

Whole slide imaging in the laboratory

For more than a century, the diagnosis of disease has been achieved by the microscopic interpretation of stained tissue sections. Although the later introduction of camera-mounted microscopes enabled photographs of areas of interest to be taken and shared, the actual process of rendering the diagnosis has essentially altered very little. However, technology of the modern era has changed all that. The storage of photographs as digital images has transformed the way that the processes of interpretation and diagnosis are now managed. Significant technological gains in the efficiency of microscope-based photography in the histology laboratory have led to the development of whole slide imaging (WSI) systems that are able to convert static microscope images into virtual, digital slides (Figure 1).



Figure 1. Whole slide imaging systems

As recent as April 2017, the Food and Drug Administration (FDA) in the United States of America approved the Philips IntelliSite Pathology Solution (PIPS) as the first such WSI system that allowed review, interpretation and subsequent diagnosis of digital surgical pathology slides (telepathology). In Europe too, many histology laboratories have become completely digitalized, enabling the reading of stained slides remotely by an observer in a different laboratory from where they were processed. Many pathologists believe that the viewing experience of whole slide images is superior to that of a microscope. Countless studies have emerged demonstrating the concordance of WSI systems with conventional light microscopy and their efficiency in facilitating pathological diagnoses in a variety of tissues. Unlike the limited field of view that is only available on one slide at a time using conventional microscopy, a scanned digital image allows viewing more slides and consequently more tissue simultaneously (Figure 2). In addition, it is possible to move the slide in any direction, focus the image and alter the viewing magnification.

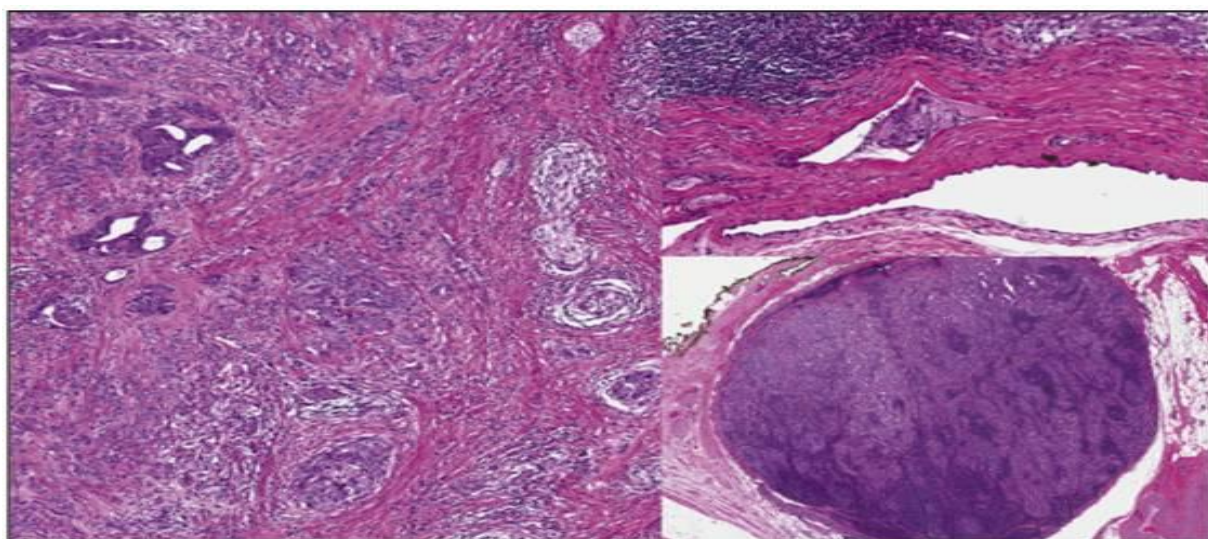


Figure 2. Digitalized large format section of prostate cancer with lymphovascular invasion and lymph node metastases

Currently, there is a vast array of WSI scanners that are available on the market although each system differs in function and capability depending on the manufacturer. Though these systems are calibrated to ensure consistent production of high quality, whole slide images, there are large differences in the number of slides that these scanners can process. Scan time for a single slide is generally under three minutes and is calculated by the time it takes to acquire a high resolution, whole slide image of the tissue represented on a standard-sized microscope glass slide. However,

some systems are able to manage large format slides and consequently will have increased scan times (Figure 3). However, these times do not account for the time taken to compress and transfer images to WSI systems in readiness for remote viewing. For cytology slides, these times are often increased further because of the problems associated with improper slide preparation. A system known as 'Z-stacking' is able to compensate for variations in thickness of stained smears by capturing images at various focal planes and stacking them in order to create a digital composite. Although the availability of storage and processing power has increased with technological advancement, many computer systems often struggle to compete for digital file storage. However, compression software and secure cloud-based technology are often used for storage by laboratories that have converted to telepathology.



Figure 3. The Huron TissueScope can scan slides up to 6"x 8"

The use of WSI technology in the United Kingdom is limited with many laboratories that are already using the system first diagnosing the samples using conventional light microscopy prior to scanning. Standardization of slide preparation and integration with laboratory management systems are obvious hurdles that need to be overcome before transformation to telepathology is realistic. Current pathology systems already use barcodes to index specimens and ensure continuity of samples through the laboratory. However, though WSI scanners are equipped with barcode recognition, the systems must also be able to store the specific data required by each laboratory. Further research is currently being carried out on the diagnostic capabilities of WSI systems as prognostic indicators. Image analysis algorithms that are able to pinpoint data within the pixels of

stained digital images are being developed to assist the pathologist in the diagnosis of disease. Consequently, if these algorithms could be used to aid precision and objectivity of the pathologist, they could also be used to predict the likelihood of cancer formation, metastases and disease progression. Automated image recognition systems that are able to identify those slides where precancerous or cancerous cells reside will therefore allow pathologists to spend more of their time on those cases where diagnosis requires greater attention.

With validation studies of digital pathology already showing diagnostic concordance with light microscopy, there is undoubtedly a place for WSI technology in clinical practice. Limited numbers of pathologists are already diagnosing increasing numbers of surgical cases and with the recent publication of recommendations and considerations for best practice by the Royal College of Pathologists, that time has definitely arrived.

Further reading

1. Best practice recommendations for implementing digital pathology. Cross S et al. The Royal College of Pathologists, London 2018.
2. Implementation of whole slide imaging for clinical purposes: Issues to consider from the perspective of early adopters. Evans AJ et al. Archives of Pathology and Laboratory Medicine 2017;141: 944-959.
3. The sentinel lymph node concept and novel approaches in detecting lymph node metastasis in prostate cancer. Montironi R et al. European Urology 2017;71(2):e73–e75.
4. Whole slide imaging for analytical anatomic pathology and telepathology: Practical applications today, promises and perils. Farris A et al. Archives of Pathology and Laboratory Medicine 2017;141: 542-550.
5. Whole slide imaging versus microscopy for primary diagnosis in surgical pathology: A multicenter blinded randomised noninferiority study of 1992 cases. Mukhopadhyay S et al. American Journal of Surgical Pathology 2018;42:39-52.

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