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The use of innovative scaffolds in the development of corneal stroma-derived stem cell therapies for future corneal regeneration strategies [Abstract]

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The Use of Innovative Scaffolds in the Development of Corneal Stroma-Derived Stem Cell Therapies for Future Corneal Regeneration Strategies

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There are 1.5 million cases of corneal blindness diagnosed annually, but only 100,000 corneal transplants performed. This is predominantly due to poor access to quality donor tissue. Therefore, alternative effective regenerative therapies are required. We have developed a bankable corneal stroma-derived stem cell (CSSC) source, for use in corneal regeneration. This follow-on work compares the feasibility of substrates to act in combination with CSSC, for the development of ocular surface regenerative strategies.

CSSC extracted from human corneoscleral rims were expanded on three substrates: (i) natural amniotic membrane-derived matrix (OmnigenTE™, NuVision™ Ophthalmics); (ii) Ologen Collagen Matrix (OCM; Aeon Astron B.V.); and (iii) Dual nano- and microfiber electrospun poly(lactic-co glycolic) acid (PLGA) scaffolds. CSSC expansion, proliferation, phenotypic marker profile and structural remodelling on the different substrates were assessed.

CSSC on OmnigenTE formed a monolayer, and maintained a mesenchymal stem cell phenotype (CD73+, CD90+, CD105+, CD34−), when cultured on the basement membrane. CSSC infiltrated the pores within the OCM and PLGA microfiber scaffolds, and a keratocyte phenotype was induced (CD34+, ALDH+, ACTA2−) leading to deposition of collagen and proteoglycans on the scaffolds. Addition of corneal epithelial cells onto the pseudo-basement membrane nanofiber layer of PLGA further restored normal epithelial-stromal interactions.

This work demonstrates the ability of different substrates to induce phenotypic changes in CSSC. CSSC-OmnigenTE has potential to become a topical stem cell therapy (biological stem cell bandage) for acute trauma medicine. OCM and electrospun PLGA induce a keratocyte phenotype and thus are more suitable for long-term partial replacement strategies for corneal transplantation.