BDIAP Educational Fellowship 2020 Recipient Report – Dr Ayesha Azam

I am extremely grateful to the BDIAP for the award of an educational fellowship to conduct research at University Hospitals Coventry & Warwickshire and Tissue Image Analytics Centre, University of Warwick for a period of 12 months. Here I report on the progress made

Research Project title

A novel deep learning-based diagnostic algorithm for detection and segmentation of amyloid in digital whole slide images

Background

I am a post-fellowship pathologist and clinical researcher currently in the final year of a NIHR sponsored MD which is investigating the use of digital pathology and artificial intelligence based deep learning tools to improve diagnostic accuracy and efficiency. Digital and computational pathology are rapidly advancing technologies which have significant potential to fundamentally change the way histopathology is practiced. The increased adoption of digital pathology has been accompanied by progress in identification of histology samples deemed difficult to diagnose using digital platform and amyloidosis is one of such recognised examples[1].

Amyloidosis is a progressive, incurable, metabolic disease characterized by abnormal deposits of protein in one or more organs or body systems. The amyloid deposits impair normal body function; can cause organ failure and in severe cases death. The definitive diagnosis of amyloidosis requires accurate examination of tissue samples under the microscope and it relies on ancillary tests; a special stain (Congo Red) and examination with polarized filters. As examination under polarized light is not possible on most digital systems, recognition of amyloid has been identified as an area of difficulty for pathologists using digital systems.

In this study, we aimed to develop a deep learning-based computer-assisted diagnostic(CAD) tool for automated amyloid recognition on digitized pathology slides to improve diagnostic accuracy and efficiency.

I undertook this study under joint supervision of Professors David Snead (Consultant Histopathologist at University Hospitals Coventry and Warwickshire and Director of PathLAKE, one of the five Innovate UK funded centres of excellence for the development of artificial intelligence in digital pathology and radiology.) and Nasir Rajpoot (Professor of Computer Science, Co-director of PathLAKE and Head of Tissue Image Analytics Centre)

Progress

We designed a retrospective diagnostic study utilizing histology image data from 2015-2020 from two institutions. With my supervisors, I outlined a plan for case identification, data collection, slides retrieval, slide preparation, staining and scanning. An integrated initial pilot study was conducted to test our research hypothesis and to check the working practices of the study. Development of a detailed annotation protocol was followed by training a team of pathologists to perform extensive annotations on H&E stained whole slide images to highlight amyloid. With close collaboration with data scientist team, I learned to train a deep learning model to identify amyloid on the H&E images. Our model's performance was tested on a completely unseen test dataset and validation was performed using an external dataset.

Outcome

By the end of 12 months, we had developed and trained first deep learning based algorithm that could reliably detect amyloid in a variety of tissue types including renal, head & neck and lung samples (Accuracy 0.94). We submitted the abstract to the Joint Meeting of European Congress of Pathology and BDIAP, Glasgow, December 2020 and our project got accepted for a poster and video presentation. We presented our research at the meeting and received excellent feedback from the participants who highlighted the usefulness of such tool in diagnostic practice and potential to improve patient care. The study abstract was also published in the 'European Journal of Pathology – Virchows Archiv'[2]. We plan to continue testing and validating this tool on more diverse data from multiple institutions to improve its generalizability. We are also in the process of preparing a manuscript aiming to submit it for publication in a peer-reviewed pathology journal in near future. The support provided by BDIAP will be fully acknowledged in that publication.

This fellowship was a fantastic opportunity to learn and develop an AI-based tool that has the potential to improve diagnostic accuracy, laboratory workflow and patient management. During this fellowship project, I learned a huge amount about training and using AI based algorithms, and their utility in the field of histopathology. Collaborating with a multi-disciplinary and multi-site team enhanced my experience and understanding of how pathologists can closely collaborate with data scientists to optimize the use of such algorithms in making challenging diagnosis which can potentially augment pathologists' expertise.

Once again, I would like to thank British Division of International Association of Pathologists for this invaluable research fellowship opportunity.

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References

1. Snead, D. R. J. *et al.* Validation of digital pathology imaging for primary histopathological diagnosis. *Histopathology* **68**, 1063–1072 (2016).

2. Azam A. S. et al. A novel deep learning-based diagnostic algorithm for detection and

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