Using stem cells to treat age-related macular degeneration (AMD)

An MRC-funded research team at University College London has developed, for the first time, stem cell-derived retinal pigment epithelium (RPE) cells for the treatment of age-related macular degeneration.

Age-related macular degeneration (AMD) is an eye condition that affects the macula — a tiny part of the retina at the back of the eye. AMD causes problems with central vision; it may make the central vision distorted or blurry, and over a period of time, it may cause a blank patch in the centre of vision.

Age-related macular degeneration (AMD) is the leading cause of blindness in people over the age of 60 in the Western world. About 25 per cent of over 60s in the UK have some degree of visual loss due to AMD. This figure is expected to triple within the next 10-20 years.

Stem cells

Funded by the MRC, Professor Pete Coffey at University College London’s Institute of Ophthalmology has led the development of stem cell-derived retinal pigment epithelium (RPE) cells for the treatment of AMD, resulting in the first clinical trial of a human embryonic stem cell-derived therapy in the UK.

The retinal pigment epithelium cells form a thin sheet lining the inside of the eye, under the retina. It is thought that AMD occurs when these cells are damaged. Professor Coffey and colleagues at the London Project¹ are pursuing two routes to replace RPE cells, firstly deriving them from human embryonic stem cells, and secondly deriving stem cells from each patient, which allows individualised cell replacement and a near-perfect match for each patient.

Impact summary

Age-related macular degeneration (AMD) is the leading cause of blindness in people over the age of 60 in the western world. About 25 per cent of over 60s in the UK have some degree of visual loss due to AMD.

Sight loss has a significant impact on quality of life. One study estimates severe AMD to cause a 63 per cent decrease in quality of life².

The cost to the economy is also substantial. The indirect cost of sight loss to the UK economy was estimated to be £4.6 billion in 2008³.

The major causes of vision loss are AMD, glaucoma and diabetes. The age-related incidence of all three is rising and set to double between 2000 and 2020.

Professor Coffey’s work in this area has been funded by the MRC. The MRC is the leading funder of regenerative medicine research in the UK.

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Proof-of-concept

The researchers initially conducted proof-of-concept clinical trials at Moorfields Eye Hospital between 2007 and 2008 using RPE cells from the patients’ own eyes. These trials enabled the team to demonstrate that placing 'healthy' RPE cells under the damaged area of the macular can prevent blindness and restore sight. However, the complexity of the surgery did not allow for this to be a viable treatment for the number of AMD patients that would need treatment.

Restored visual function

The team then found that given the right conditions, human embryonic stem cells could be transformed into healthy, fully functioning RPE cells. They have demonstrated restored visual function in an animal model of AMD\(^4\).

The team have successfully grown RPE cells from both human embryonic stem cells and adult stem cells from specific individuals. These stem-cell derived cells not only behave like normal RPE cells when grown into sheets, but also have a gene expression profile identical to natural human RPE. This is important as any RPE-based transplantation strategy designed to treat AMD must show that the transplanted cells are faithful copies of the cells to be replaced.

Clinical trials

Clinical trials of human embryonic stem cell-derived RPE cell transplantation will begin in early 2014\(^5\), whereas the individual stem-cell derived RPE cells transplantation project is now entering the pre-clinical stage.

Photoreceptors

A further longer term and important arm of the project has been to develop the technology by which stem cells can be transformed into photoreceptors (primarily cones and rods) and transplanted into patients. It is believed that the photoreceptors are lost after the RPE cells have degenerated. The clinical application of this part of the project is for cases where the disease has been present for a number of years and the vision lost.

End notes

1 https://www.thelondonproject.org/
3 Future Sight Loss UK 1, Access Economics/RNIB, 2009
5 http://clinicaltrials.gov/ct2/show/NCT01691261?term=age-related+macular+stem+cell&rank=3