



Nick Lane

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The mechanism of accommodation and its relevance to presbyopia has been debated since Victorian times, and the arguments are still surprisingly vehement. Are new data bringing us any closer to a resolution?

Sir Arthur Conan Doyle, author of the Sherlock Holmes books, also wrote a book called *The Lost World*, dominated by a brilliant and insufferably arrogant scientist, Prof Challenger. After an expedition to the lost world – a remote and inaccessible plateau in South America, where dinosaurs still roam – Challenger returns to London to present his findings to a public meeting of the Royal Society. A ferocious argument erupts, which is only resolved when the professor lets loose a pterodactyl, which flaps slowly around the Natural History Museum, before escaping through a window.

Science doesn't usually arouse such high passions these days, though we still rely on data – if a pterodactyl can be regarded as a datum – to support any conclusions. *The Lost World* was written in 1912, more than half a century after Helmholtz started another long-running and at times equally acrimonious debate, now 150 years old, on the mechanism of accommodation. Despite the release of a whole pack of pterodactyls, or at least data, the debate still retains a Victorian sense of melodrama and personality, and indeed some protagonists do occasionally come alarmingly close to blows.

In essence, Helmholtz argued that constriction of the ciliary muscle releases the tension on the zonules, leading to a relaxation and rounding of the lens, so increasing its power. Some 40 years later, Tscherning argued more or less the opposite: that ciliary-muscle contraction increases the tension on the zonules, thereby altering the shape of the lens without changing its thickness. Another prominent theory, originally postulated by Mueller around 1854, and given modern form by Coleman, is that accommodation is achieved through anterior movement of the lens, under pressure from the vitreous. But it was the resurrection of Tscherning's conception by Schachar in the 1990s that re-injected the sense of Victorian melodrama into the debate.

"People get very resolute in their beliefs," Dr Spencer Thornton MD, University of Tennessee Health Science Center, Memphis, told *EuroTimes*. "There's been a big resistance to anything beyond Helmholtz. I don't doubt that increased lens sphericity contributes to accommodation, but in my view there are at least six mechanisms that all contribute partially including anterior lens movement, the belt action of the iris, and indeed gestalt, the brain's ability to interpret."

The flip side of the coin is presbyopia. The Helmholtzian view posits sclerosis of the

lens, by which he is usually taken to have meant a loss of elasticity, preventing the rounding necessary for accommodation. The hypothesis doesn't predict changes in the zonules, the ciliary muscle, lens movement, vitreous phase or lens growth, all of which are modified to some extent as we age, though not necessarily at the same rate as the progression of presbyopia.

In contrast, a gradual loss of tension on the zonules with age is central to the Schachar theory of presbyopia. Continuous lens equatorial growth throughout life is posited to lower zonular tension, thereby rendering the zonules unable to pull the lens into the correct shape to accommodate. To its great credit, the theory makes a number of testable predictions, many of which are the polar opposites of the Helmholtzian view.

In particular, the equatorial diameter of the lens should increase with age, lowering zonular tension. Anything that can restore zonular tension, such as scleral expansion/spacing, should in principle restore accommodation (assuming that the lens has not become too sclerotic in the interim). In contrast, if presbyopia is caused by hardening alone there is no reason whatsoever why scleral spacing should work. If it does work, then Helmholtz must have been wrong about the cause of presbyopia, and by extension, about the mechanism of accommodation too.

Scleral spacing and the mechanism of accommodation

The latest round of results of the scleral spacing procedure were presented in Barcelona, this November, at the first congress of the International Presbyopia Society by Barrie Soloway MD, of the New York Eye and Ear infirmary.

"The fact is it works," Dr Soloway told *EuroTimes* "though frankly I've given up worrying about exactly how. It could be supporting the Schachar theory, but it's also compatible with the Coleman theory of anterior lens movement," he said.

In October, the FDA phase III trial had recruited a total of 135 patients and 32 controls. In the treatment group, visual acuity had improved from 20/63 or worse at entry to 20/50 or better in 87 per cent of patients; 20/40 or better in 76 per cent of patients; 20/30 or better in 46 per cent of patients; and to 20/25 or better in 18 per cent of patients.

These results were achieved without any loss of distance acuity, over a minimum six-month period. Follow-up is planned for two years. The difference with the control group (in whom VA remained unchanged) was statistically significant, and Dr Soloway is quick to point out that measures of near vision like the Landolt C test at 40cm are objective endpoints: "Either you can see where the square is missing from the circle, or you can't," he said.

There have been relatively few complications compared with earlier prototype scleral spacing implants, and in particular almost no cases of anterior segment ischemia, conjunctival erosion, irritation or inflammation.

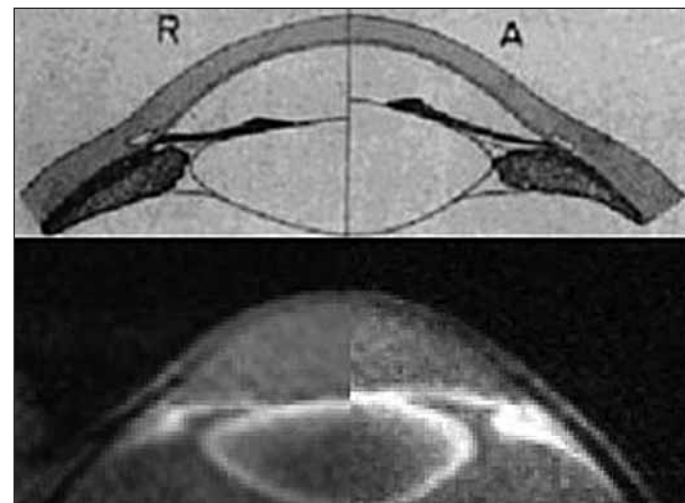
Despite improvements in the implants, the most common complication was still subluxation; Dr Soloway noted a total of eight cases. In a sense, however, subluxation provided a proof of concept: "Visual acuity deteriorated during subluxation, in some cases to 20/80 or worse, and was restored to 20/40 or better when we corrected the subluxation."

Dr Thornton sees the results as vindication for his own technique of ciliary sclerotomy, which he argues is safer and more effective, utilising as it does four radial incisions to the ciliary body, rather than the transverse incisions of scleral spacing; but in both cases the intention is to expand the globe, increasing the space and freedom of movement in the anterior segment – freeing the lens from 'crowding', as Dr Thornton puts it.

The clinical trial of ciliary sclerotomy will start recruiting patients in early 2007.

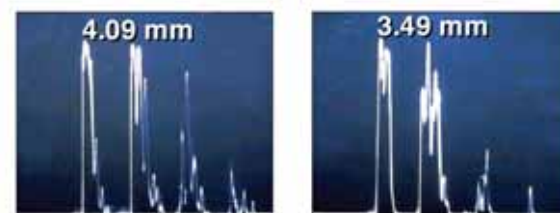
But the positive scleral spacing results have not gone unchallenged. While not disputing the measured benefits to near vision, Prof Jane Koretz, PhD, at the Rensselaer Polytechnic Institute, Troy, New York, contests their relevance to accommodation.

"The real difficulty is that measuring visual acuity does not give an indication of whether accommodation is occurring. There might be some advantages of the technique, but these could just as easily be artefacts caused by alterations to the cornea," she told *EuroTimes*.



Composite image of relaxed accommodation and accommodation compared to Helmholtz's classic drawing

A-Scan demonstrates shallowing of anterior chamber with anterior movement of lens on accommodation



(L) Distance Fixation, and (R) Near Fixation

To Increase Working Room



- A small IOL in the aphakic eye allows more working room in the posterior chamber (top).
- In the phakic eye an enlarged posterior chamber is needed to give more room for the lens (bottom).

