Digital pathology and COVID-19 and future crises: pathologists can safely diagnose cases from home using a consumer monitor and a mini PC

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INTRODUCTION

COVID-19 pandemic has a profound impact on routine pathology services.[1] Digital pathology can play a role 'to safeguarding clinical services and pathology-based research in the current climate and in the future'.[1] This digital-based approach to diagnosis represents a new way in the evaluation of surgical pathology slides from formalin-fixed paraffin-embedded tissue (FFPE). It makes the pathologist free from the constraints of using an optical microscope in his/her office. At the same time, it can have an effect on 'social interaction' among pathologists, including their interplay with clinicians and even patients. A recent contribution from our group briefly dealt with the changing aspects of such a relationship at the peak of the COVID-19 pandemic.[2] The aim was to try to foresee how the kind of experience acquired during the pandemic could have influenced the approach to histopathology in the digital and postdigital eras.

Our laboratories as well as many others worldwide, even though not yet ready for substituting and replacing the optical microscope with a scanner for digital pathology image creation, already have digital cameras and scanners for 'sharing images and consulting, teaching and communicating with clinicians and patients'.[2]

STILL IMAGES VERSUS VIRTUAL SLIDES

Still images, that is, images obtained with a digital camera connected to an optical microscope and representing the area(s) of interest selected by a pathologist in the whole tissue section, can be shown on a display device. This is what can be done for quick intradepartmental consultation while trying to keep social distancing at work. However, by using this simple approach, most pathologists in our institutions do not feel confident to express a definite opinion in all cases. Scanners are designed to obtain virtual slides of entire tissue sections, including large-format histology. Two different scanners are available to us, one identical to that mentioned by Retamero *et al*.,[3] capable of digitising 75×25 mm glass slides,[1 2] and another to scan 75×50 mm glass slides, that is, large-format histology.[4] Additional types of scanners are available on the market, but not to us.

The great advantage of virtual slides over the so-called still images is that the pathologist can 'move around' on the slides, including changing magnification or zooming in, searching for diagnostic clues as if he/she were using an optical microscope. The entire tissue section is displayed in the virtual slide (figure 1) and not simply part of it.

Urogenital pathologists

Our main interest is uropathology, in particular radical prostatectomy and bladder specimens. Virtual slides are shared among us or sent over the internet to others. There is no limits as far as the locations of their institution and country are concerned. One of the cloud platforms can be used to send the virtual slide with a link to download the image(s). The procedure is quite fast and simple, also considering that the size of a virtual whole mount section can be in the range of gigabits. The viewing and image analysis software is downloaded from the internet, free of charge.[2]

Smart working from home

To prevent any delay in critical patient care, virtual slides can be reviewed through the so-called smart working from home. There is no need for any extra equipment. Virtual slides are sent and received via a home internet connection (a secure VPN high-speed internet connection is preferred) and shown in real time on a TV home (consumer) screen, as a display device, linked to a mini PC. A wireless mouse is used to scan the slide, zoom in and make annotations of specific features. The viewing pathologist does not feel isolated because he/she can simultaneously communicate with others, while analysing the slides, via one of the video conferencing platforms easily available. Such communication includes the voice and image of a colleague, shown in a window in a corner of the TV home screen, at the same time as the virtual slide (figure 1).

Confocal microscopy and smart working

Current scanners are not intended for use with non-FFPE specimens. Confocal microscopy acquires digital images from fresh tissue that are either displayed on a computer monitor or shared with a remote viewer for real-time evaluation. Our group has acquired some experience on this with prostate biopsies to check for the presence of cancer and, at the time of the radical prostatectomy procedure, for the evaluation of the surgical margins.[5] As an example of smart working from home, one of us (AC) was able to evaluate virtual slides of surgical margins displayed on a high-definition TV screen at

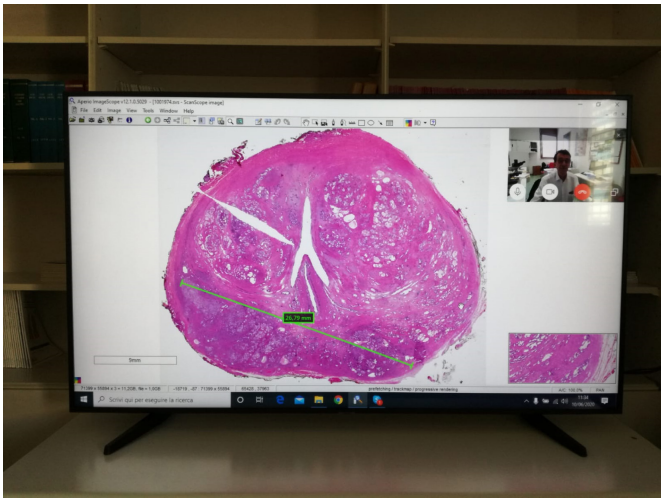

Figure 1 Virtual whole mount section of a radical prostatectomy specimen displayed on a 65″ high-definition TV screen. A pathologist is discussing the case in real time with a colleague that appears in the upper right corner. The green line across the prostate was drawn with the wireless mouse to measure the diameter of the tumour (the actual value in millimetre is superimposed). The small window in the left bottom corner shows details of the lesion at a high electronic magnification. The senior author of this paper, Rodolfo Montironi, permitted to publish his photo in the figure.

home and at night in the USA, whereas a radical prostatectomy was performed in the morning in Europe.

Support to smart working from home

As a support to our experience of smart working from home, it is worth mentioning:

- As an emergency response to the pandemic, the UK Royal College of Pathologists has provided guidance for remote reporting of digital pathology slides during periods of exceptional service pressure.[6]
- The US Food and Drug Administration (FDA) has granted a waiver for the use of readily available consumer monitors at home with the Philips IntelliSite Pathology Solution.[7]
- The FDA has announced clearance for Leica Biosystems to market its Aperio AT2 DX System, substantially equivalent to Philips' device, for clinical diagnosis in the USA as well as for remote diagnosis of COVID-19 cases under emergency use.[8]

FUTURE PERSPECTIVES AND CONCLUSIONS

There are future uses of virtual slides, still to be fully explored and implemented.[9] Individual patients, for instance, could carry a microchip with virtual slides, radiological images, clinical records and other data. This will allow healthcare personnel, including urologists, to review the stored digital material using a TV screen in a physician's office, away from a pathology service, and compare the features with the actual clinical presentation.

In conclusion, we are moving into an era of global digitalisation in the 21st-century pathology service. Most of our future activities will probably be based on what is described by Browning and colleagues[1] and what we do at the present time of the pandemic, that is, 'safely diagnosing cases from a home office using a consumer monitor' and mini PC.[8] However, we should not forget that the success on virtual slide scanning and evaluation is dependent on the role and support of paramedical and medical personnel for tissue sampling, processing, cutting and (immune-)staining as well as integration or fusion with data from other sources, including molecular pathology data.

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