

Telemedicine – Applications in Pathology

*Dr. Sangeeta B Desai **

Introduction

Telemedicine can be defined a group of activities which include investigation, monitoring, and management of patient data as well as the education of patients and staff by means of systems which allow quick access to expert advice and patient information, no matter where the patient and the relevant information are located (definition by the European Union Committee).¹

Telemedicine can play a major role in multiple aspects of patient care which includes radiological and pathological diagnostic services, home care, exchange and integration of medical data, education and training. Almost all the branches of medicine, including radiology, pathology, dermatology, cardiology, oncology, anesthesia, psychiatry, critical care and even endoscopy and surgery are beginning to utilize this technology, and have the opportunity and the potential to refine its utility optimally.

Telepathology, a subset of Telemedicine, is the practice of pathology at a distance using Information & Communication Technology.

Telepathology

It involves two or more partners. At one end, a pathologist views the slides under a microscope, captures images in a suitable format and transmits images to a distant site over a telecommunication link. Interpretation by a telepathologist is done by viewing the images on a video monitor at the receiving site. Telecommunications links can include telephone lines, internet or satellite communication. It provides local medical centers with rapid access to highly specialized expertise in pathology.

Telepathology helps pathologists and patients located in remote areas of the country to get quick reports, which in turn translates into prompt appropriate treatment.¹⁻⁵

Telepathology can be applied to various aspects of pathology, such as biopsies, surgical specimens, intraoperative frozen sections, cytology etc. Telepathology is not a substitute for glass slide diagnosis. It is a need based service, based on the premise of non-availability of immediate expert help in the vicinity of the primary pathologist's area of work. Traditionally, pathologists are

* Oncopathologist, Tata Memorial Cancer Centre, Mumbai e-mail: sangeetabdesai@rediffmail.com

accustomed to viewing high-quality images with their light microscopes. Getting pathologists acclimatized to digital imaging and telepathology is challenging, and requires a change in the pathologist's mind-set. On a positive note, attitudes towards telepathology are also changing, as pathologists gain confidence in this science, largely because of the improvement in the quality of digital imaging and familiarity with digitization and telecommunication technologies.

Types of Telepathology ¹

Telepathology has developed along two lines designated as

- Static telepathology
- Dynamic telepathology.

Static telepathology, also known as 'store and forward' or a passive approach to telepathology is the simplest & inexpensive form of telepathology. It involves the capture of still diagnostic images at one site and their

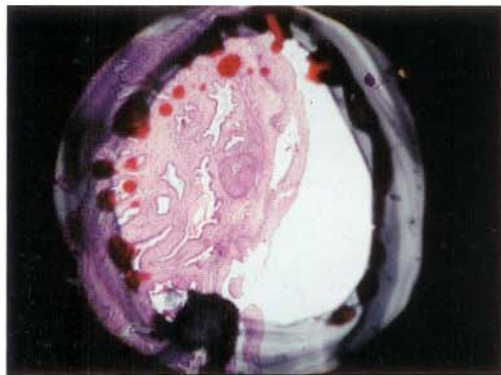


Figure 1: Scanner view of cervical biopsy shows endocervical gland involved by changes consistent with cervical intraepithelial neoplasia III (40x).

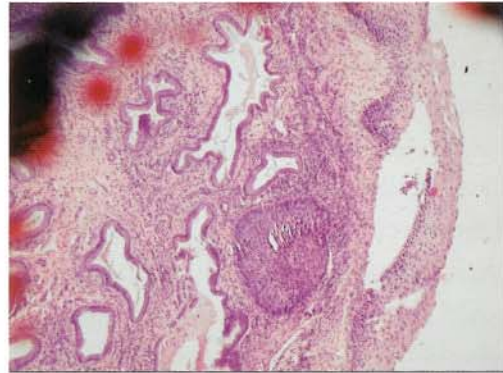


Figure 2: Low power view shows endocervical gland involved by changes consistent with CIN III (100x).

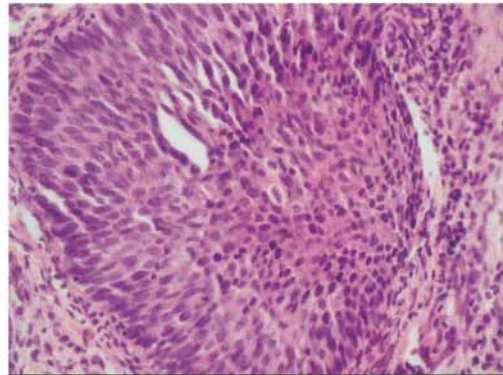


Figure 3: High power view of endocervical gland shows CIN III (400x).

electronic transmission and viewing at a remote site (Figures 1-3). The advantages of this system include low cost of the equipment and information transfer, worldwide access, simple and easy handling. The disadvantages are missing interactive handling and discussion abilities, missing control of the received images, and potential sampling errors.

Dynamic telepathology is also known as robotic interactive telepathology (RITP), real

time telepathology or active telepathology. It is a more sophisticated technique, which allows the telepathologist to have a complete control over the images he is viewing. The microscope is fitted with a robotic control of the stage movement, focusing and objective lens selection. The advantage of this system is that it is almost similar to using a conventional light microscope, with the sampling error being eliminated. Dynamic telepathology is performed between the two fixed partners viz. larger institutions with smaller hospitals located in remote areas. The disadvantages include the high cost of the equipment, the incompatibility between the systems provided by the different suppliers, the amount of time taken to scan the slide in real-time and the specialized equipment required in the form of a motorized microscope and broad bandwidth communication link required for transmission.

Hybrid systems combine static and dynamic elements. In such systems, a series of static images are captured and transmitted at the start of the dynamic telepathology session. This helps in the reduction of time used for controlling the robotic microscope.

The minimum requirements needed for telepathology purposes are:

- A light microscope
- A high-resolution camera, either a digital camera or an analog camera with a frame grabber card

- PC work-station for the telepathologist
- Access to telecommunication network, either by modem or digitized data transfer card

It is widely assumed that full colour images would be required by the surgical pathologists for accurate histopathologic interpretation. However, in an interesting study conducted by Doolittle et al⁶, pathologists were asked to detect the difference in the quality of microscopic images that were reduced from 24 to 8 bits of colour. It was concluded that there was a significant preference for the 8-bit images as being of “better quality”. This suggests that adaptive colour reduction would help reduce file size without compromising data transmission and diagnosis.

Wider Applications of Telepathology¹

Telepathology has validated applications in few areas of pathology, whereas in certain areas, the applications have yet to be tested.

Validated applications

1. Intraoperative frozen sections
2. Routine surgical pathology
3. Second opinions
4. Surgical pathology consultations
5. Expert-to-expert consultations
6. Quality assurance
7. Distance education

Provisional applications, which await validation

1. Cytology, Fine needle aspiration cytology
2. Cytogenetics, immunohistochemistry
3. Haematology
4. Autopsy pathology

Future applications

5. Point-of-care pathology services
6. Ultra rapid turn-around time surgical pathology
7. Proficiency testing

Current applications

The first and most widely used application of telepathology is intra-operative frozen section services. These have been implemented in many countries like Norway, Switzerland, Germany, Japan and the United States.

Robotic telepathology is being used to provide routine surgical pathology services in certain institutions.

Telepathology has also been used for expert consultations, second opinions, quality assurance and educational programmes.

Provisional applications

Telepathology can find application in cytology, fine needle aspiration cytology, haematology, cytogenetics, immunohistochemistry, etc. McLaughlin et al⁷ carried out a feasibility study of telemicrobiology and documented

concordance between readings of conventional gram stained slides and video images. Telemicrobiology appeared to be somewhat time consuming as compared to conventional light microscopy. However, there are some unresolved issues in these matters and all relate to the limitations of telepathology services.

Future applications

Research is now being done to fit telepathology into point-of-care health care delivery strategies, like setting up a telepathology work-station at a breast clinic or in a radiology department to ensure adequacy of fine-needle aspirates.

Ultra rapid turn around time surgical pathology is being developed using automated immunohistochemistry processors and robotic telepathology.

Proficiency testing is another interesting potential application of telepathology. Technology options include the use of Internet-based robotic microscopy, galleries of store-and-forward images, and virtual slides.

Telepathology can be used to provide round-the clock services by taking advantage of different global time zones around the world.

“Virtual slides”

The recently published paper by Weinstein et al⁸ describes a reinvention of light

microscopy, a miniaturized array microscope for ultra rapid virtual slide processing. The ultra rapid virtual slide scanner may be used for the current applications of telepathology, including routine diagnostic surgical pathology, second opinions, expert opinions, education and research.

References

1. Kayser K, Szymas J, Weinstein R. Telepathology. Telecommunication, Electronic education and Publications in Pathology. Springer Verlag, Heidelberg, Germany, 1999.
2. Desai S, Patil R, Kothari A, Shet T, Kane S, Borges A, Chinoy R. Static telepathology consultation service between Tata Memorial Centre, Mumbai and Nargis Dutt Memorial Charitable Hospital, Barshi, Solapur, Maharashtra: An analysis of the first 100 cases. *Indian J Pathol Microbiol* 2004; 47: 480-485.
3. Desai S, Patil R, Chinoy R, Kothari A, Ghosh TK, Chavan M, Mohan A, Nene BM, Dinshaw KA. Experience with the use of telepathology at a tertiary cancer centre and a rural cancer hospital. *National Medical Journal of India* 2004; 17: 17-19.
4. Desai S, Ghosh TK, Chinoy R, Mohan A, Dinshaw KA. Telepathology at Tata Memorial Hospital, Mumbai and Barshi, a rural centre in Maharashtra. *The National Medical Journal of India* 2002, 15: 363-4.
5. Desai S, Ghosh TK, Chinoy RF, Mohan A, Dinshaw KA. Telepathology at the doorstep of a village. *Nuclear India* 2002; 36: 9-10.
6. Doolittle MH, Doolittle KW, Winkelman Z, Weinberg DS. Color images in telepathology: How many colors do we need? *Hum Pathol* 1997; 28: 36-41.
7. McLaughlin WJ, Schiffman RB, Ryan KJ, Manriquez GM, Bhattacharyya AK, Dunn BE, Weinstein RS. *Telemedicine Journal* 1998; 4: 11-17.
8. Weinstein R, Descour MR, Liang C, Barker G, Scott KM, Richter L, Krupinski E, Bhattacharyya AK, Davis JR, Garham AR, Rennels M, Russum WC, Goodall JF, Zhou P, Olszak AG, Williams BH, Wyant JC, Bartels PH. An array microscope for ultrarapid virtual slide processing and telepathology. Design, fabrication, and validation study. *Human Pathology* 2004; 35:1301-1314.