
ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN — POLONIA

VOL. LIV, 47

SECTIO D

1999

Department of Anatomical Pathology, Histopathology and Cytology,
Faculty of Medicine and Health Sciences, University of Transkei (UNITRA), RSA

Katedra i Zakład Patomorfologii Akademii Medycznej w Lublinie
Kierownik: prof. dr hab. Daniel Chibowski

ANDRZEJ STĘPIEŃ, LECH BANACH,
DANIEL CHIBOWSKI, ELŻBIETA KOROBOWICZ,
LECH WRONECKI, ELŻBIETA SOBOLEWSKA

*Histo- and cytopathologic remote diagnosis
(telepathology). Preliminary report*

Diagnostyka histo- i cytopatologiczna na odległość
(telepatologia). Doniesienie wstępne

Telepathology gains acceptance as a method of offering high quality pathomorphological diagnosis to remote medical institutions. It is expected to play an ever increasing role in the near future in teaching pathology, in teleconferencing as well as in quality control. The transmission of digitalized histo- and cytopathology images for remote consultation by experts in the field is facilitated by telepathology. The tele-connections and transfer of text information as well as images via Internet, is possible using standard procedures. The authors of this preliminary report present their own experiences in the capture of images, and the transfer of data and these digitalized images via e-mail to the centers on other continents. The instruments and infrastructure present in the Department of Anatomical Pathology in Lublin were used.

Telepathology is a branch of telemedicine, that has been developed dynamically in recent years thanks to progress in the technology of informatics, telecommunication and computerization. Both teleradiology and telepathology are disciplines based on the visual analysis of images, but contrary to well established practice of teleradiology, telepathology is still a discipline gaining acceptance and experience (2, 3, 4, 17).

Several of the initially significant technical aspects of the teletransmission of images are solved quite satisfactorily now. The most important research going on now is concerned with the feasibility of telepathology for the primary distant pathomorphological diagnosis (e.g. remote frozen section diagnosis), secondary diagnosis (expert consultation of cases diagnosed already by "a general pathologist"), the sensitivity and specificity of the method, comparison of the quality of diagnoses by telepathology with the traditional microscopic diagnoses, ethical aspects and legal responsibility of participants of the telediagnostic process, cost-effectiveness (1, 5, 6, 9, 11, 12). Moreover, every year more new user friendly systems or improvements in the existing programs are described.

There are two basic modes of telepathology – static (or passive) and dynamic (or active) telepathology. Hybrid telepathology systems combined features of both static–image and dynamic–robotic telepathology. In the passive mode of telepathology the selected fields of the histology (cytology) slides are captured and saved in the computer’s memory (using one of the existing formats of recording of images – most often JPEG), for transfer in the digitalized form to a remote specialist for consultation. There the images are diagnosed on the screen of the computer’s monitor at any time, convenient for the consulting person. The sender controls the selection of the fields. The diagnostic process of the slides in the dynamic mode resembles the traditional microscopy: it happens in real time, the distant consultant controls from the remote site a (robotic) microscope, selects the fields for still images or video capture and transmission (7, 8, 14, 16, 18).

The purpose of the present work was an attempt to transmit images from the Department of Pathology of the Medical Academy in Lublin to distant institutions, as well as to receive images from elsewhere, using the existing departmental infrastructure.

MATERIAL AND METHODS

Selected cases of Fine Needle Biopsies (FNB) and of histopathological slides, were captured and saved in digitalized form in the JPEG format for electronic transmission to below listed institutions to assess their suitability for telepathological consultations. Text information and images were transferred to: 1. Armed Forces Institute of Pathology (AFIP), Washington DC 20306–6000. USA. 2. Department of the Anatomical Pathology of UNITRA, Umtata, RSA. 3. Department of the Anatomical Pathology of the Medical University of South Africa (MEDUNSA), Pretoria, RSA.

The following hardware and software was used for the capture and registration of the images: Microscope: Jenamed–2; IBM compatible computer Pentium–S/90MHz, HD 850MB, 16MB RAM, Colour Monitor 14" S–VGA; Camera: Bischke 1/2" Colour Camera CCD–FS–2012P (resolution 570 horizontal TV lines); Multi Scan5 software and hardware with Show Time Plus, S–VHS frame grabber; Operating System Microsoft Windows 3.1.

The hardware and software for internet connection and transfer of data: IBM compatible computer Pentium–S/133MHz, HD 1.5GB, 32MB RAM, Colour Monitor 15" S–VGA; Software: Operating System Microsoft Windows 95 Plus, Microsoft Internet Explorer 5, Microsoft Outlook Express 5, Microsoft Photo Editor 3, WinZip®6.2.

X–rays were scanned using ACTOWN SCANII 30 in case of need and saved in JPEG format as well. The above listed hard– and software facilitated static telepathology connections. The images registered were assessed before the transfer using Microsoft Photo Editor 3. Eight images were disqualified because of poor technical quality after that preliminary selection.

Twelve cases of FNB’s and two histopathology cases were transferred altogether. The cases were examined on the computer’s monitor under 3.2X, 12.5X, 25X and 40X microscopic magnifications and additional 2X magnification of the camera. Fields selected by a specialist pathologist as representative were saved in JPEG format (640X480 pixels resolution). An image required from 40–180 KB of computer’s memory (70KB in average). At least 4 fields were saved from each magnification of each slide (16–26 images per case). The images were e–mailed to UNITRA and MEDUNSA using Outlook Express 5 program. Images were packed using WinZip(6.2 before attachment to a standard e–mail letter. Images were posted to AFIP in a similar way, however the text information was faxed separately there. Five cases were transferred to AFIP using a “secure WWW server” (<http://www.afip.org/telepathology/serv.html>).

Contributor's Consultation Request Form had to be filled in, following the instructions prepared by specialists from AFIP. The information required contains amongst others personal data of the patient, clinical data, preliminary pathology diagnosis. Images are attached in a predetermined way after the form has been filled in. There is no need for using WinZip program in this mode of the transmission. The answers from UNITRA and MEDUNSA were received via e-mail, but AFIP faxed their answers, using e-mail only for additional requests etc.

RESULTS

The time of selection of one field and saving of the image was about 1 minute. 4 to 7 minutes were needed to fill in the Contributor's Consultation Request Form (AFIP). Preparing images for a transfer as an e-mail attachment (writing in text data, zipping the images) required from 3–7 minutes, and 20–30 minutes were needed per a case. The transfer via the "secure Internet server" to AFIP failed two times. The images attached to an e-mail failed to arrive twice (to AFIP). Repeated transfers of both the text data as well as of images via e-mail were successful in those cases. The quality of the received images was regarded by receiver as suboptimal, sufficient for diagnosis, sufficient or good in particular cases. Generally the quality of saved high magnification pictures was better than that of low magnification ones, and of FNB smears better than of histopathology slides.

DISCUSSION

Request for consultation of histopathology/cytology slides is part of the everyday practice. It is even obligatory to examine such slides by two pathologists in several laboratories, before a final diagnosis is made. This requirement is easy to conform to in large pathology departments in which one specialist works next to another pathologist or in the neighbouring room. A single pathologist practising his profession alone, has to post, send by a courier or otherwise transport slides to the consulting institution. Rare, interesting or difficult to diagnose slides, have to be sent to an expert in the field, even from relatively large pathology departments, as a needed, "narrow specialist" may work in a distant institution (15, 17).

The high costs of posting, "troublesome" administrative regulations (e.g. duty fees, epidemiological regulations), especially when the blocks are posted abroad, may cause delays in receiving second opinion or diagnosis. One can omit all of the problems causing delays by sending data and images electronically (using telepathology). Time required for capture of images and their transfer is short – not exceeding half an hour altogether per a case (if numerous images have to be captured, but is shorter with less images). Examination of images from the computer's monitor and diagnosis of cases does not last longer than from under the microscope, and prompt diagnosis may be of utmost importance for early and direct application of appropriate treatment (6, 13).

The frozen section examinations and teliagnosis as well as telepathology in selected fields of tumour diagnosis is of high sensitivity and specificity approaching the diagnoses directly from under the microscope (5, 6, 9, 10, 13, 15). And in several instances this is the only way of pathomorphological examination by using such procedure (e.g. from hospitals without resident pathologist), or in other cases it may shorten the time of sending the diagnosis to the operation team in a hospital using telepathology instead of a courier to transport the excised specimen for the examination in the pathology laboratory (5, 6, 9, 10, 13, 15).

The development and improvements of telecommunications, mobile phones, Internet and cable T.V. affects the mode of our lives more and more. We can see the "stormy" development of Internet trade, service to a remote receiver from one's home in case of e.g. informatics, computer services, the whole world of virtual reality. Telepharmacy, telecardiology, telepsychiatry, telesociology, telenursing and more "tele-" medical specialties grow popular in several countries. Those are new words and new disciplines emerging in the recent years. Surgeons plan some surgical procedures and predict their possible outcomes using virtual operations before embarking on a real one. The first distant surgical procedures using effector robots directed from a remote places by a specialist have already been performed, and methods of teaching using "virtual reality" programs gain acceptance. Telepathology cannot lag behind, there is need for this procedure.

Telepathology has been used in the Department of Anatomical Pathology of UNITRA since 1995. First connections were with AFIP, next with MEDUNSA, Thoraxclinic in Heidelberg, University of Zagreb (Croatia) and others joining in, in the following years. Images saved in JPEG format were transferred bothways via Internet e-mail for consultations, exchange of interesting cases, quality control or teaching. In co-operation with some institutions special program by VAMS (Zagreb, Croatia) was used. That program (ISSA) facilitates transfer of both-text information and images using the telecommunication program PHAROS (by VAMS). It serves as an archiving system as well. It enables the consultation in real time using common phone line, ISDN or Internet connection. Department of Anatomical Pathology of UNITRA participates also in programs of teleradiology and teledermatology in the RSA that form part of the National program of HEALTHLINK, bringing the expertise to the remote areas of this vast country with insufficient coverage by Health Services. The archive of histological images of the Department serves for pregraduate training purposes. It is utilized by students in the innovative Problem Based, Community Oriented Curriculum.

This work proved the practicality of using the infrastructure existing in the Department of Anatomical Pathology of the Medical Academy in Lublin, for the purposes of telepathology. The quality of some of the elements of the system needs improvement however. The quality of images should be examined on larger, high resolution monitors (at least 19") using special graphic programs (e.g. Adobe or Corel Draw). The instruction and training of participants to capture, save and post the images was easy and required no more than 2-3 in-training sessions. Adaptation of specialists pathologists to diagnose images from the computer's screen instead from under the microscope does not require a long term training as well (3, 9). Further research on several aspects of telepathology is ongoing or in phase of preparation of projects in co-operation of the Departments of Anatomical Pathology of Medical University in Lublin and of UNITRA.

REFERENCES

1. Banach L., Stępień A., Lancaster E. W., Fontelo P., van Bogaert D.: Telepathology via the Internet: Transcontinental Consultation in Anatomic Pathology Using Static Images: South African Experience. XIII International Congress of Cytology. *Acta Cytol.*, 42, 461-462, 1998.
2. Banach L.: Telemedicine in Transkei, South Africa. *Elec. J. Path. Hist.*, 4, 984-1001, 1998.
3. Dervan P.A., Wootton R.: Diagnostic Telepathology. *Histopathology*, 32, 195-198, 1998.
4. Eusebi V., Foschini L., Erde St., Rosai J.: Transcontinental consults in surgical pathology via the internet. *Hum. Pathol.*, 28, 13-16, 1997.
5. Galvez J., Howell L., Costa M.J., Davis R.: Diagnostic concordance of telecytology and conventional cytology for evaluating breast aspirates. *Acta Cytol.*, 42, 663-667, 1998.

6. Halliday B.E., Bhattacharyya A.K., Graham A.R., Davis J.R., Leavitt S.A., Nagle R.B., McLaughlin W.J., Rivas R.A., Martinez R., Krupinski E.A., Weinstein R.S.: Diagnostic accuracy of an international static-imaging telepathology consultation service. *Hum. Pathol.*, 28, 17–21, 1997.
7. Hufnagl P.: Telepathology – daily practice in the near future? Abstract. 6th Workshop “Computers in Pathology”. *Telemedicine. Telepathology. Telemicroscopy. Pol. J. of Pathol.*, 48, 75, 1997.
8. Kayser K., Szymas J., Weinstein R.S.: Telepathology: Telecommunication, Electronic Education and Publication in Pathology. Springer Verlag, Berlin–Heidelberg–1999. 24–28.
9. Krupinski E.A., Weinstein R.S., Rozek L.S.: Experience-related differences in diagnosis from medical images displayed on monitors. *Telemed. J.*, 2, 101–108, 1996.
10. Marsan C., Vacher–Levenu M.C., Cochand–Priolet B.: A cytopathology consulting station. *Pol. J. Pathol.*, 49, 41–2, 1998.
11. Mea V.D., Puglisi F., Bonzanini M., Forti St., Amoroso V., Visentin R., Palma P.D., Beltrami C.A.: Fine–needle aspiration cytology of the breast: A preliminary report on telepathology through internet multimedia electronic mail. *Modern Pathol.*, 10, 636–641, 1997.
12. Raab S.S., Zaleski M.S., Thomas P.A., Niemann T.H., Isacson C., Jensen C.S.: Telecytology: Diagnostic accuracy in cervical–vaginal smears. *Am. J. Clin. Pathol.*, 105, 599–603, 1996.
13. Raab S.S., Robinson R.A., Snider Th.E., McDaniel H.L., Sigman J.D., Leigh Ch.J., Thomas P.A.: Telepathologic review: utility, diagnostic accuracy, and interobserver variability on a difficult case consultation service. *Modern Pathol.*, 10, 630–635, 1997.
14. Szymas J., Wolf G.: Remote microscopy through the internet. *Pol. J. Pathol.*, 50, 37–42, 1999.
15. Weinberg D.S., Allaert F.A., Dusserre P., Drouot F., Retalliau B., Welch W.R., Longtine J., Brodsky G., Folkert R., Doolittle M.: Telepathology diagnosis by means of digital still images: an international validation study. *Hum. Pathol.*, 27, 111–8, 1996.
16. Weinstein R.S.: Static image telepathology in perspective. *Hum. Pathol.*, 27, 99–101, 1996. (Editorial).
17. Weinstein R.S., Bhattacharyya A.K., Graham A.R., Davis J.R.: Telepathology: A ten–year progress report. *Hum. Pathol.*, 28, 1–7, 1997.
18. Winokur T.S., McClellan S., Siegal G.P., Reddy V., Listinsky C.M., Conner D., Goldman J., Grimes G., Vaughn G., McDonald J.M.: An initial trial of a prototype telepathology system featuring static imaging with discrete control of the remote microscope. *Am. J. Clin. Pathol.*, 110, 43–9, 1998.

Otrz.: 1999.11.26

STRESZCZENIE

Telepatologia jest nową metodą, pozwalającą na uzyskiwanie diagnozy patomorfologicznej z odległych ośrodków medycznych, która jest wykorzystywana w coraz większym zakresie w nauczaniu, telekonferencjach i kontroli jakości rozpoznań patomorfologicznych. Autorzy tego wstępnego doniesienia prezentują własne doświadczenia w uzyskiwaniu cyfrowych obrazów histopatologicznych i prze-

syłaniu ich do ośrodków na innych kontynentach (AFIP – USA, UNITRA i MEDUNSA – RPA) drogą poczty elektronicznej, przy użyciu sprzętu i infrastruktury Katedry i Zakładu Patomorfologii AM w Lublinie. Jakość obrazu obserwowana przez odbiorcę była określana jako wystarczająca lub dobra dla postawienia rozpoznania. Praca ta potwierdza możliwości praktycznego zastosowania telepatologii do celów ustalenia rozpoznania patomorfologicznego. Dalsze badania są kontynuowane lub w fazie przygotowania w kooperacji Katedry i Zakładu Patomorfologii AM w Lublinie i UNITRA – RPA.