Weill Medical College, Cornell University, New York.

A catenary is the curved shape formed when a perfectly flexible,



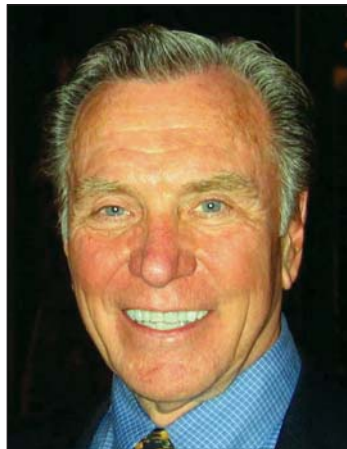
Henk Weeber

uniformly dense, and inextensible cord is suspended so that it hangs freely from its endpoints. That shape is characterised by a steeper anterior curvature and a relatively flat fall off in the periphery, and is illustrated by the geometric form of the curving main cables of suspension bridges, such as the Golden Gate Bridge in San Francisco or the 25th of April Bridge in Lisbon, Dr Coleman explained.

In the eye, the curve formed by the anterior lens surface represents the catenary and the ciliary body is the equivalent of the pylons of the suspension bridge that directs the catenary shape.

Dr Coleman's catenary theory proposes that the lens, zonule, and anterior vitreous form a diaphragm between the anterior and posterior chambers of the eye. Contraction of the ciliary muscle for accommodation causes a piston-like forward movement of this entire diaphragm that creates a pressure gradient between the anterior and posterior chambers and supports a steep radius of curvature of the anterior lens surface while causing a slight flattening of its posterior face.

"Vitreous support allows the posterior capsule to remain unchanged while the anterior lens shape is restrained by the inelastic capsule to form the catenary curve," he explained.



Spencer Thornton

Evidence supports theory

Dr Coleman said that every anatomic change measured in the human eye during accommodation, including the decrease in lens equator and the steepening of the lens anterior curvature, can be accounted for by the model of a catenary. In addition, available evidence from anatomic and physiologic studies is consistent with the catenary theory.

That evidence includes: 1) the relatively inelastic nature of the lens capsule, 2) the presence of vitreous support to shape the lens, and 3) the presence of accessory collagen and zonular support in the anterior peripheral vitreous that produce tangential support of the lens, but not equatorial traction force.

Dr Coleman presented images from high-frequency ultrasonography demonstrating presence of accessory zonules in the anterior vitreous and a diaphragm consisting of the anterior vitreous, zonules, accessory zonules and the lens that together are capable of producing a catenary shape. Other studies characterising the zonular apparatus and zonule insertion in the lens indicate there is a backward directed force that is not directly equatorial, and that would require vitreous support, he said.

Dr Coleman also described studies he performed in primate

eyes demonstrating that ciliary body stimulation produced a pressure difference between the vitreous and aqueous compartments. He noted that finding is consistent with the concept that the vitreous compartment supports the catenary shape of the lens and provides evidence for the existence of a "diaphragm" between the vitreous and anterior chamber.

"Furthermore, as every cataract surgeon knows from experience with capsulorhexis creation, the capsule is relatively inelastic tissue," Dr Coleman said.

Construction of a mechanical model of the catenary theory demonstrates how it can account for the rapid, reproducible, and precise change in lens shape that occurs with accommodation. The model uses a latex balloon lying on a plastic wrap platform that is suspended between two support rods. Dr Coleman showed that reduction of the distance between the rods by 4% from 12.5 cm to 12.0 cm results in increased steepness in the catenary shape that matches the change in the anterior lens geometry occurring with accommodation.

