Early Stage Researcher (PhD Year 1)? (X)		Mature Researcher (Beyond PhD Year 1?)	Y
Entry for the Engineers Ireland Biomedical Research Medal? (X)		Post-Doctoral Researcher/Senior Researcher/PI	N

LOAD INDUCED CHANGES IN COLLAGEN FIBRE ARCHITECTURE IN ARTERIES CHARACTERISED BY SMALL ANGLE LIGHT SCATTERING

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INTRODUCTION

The structural strength of arteries is governed by reinforcing collagen fibres present in the vessel wall. Although healthy vessels are capable of fibre remodelling, unhealthy fibre remodelling patterns may be associated with disease [1]. A greater understanding of the remodelling of these fibres may provide greater insight into arteries at risk of disease and how arterial repair may be induced.

Small angle light scattering (SALS) is a technique which has previously been used to determine the structure of thin, highly organised tissue structures, such as bovine pericardium and porcine aortic valve tissue [2].

The aim of the present study is to design and develop a fully automated SALS system capable of determining the changes in arterial fibre architecture in response to strain.

MATERIALS AND METHODS

An in-house SALS system has been developed making use of an unpolarised 5mW HeNe laser (λ = 632.8 nm) and two focusing lenses in order to pass light through a tissue sample held in an automated sample positioner. The sample positioner incorporates two stepper motors controlled by LabVIEW to allow movement of the sample in the x and y plane with a resolution of 5 µm. The sample is interrogated sequentially in 250 x 250 µm regions. The resulting scattered light pattern is recorded by a CMOS camera and analysed through a custom Matlab code to determine predominant collagen fibre directions.

To validate the system, testing was conducted on test plates with known printed configurations. Once validated, SALS testing was carried out on flat porcine carotid artery wall sections fixed at different stretch ratios. Carotid artery samples were fixed and processed using a standard histological tissue sectioning protocol. Validation of the results was achieved through histological staining of the sections.

RESULTS

Figure 1a displays the collagen fibre directions in an unstretched carotid artery section, as predicted by SALS, overlaid on picrosirius red stained histological images. Figure 1b shows the reorganisation of the constituent collagen fibres under circumferential stretch (λ=1.25).

Collagen fibre patterns in the artery were also obtained through the thickness of the artery wall using SALS, for both strained and unstrained configurations.

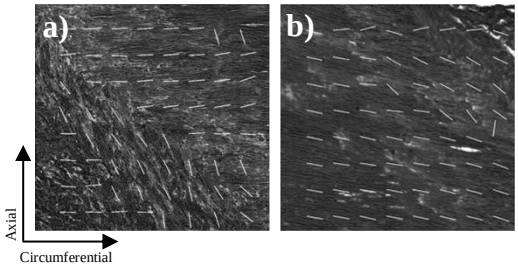

Figure 1 Fibre orientation as determined by SALS overlaid on histological carotid wall images. a) unstretched (λ=1) and b) stretched circumferentially (λ=1.25).

DISCUSSION

Results shown in Figure 1 highlight the dependence of fibre orientation on the levels of stretch experienced by the artery wall. A clear realignment of collagen fibres in the direction of loading is visible from Figure 1a and 1b. Although these results are widely known and shown in literature, this is the first time they have been resolved through SALS.

Although SALS is limited to thin samples, time consuming staining protocols are not required for fibre characterisation. The speed, accuracy and ease of use of this system make it a powerful system for providing insights into the response of arterial tissue to load.

Future work aims to fully identify load induced tissue changes in healthy and diseased arterial tissue using SALS.

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