

*digital fundus eye images,
tools supporting medical diagnosing*

Maria BERNDT-SCHREIBER, Dariusz SZCZEPANIAK*

FUNDUS IMAGING – A PROPOSAL OF AN EXTENDED APPLICATION TOOL SUPPORTING MEDICAL DIAGNOSING

SHORT NOTE

Digital fundus eye images may reveal essential features being important for the diagnoses of many pathologies once they are correlated with other specific medical data. A proposal of a comprehensive application referring both to the images and various additional medical data has been briefly described and discussed.

1. INTRODUCTION

It is commonly accepted that the quantitative description of fundus eye images is of special importance for ophthalmologists, and particularly in the case of diabetic patients. However, the observations and assessments of these images for detection and monitoring pathological changes may also be essential for many other diseases, including neurology, cardiology and nephrology cases. Recent cross-sectional population based epidemiological studies [5],[8] reveal that some retinal vascular abnormalities observed in 2-15% of non-diabetic population may indicate cumulative damages due to hypertension and aging. The studies reveal that some of the features may appear long-term markers of hypertension related both to current and past blood pressure values. Therefore it is believed that a reliable quantitative description of the abnormalities may also provide a useful risk indicator for cerebrovascular and cardiovascular diseases. A precise monitoring of the visible changes of the optic nerve and retinal vessels seems a special challenge also in the case of renal diseases. It could provide a potential classification of retinal lesions related to renal failure (e.g. renovascular hypertension), also before and after treatments, including dialysis and transplantation. Retinal vessels in fundus eye images are the only vascular networks observed from the outside of the body in a non-invasive way – with the new digital technologies nowadays many relevant processes, e.g. neovascularisation, may be thus monitored and controlled, basing on the quantitative analysis of retinal microvascular changes.

In our previous approach applied in pilot studies, based on direct measurements and fractal analysis [1-3] we have considered digital fundus eye images of ophthalmology patients and a

* Nicolaus Copernicus University, Faculty of Mathematics and Computer Science, 87-100 Toruń, Poland;
e-mail:berndt@phys.uni.torun.pl

control group volunteers. The results have appeared encouraging and now we would like to extend the studies to include the images collected at the nephrology department. We are aware a comprehensive data base management system is needed for proper diagnosing procedures in such, usually very sophisticated, situations. The data base system design is the main topic of the present preliminary communication.

2. METHODS AND TOOLS

2.1. MATERIALS AND DATA

The photographs are taken in non-invasive routine examination, using Philips ESP2/00 digital camera combined with a Zeiss Retinophot Fundus Camera. For each patient a full protocol of additional clinical data covering age, gender, cause of renal failure, HD duration, as well as relevant laboratory results and remarks on epoetin (EPO) therapy, is collected. In the ophthalmological descriptions special attention is paid to typical features of the fundus images for the renal patients, such as microaneurysm and retinal hemorrhage, cotton-wool spots, disc swelling, arteriolar narrowing, arteriovenous nicking, neovascularisation.

2.2. DATA BASE SYSTEM DESIGN

In our previous approach, dealing with smaller data sets, we have developed MS Access database applications [1-2]. Having in mind further developments and the need of the network access to the data we have started with WWW Server – Apache, PHP interface software and MySQL data base system. JavaScript has been also used for verification on the user's side.

The basic modules of the system design provide:

- users' interface and profiles for the list of userstools for patients' searches
- basic data of patients
- biopsy results
- nephrology examinations
- endurance trials results
- bio-chemical analysis results
- diabetic data
- neurology examinations
- history of the patients results
- images with full information and descriptions
- reports on the ophthalmological diagnoses
- general and individual queries for results presentation
- interface for appending diagnoses and descriptions

Below in Figure 1 a sample screen of the application's interface is presented.

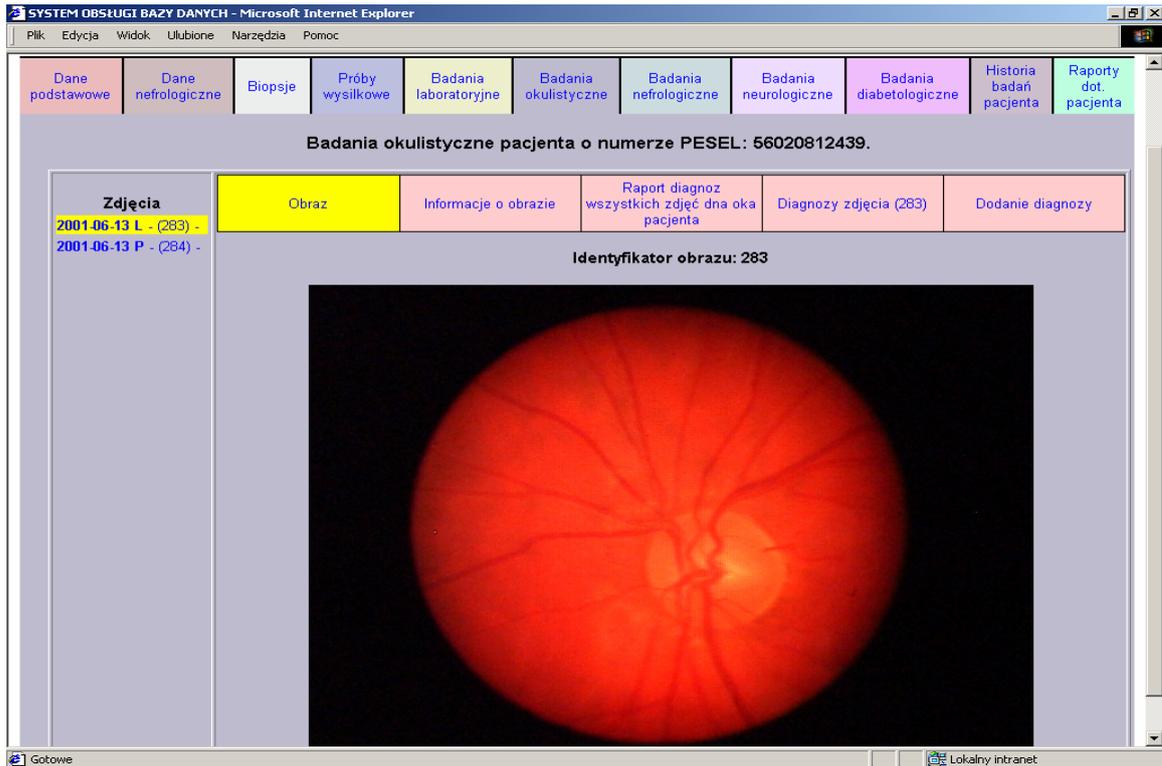


Fig.1. Sample screen of the application’s interface showing a patient’s image and relevant data entries

The photographs are taken in the hospital and transferred to the University server - special attention is paid to the relevant file transferring procedures. Appropriate interfaces enable control and verifications procedures, providing final reports on the transfers’ failures or successes. See the Figure 2. below showing the report on the transfer’s success.

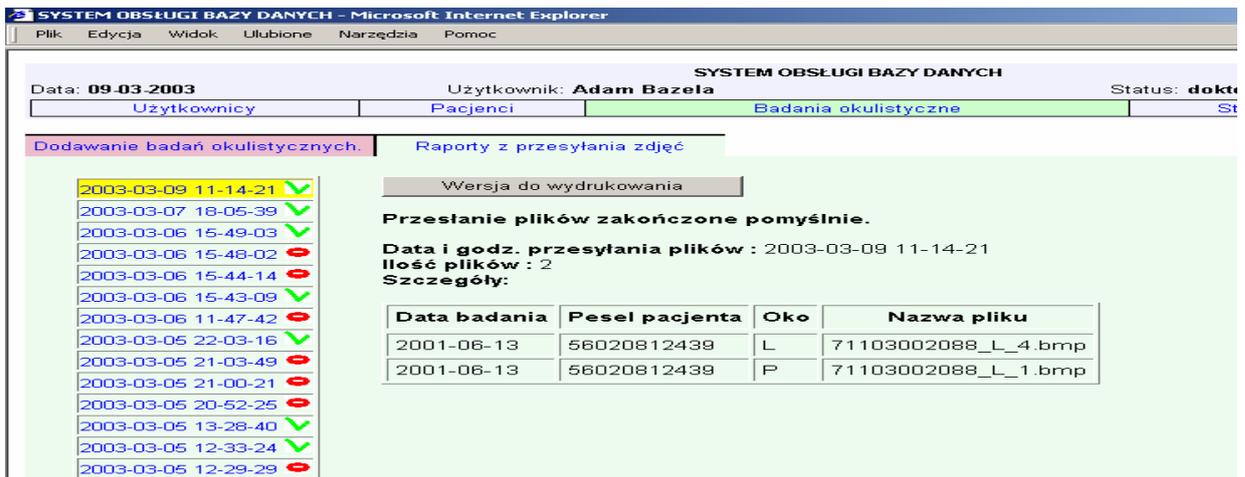


Fig.2. A sample report on file transfer procedures

3. CONCLUSIONS

A proper design of a comprehensive data base management system, being user friendly for a clinical use on the one hand and, on the other, providing a holistic overview of the renal patients imaging and various medical data, is essential when starting the studies of fundus imaging correlations in diagnosing procedures. It is particularly important when planning automated tools for image analysis [7], and also in the context of its potential telemedicine applications [6]. An extended image analysis, including colour segmentations is the next stage to be considered in our future approach [4].

BIBLIOGRAPHY

- [1] BERNDT-SCHREIBER M., BIEGANOWSKI L, KOWALCZYK A., MACIEJEWSKI K., Digital Analysis of Ophthalmological Images – a Proposal for a Screening Strategy, Polish J. Med. Phys. & Eng., Vol. 8 (2), 89-98
- [2] BERNDT-SCHREIBER M., BIEGANOWSKI L, KOWALCZYK A., MACIEJEWSKI.K., MUSZYTOWSKI M., Analysis of Digital Fundus Images – an Overview of Methods Supporting Medical Diagnostics (in Polish), [in] 5th Symp. on Modelling and Measurements in Medicine, Ed. J. Gajda, Wydawnictwo AGH, Kraków,2003
- [3] BERNDT-SCHREIBER M., BIEGANOWSKI L, KOWALCZYK A., MACIEJEWSKI, K., Bio-morphological Measurements Based on Digital Fundus Eye Images, accepted for publication in Int. J. Applied Mathematics and Computer Science, 2003
- [4] GONZALEZ R., C., WOODS R., E., Digital Image Processing, Prentice Hall Inc., 2002
- [5] HUBBARD L. D., BROTHERS R.J., KING W. N., CLEG L. X., KLEIN R., COOPER L. S., SHARRETT A. R., DAVIS M. D., CLAI J., Method for Evaluation of Retinal Microvascular Abnormalities Associated with Hypertension/Sclerosis, Ophthalmology Vol. 6, No 12, pp.59-80, 1999
- [6] LAMMINEN H., RUOHONEN K., Fundus Imaging and the Telemedical Management of Diabets, J. Telemed Telecare Vol.8 No5, pp.255-258, 2002
- [7] LEE S. C., LEE E. T., KINGSLEY R. M., WANG Y., RUSSELL D., KLEIN R., WARN A., Comparison of Diagnosis of Early Retinal Lesions of Diabetic Retinopathy between a Computer System and Human Experts, Arch. Ophthalmol. Vol 119 No 4, pp.509-515, 2001
- [8] WONG T. Y., KLEIN R., KLEIN B. E., TIELSCH J. M., HUBBARD L., NIETO F. J., Retinal Microvascular Abnormalities and their Relationship with Hypertension, Cardiovascular Disease and Mortality, Survey of Ophthalmology Vol. 46, No1, pp. 59-80, 2001