Hyperspectral imaging facilitates early detection of intra-operative ischaemia during neurovascular surgery

Oscar J MacCormac, MD[1,2]; Conor C Horgan, PhD[3]; Zhonghao Wang, MSc[1]; Matthew Elliot, MD[1,2]; Dale J Waterhouse, PhD[3]; Sebastien Ourselin, PhD[1,3]; Michael Ebner, PhD[3], Christos Tolias, MD[2]; Ahilan Kailaya-Vasan, MD[2]; Tom Vercauteren, PhD[2,3]; Jonathan Shapey, MD, PhD[1,2,3]
[1]School of Biomedical Engineering and Imaging Sciences, King's College London; [2]King's College Hospitals Dept. of Neurosurgery; [3]Hypervision Surgical Ltd.

Introduction

Hyperspectral imaging (HSI) is an advanced, wide field optical imaging technique that enables the visualization of light reflectance beyond that of the naked eye.

In tissue, the refined spectral information from HSI permits real-time extraction of biological and physiological parameters, one of which is **tissue oxygenation (StO_2).**

Intra-operative stroke occurs in up to 6.4% of cranial neurosurgical procedures, and thus **early detection of intra-operative ischaemia** may prove key to **improving patient outcomes**.

Figure 1. Snapshot mosaic hyperspectral camera mounted to Zeiss Kinevo-900 neurosurgical operating microscope

Methods and Materials

A snapshot mosaic HSI camera was coupled to a Zeiss Kinevo-900 **(Fig. 1)** and connected to a dedicated camera control unit.

HSI video recordings were acquired during eight aneurysm surgeries and eight arteriovenous malformation (AVM) extirpations.

Recordings manually annotated by a neurosurgeon **(Fig 2.)**, facilitating extraction of StO_2 information from each annotated region of interest (RoI).

Results

Using our system, real-time **HSI recordings were successfully and safely acquired** during all 16 cases.

StO_2 information was extracted from tissue structures across cases.

HSI **detected a decrease in StO_2 (Fig 3.) over a region of cortex 8 minutes before** electrophysiological change was demonstrated during one MCA aneurysm clipping.

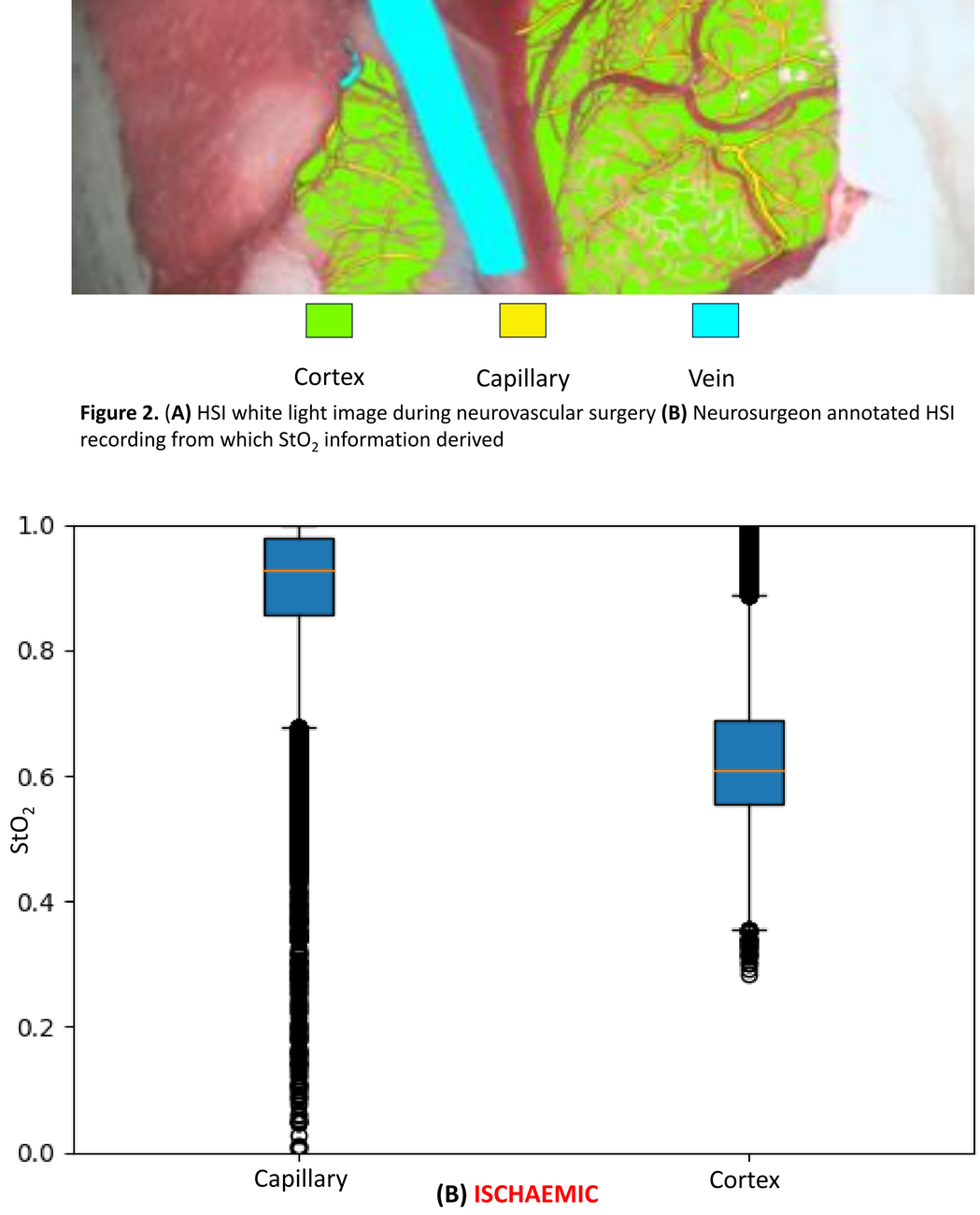

Figure 2. (**A)** HSI white light image during neurovascular surgery **(B)** Neurosurgeon annotated HSI recording from which StO_2 information derived

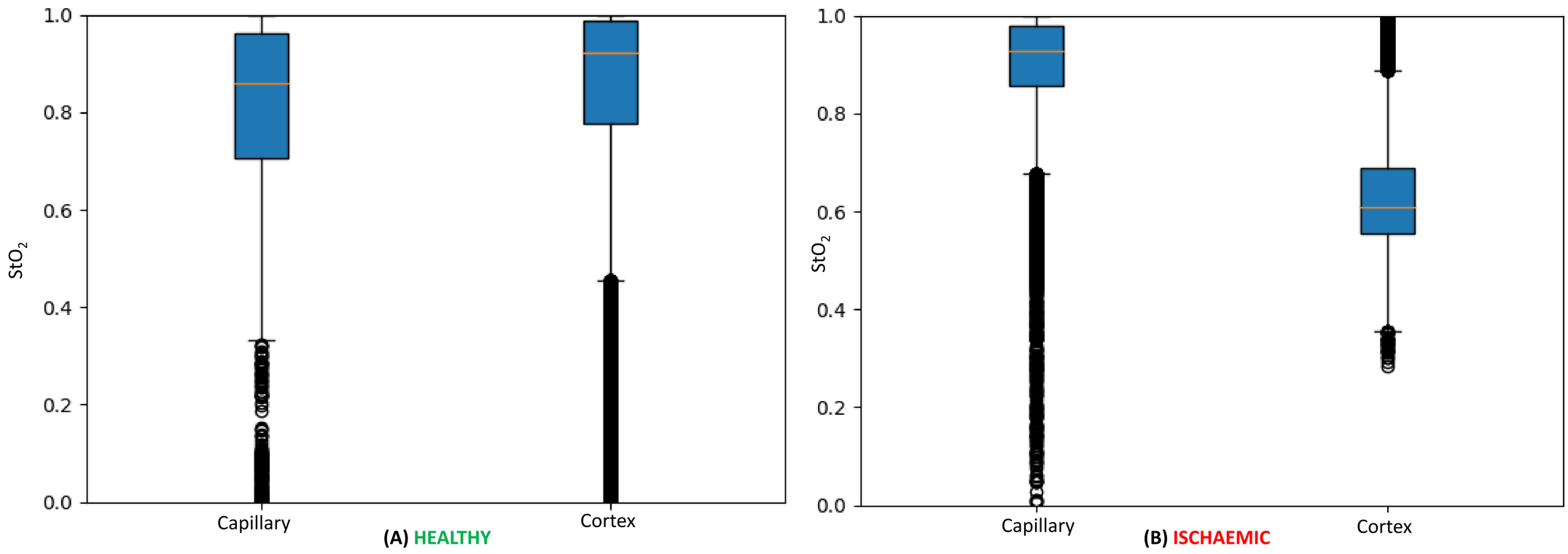

Figure 3. HSI derived StO_2 values for capillary and cortex at the beginning of surgery demonstrating healthy values **(A)** and ischaemic values **(B)** during inadvertent vessel occlusion

Conclusions

Our HSI system has demonstrated capability in providing **enhanced tissue information in real-time** during surgery.

HSI is **capable of detecting ischaemic changes** much **earlier** than current methods, paving the way for earlier intra-operative decision making and **safer surgery in the future.**

Contact
Dr Oscar MacCormac School of Biomedical Engineering and Imaging Sciences
King's College London
E: oscar.j.maccormac@kcl.ac.uk

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