USING DIGITAL IMAGE CORRELATION TO DETERMINE MECHANO-TRANSDUCTION BEHAVIOUR OF THE VISCEROFUGAL NEURON IN THE GUT

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Introduction

Mechanical force is encoded by action potential discharge in sensory neurons, such as the viscerofugal neuron; this is known as mechano-transduction. Most studies of mechano-transduction compare neural firing responses to global strain or the applied load. This allows discrimination of an appropriate stimulus for sensory neuron activation, but does not reveal how mechanical states are related to sensory neuron firing. This level of understanding can only be achieved if local mechanical states, such as local strain, are known.

Viscerofugal neurons are mechanosensory neurons in gastrointestinal wall. A method to record firing and cell body location of viscerofugal neurons was recently developed [Hibberd,2012]. Digital image correlation method can be used to calculate the local strains in samples of soft tissue. The relative simplicity of in vitro gut preparations used to record viscerofugal neurons is highly amenable to digital image correlation. This presents an ideal opportunity to study both global and local strain within the tissue and its relationship to mechanosensory neural firing responses.

Methodology

Paralysed flat-sheets of guinea-pig colon were loaded uni- and bi-axially while video recording. Viscerofugal neurons were localized and recorded extracellularly from colonic nerves [Hibberd,2012]. Numerous graphite markers were applied to the tissue surface, adjacent identified viscerofugal cell bodies for subsequent image analysis.

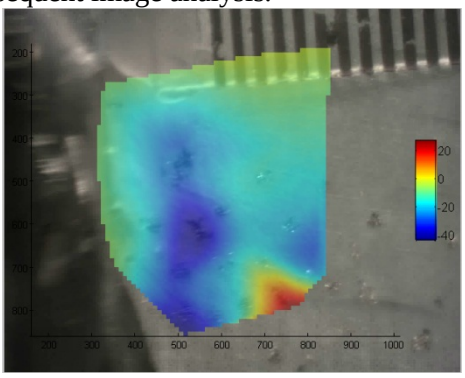

Figure 1: Example displacement plot for loading conditions 1x3g. Colours represent displacement in pixels, and 1 pixel = 3.2µm.

Digital image correlation and tracking script [Eberl,2006] was adapted to allow for the unique markers and larger displacement. *Fig. 1* shows an example displacement plot obtained from this procedure. Local strains can be calculated at the known location of the cell body of the nerve.

Results

As expected, local strains surrounding cell bodies differed from global strains. In general, local strains are lower than global strain; likely due to the location of cell bodies which are typically near the fixed edge of the sample. There is a stronger correlation between the local circumferential strain and neural response than longitudinal strain.

Local strains can be compared with neural response. *Fig. 2* shows circumferential strains versus the neural response.

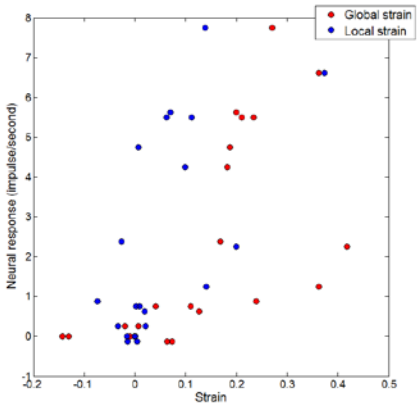

Figure 2: Neural response versus strain in circumferential direction for one sample; blue indicates local strain, red indicates global strain.

Discussion

The results shown in *Fig. 2* suggest that the viscerofugal neuron has a lower threshold for firing as a function of strain. Digital Image Correlation techniques may prove valuable in the research of mechano-transduction in sensory neurons in the gut.

References

Eberl, C.,2006,Digital Image Correlation and Tracking.

Hibberd, T. J., *et al.*,Neurosci,225:118-129,2012.

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