Human airway smooth muscle maintain in situ cell orientation and phenotype when cultured on aligned electrospun scaffolds

Gavin Morris¹, Jack Bridge¹, Alan Knox², Jonathon Aylott³, Osama Eltboli⁴, Christopher Brightling⁴, Amir Ghaemmaghami⁵, Felicity Rose¹

¹Division of Drug Delivery and Tissue Engineering, School of Pharmacy, University of Nottingham, UK.  
²Division of Respiratory Medicine, School of Clinical Sciences, University of Nottingham, UK.  
³Laboratory of Biophysics and Surface Analysis, School of Pharmacy, University of Nottingham, UK.  
⁴NIHR Respiratory Biomedical Research Unit, University of Leicester, UK.  
⁵Division of Immunology and Allergy, School of Molecular Medical Sciences, University of Nottingham, UK.  
gavin.morris@nottingham.ac.uk

INTRODUCTION:
Human airway smooth muscle (HASM) contraction plays a central role regulating airway resistance in both healthy and asthmatic bronchioles. In vitro studies that investigate the intricate mechanisms regulating this contractile process are predominantly conducted on tissue culture plastic (TCP), a rigid, 2D geometry, unlike the 3D microenvironment smooth muscle cells are exposed to in situ¹. It is increasingly apparent that cellular characteristics and responses are altered between cells cultured on 2D or 3D topographies². Electrospinning is an attractive method to produce 3D topographies for cell culturing as the fibres produced have dimensions within the nanometre range; similar to cells’ natural environment.

METHODS:
Polyethylene terephthalate (PET) was electrospun into uni-axially orientated nanofibres. The effect of this topography on HASM cell adhesion, alignment, morphology, and contractile protein characteristics was compared to both 2D-cultured and in situ smooth muscle.

RESULTS:
Fibre orientation provides contact guidance to cells enabling the formation of fully aligned sheets of HASM cells similar to in situ smooth muscle. Moreover, HASM cells cultured on the scaffold present an elongated cell phenotype with altered contractile protein levels and distribution.

Fig. 1 ASM protein levels when cultured on 2D or 3D aligned topographies

DISCUSSION & CONCLUSIONS:
The platform presented provides a novel in vitro model that promotes airway smooth muscle cell development towards a more in vivo-like phenotype whilst providing topological cues to ensure good cell alignment.

REFERENCES:

ACKNOWLEDGMENTS:
This work was funded by the National Centre for the Replacement, Refinement and Reduction of Animals in Research.