TECHNICAL OPTIONS OF DOCUMENTATION OF THE ANTERIOR SEGMENT AND THE OCULAR FUNDUS FINDINGS WITHIN MISSION PROJECTS

Furdová A.[1], Krčméry V.[2,3], Horkovičová K.[1], Furdová Ad.[1], Sláviková T.[4]

[1]Department of Ophthalmology, Faculty of Medicine, Comenius University and University Hospital Ružinov, Bratislava
[2]Microbiological Institute, Faculty of Medicine, Comienius University, Bratislava
[3]Department of Tropical Medicine, Tropic Team, St. Elizabeth Oncological Institute and St. Elizabeth College of Health and Social Work, Bratislava
4Institute of Histology and Embryology, Faculty of Medicine, Comenius University, Bratislava

The authors of the study declare that no conflict of interest exists in the compilation, theme and subsequent publication of this professional communication, and that it is not supported by any pharmaceuticals company.

Doc. Mgr. MUDr. Alena Furdová, PhD., MPH, MSc.
Klinika oftalmológie LFUK a UNB, nemocnica Ružinov
Ružinovská 6,
826 06 Bratislava
e-mail: afrf@mail.t-com.sk, alikafurdova@gmail.com
tel: pracovisko +421 2 48234 kl. 607

SUMMARY

Documentation of the anterior segment and the eye fundus with instruments that enable quality precision diagnostics is a common and important part of screening in humanitarian ophthalmology projects. It is the essential element in diagnosis, monitoring and management of eye diseases. In sub saharan countries within the screening for ophthalmologist are not available the modern technologies such as biomicroscope (slit lamp) or fundus camera. We describe our experience with photographs of anterior segment of the eye by using digital camera and Smartphone. The documentation of the eye fundus was recorded through 20D Volk spherical lens to Smartphone.

Material and methods: Within the screening projects in collaboration with St. Elisabeth University of Health and Social Sciences for eye diseases in the year 2014 in Bigugu, Rwanda and in 2015 in Mapuordit, South Sudan, we examined patients who were unable to reach ophthalmologic care. We used a flashlight, a direct ophthalmoscope, tables to determine visual acuity on illiterate, Schiøtz tonometer, Volk lens, Smartphone. Patients who underwent screening, and needed glasses, got from humanitarian collection already used dioptric eyeglasses or sunglasses. For documentation of the anterior segment we used a digital camera and for patients in whom it was necessary to document fundus findings detected by direct ophthalmoscopy we took the opportunity of Smartphone with 8 Mpix camera and the LED flash and Volk lens plus 20 Diopters.

Results: In 2014 within the project in Bigugu, Rwanda and in 2015 in Mapuordit, South Sudan, we examined patients in an improvised clinic without access to electricity.
We examined in 2014 a total of 340 patients and in 2015 a total of 290 patients. Patient age was due to the unavailability of designated identification records estimated with the help of an interpreter. In both groups, the mean age of the patients was about 30 years. The most common diseases leading to blindness were cataract, trachoma, post-traumatic conditions. Infectious diseases and consequences of untreated infectious diseases were the cause of 20% of the permanent changes on the surface of the eye or the adnexa. In the group of HIV positive patients we did not mention pathological findings on the eye fundus.

Conclusion: Anterior segment findings documentation with digital camera or mobile phone and fundus examination using a Smartphone and Volks lens with a value of plus 20D is inexpensive and manageable technique which can capture high quality and reproducible images. These techniques are suitable for photo documentation of anterior segment and also eye fundus screening within humanitarian projects of eye diseases in developing countries.

Key words: anterior segment examination, eye fundus examination, Smartphone, digital camera, humanitarian screening projects of eye diseases

Čes. a slov. Oftal., 72, 2016, No. 3, p. 86–90

INTRODUCTION

Documentation of findings on the ocular fundus with the aid of developed instruments that enable better quality and more precise diagnosis is today a regular and important component of clinical practice, and a fundamental component in the diagnosis, monitoring and management of ocular pathologies (3, 5).

In developing countries, modern technologies such as fundus cameras, which could enable imaging of the ocular fundus of a similar standard as that in developed countries, cannot be found outside of centres. As a result it is necessary to make use of alternatives, which are easily transportable to remote regions and involve minimal user and financial demands (2, 4, 6). The use of a smartphone and spherical Volks lens with a value of plus 20 dioptres represents precisely such an alternative, and can be used for the necessary photo documentation in the case of acute admittance of patients or applicable consultation (9, 10, 11).

The aim of our study is to present our first experiences with photo documentation of the anterior segment of the eye using a mobile telephone and digital camera without a tripod, and of the ocular fundus with the

aid of a 20D spherical lens and mobile telephone Lenovo S660, operating system Android, version 4.2 (Jelly Bean) with an 8 Mpix camera and LED flash without the use of commercial adaptors, within the framework of projects for screening ocular pathologies in countries of sub-Saharan Africa (Rwanda, South Sudan).

MATERIAL AND METHOD

Within the framework of projects and co-operation with the St. Elizabeth College of Health and Social Work in remote regions (Rwanda in 2014, South Sudan in 2015), before our departure we organised a collection of used dioptric glasses and sunglasses, which we sorted, treated with ultrasound and indicated each pair of glasses with a number and parameters – dioptric (spherical parameter, cylindrical value), pupillary distance. The basic equipment of the improvised examination unit we had available was composed of a testing glasses frame, a set of concave and convex lenses, direct battery ophthalmoscope, Schiötz tonometer, paper wall form of Snellen's optotypes for illiterate patients, magnifying glass and torch, mobile telephone and digital camera. Patients who came for examination and required an optical aid obtained glasses from our collection (fig. 1). Patients in whom it was not possible to correct visual disorders by dioptric glasses received sunglasses. In the majority of cases patients had not yet encountered such an optical aid.

We examined the basic functions of sight – central visual acuity (CVA) using a wall table for illiterate patients, for near vision we used an improvised "reading table", we further examined the auxiliary organs of the eye and the anterior segment, optical media, we assessed the reflex of the ocular fundus and changes on the ocular fundus with the aid of a direct ophthalmoscope. In patients in whom it was necessary to document determined findings on the ocular fundus by a direct ophthalmoscope we utilised the option of Lenovo S660 smartphone, the Android operating system, version 4.2 (Jelly Bean) with an 8 Mpix camera and LED flash, and a Volks lens with a value of plus 20 dioptres.

Photo documentation was performed on all patients with the aid of a mobile telephone or digital camera. Documentation of the ocular fundus was performed only in 2015 in artificial mydriasis (Atropine Sulphate Ophthalmic Solution USP 1% w/v) in lying position, in a slightly darkened room. No other functions, applications or programs of basic software were used for adjustment of the images, either during the actual examination or after their transmission by USB cable to a computer in the highest possible quality, within the framework of the possibilities of the used smartphone.

RESULTS

In the period of January – February 2014, within the framework of a project in Bigugu, Rwanda, we examined patients who came to the remote mountainous area for treatment at a "health point". We examined and treated 340 patients and we provided a corrective aid to 180 patients (fig. 1).

In the period of January – February 2015, within the framework of a project in the Mary Immaculate DOR Hospital Mapuordit, in the state of Lakes, South Sudan, we examined outpatients and hospitalised patients. In total we examined and treated 290 patients and provided a corrective aid to 190 patients.

In 2014 we determined central visual acuity better than 6/60 in 75% of patients, whilst 25% of patients were below the limit of 6/60. The most common causes of reduction of central visual acuity were cataract, trachoma and uncured infectious diseases (fig. 2, 3).

In 2015, within the framework of the project in South Sudan, we also performed documentation of findings on the ocular fundus of hospitalised patients with the aid of a Volks lens and a smartphone (fig. 4, 5, 6, 7). Within a time interval of 2 weeks, out of the total number of 241 examined patients, of whom 141 were male (58.5%) and 100 were female (41.5%), we examined and documented the finding on the ocular fundus with the aid of a Volks lens and mobile telephone in 9 patients (6 men, 3 women) with an average age of 32.3 years (from 10 years to 62 years) and visual acuity from 0.01-1.0 (average visual acuity 0.8). The scale of diagnoses of patients in whom we sought changes on the ocular fundus covered Burkitt's lymphoma, visceral leishmaniasis (Kala-Azar), malnutrition of unknown etiology, tuberculosis, HIV positive patients, suspected Usher syndrome and one patient with hypertension. The patients in whom the ocular fundus was examined were selected from the total number on the basis of their consent to the examination, the transparency of the optic media and their hospitalisation. Due to the fact that within the given conditions the only pharmaceutical available was a long-term acting mydriatic drug (atropin eye drops), which causes blurred vision within an interval of 24-48 hours, was available, we did not treat outpatients.

In 7 out of 9 cases there was no prospect of any change on the ocular fundus, in 2 we succeeded in documenting pathological changes on the ocular fundus (table 1).

DISCUSSION

Examination of the ocular fundus in developing countries of the Third World is absolutely unavailable in the majority of small hospitals, because co-operation with an ophthalmologist is not possible. Some pathologies however require an examination of changes on the ocular fundus, and on the basis of the determined changes it is then possible also to further address the monitoring and management of the pathology (e.g. diabetes). Within the framework of co-operation with the St. Elizabeth College of Health and Social Work we had the opportunity to participate in projects in Rwanda and South Sudan in the local hospital in Mapuordit, where an ophthalmology clinic was established a number of years ago for a transitional period, but was closed more than 4 years ago, after which the patients from the local region were not examined by an ophthalmologist and no basic screening of ocular pathologies was performed (1).

It is possible to document pathologies of the anterior segment of the eye with the aid of a digital camera, and subsequently to consult an expert. Up to now it has not been possible to document pathologies which are manifested by their changes on the ocular fundus easily, and as a result the solution with the aid of a smartphone and simple Volks lens has been demonstrated to be very effective and inexpensive for those who perform screening of ocular pathologies in selected regions of the Third World. The inspiration for our study was the results from the study from December 2014 conducted by Němčanský et al., who published their observations and experiences with 15 patients observed over a time period of 2 months at the Department of Ophthalmology at the University Hospital in Ostrava. The authors evaluated photo documentation of the posterior pole of the eye (7). In our project in 2015 the photo documentation for all patients was produced in artificial mydriasis in a lying position, in a slightly darkened room. No further functions, applications or programs of basic software were used for adjusting the images, either during the actual examination or after their transmission via a USB cable to a computer in the highest possible quality within the framework of the possibilities of the used smartphone.

The principle of this technique is that it is possible to apply also upon screening of pathologies of the ocular fundus in prematurely born children, as documented in a cohort of patients by Oluleye et al. in Lagos, Nigeria (8).

In our cohort also we examined a small group of patients within a short time interval and severe conditions in South Sudan; we evaluated the findings on the posterior pole, it was not possible to assess the periphery of the retina by this method (1).

Fig. 1 Collection of eyeglasses

Fig. 2 Infectious diseases and pathologies of the anterior segment were the most common within the framework of the project

Fig. 3 Macro photo of anterior segment of eye of patient with cataract

CONCLUSION

Examination of the anterior segment of the eye with the aid of a digital camera on a mobile telephone and examination of the ocular fundus with the use of a smartphone and Volks lens with a value of plus 20D is an inex-

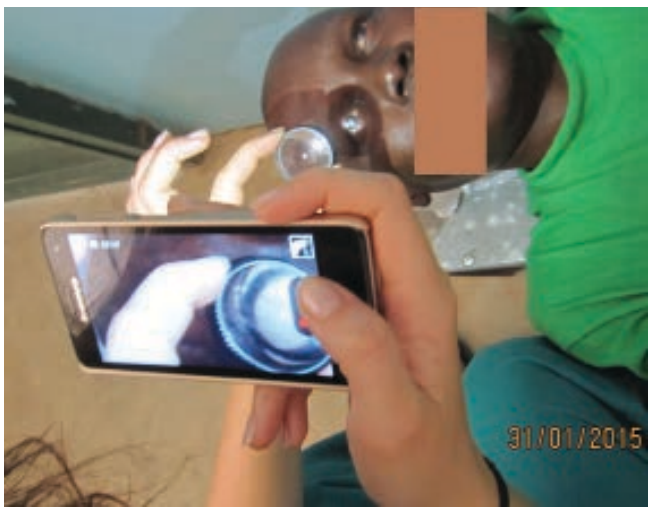

Fig. 4 Beginning of examination of ocular fundus with the aid of a Volks lens and smartphone

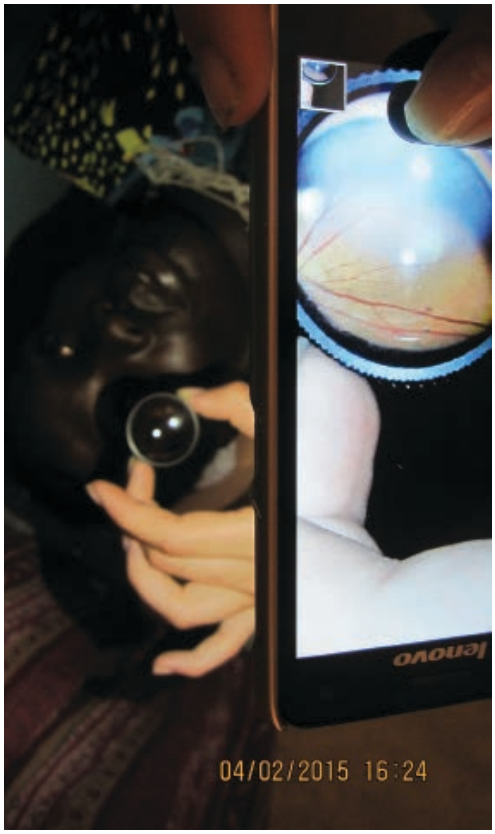

Fig. 5 Volks lens placed before the eye during examination of the ocular fundus with the aid of a smartphone

Fig. 6 Photography of detail of ocular fundus produced with the aid of a Volks lens and smartphone

Fig. 7 Detail of ocular fundus produced with the aid of a Volks lens and smartphone in patient with Usher syndrome

pensive and manageable technique by which it is possible to capture quality, reproducible images suitable for photo documentation and screening in ophthalmological practice in the demanding climatic and social conditions of projects in developing countries. Within a short time interval and in severe conditions in Rwanda and South Sudan we examined a relatively small cohort of patients. Within the framework of the project in South Sudan, however, this represents our first experience of the successful use of the technique of a 20D lens and smartphone in our humanitarian project, and will certainly find application in screening of the ocular fundus also in future within the framework of joint projects of the Faculty of Medicine of Comenius University and the St. Elizabeth College of Health and Social Work in examining ocular pathologies in developing countries.

Table 1 Overview of examined patients with comparison of CVA, diagnosis on the basis of which the patient was hospitalised and a description of the finding on the ocular fundus (HIV – Human Immunodeficiency Virus, TBC – tuberculosis)

Patient no.	Age	Sex	CVA	Diagnosis	Change on ocular fundus
1	10	M	1	Burkitt's lymphoma	None
2	26	M	1	Malnutrition of unknown etiology	None
3	16	M	1	Kala-Azar	None
4	37	F	1	HIV+	None
5	40	F	1	HIV+	None
6	26	F	1	TBC	None
7	20	M	0.01	Usher syndrome	Pronounced pigment clusters of irregular shape and arrangement on entire surface of ocular fundus
8	62	M	0.01	Incipient cataract, bilateral	None
9	54	M	1	Hypertension	Pigment ring around disc of optic nerve

LITERATURA

1. **Furdová, Ad.**: Využitie smartfónu ako zobrazovacej techniky pri vyšetrení očného pozadia u pacientov v krajinách tretieho sveta. Interaktívna konferencia mladých vedcov 2015. Zborník abstraktov [elektronický zdroj]. Bratislava : Preveda, 2015. - Abstract No. 1166 [2 s.] [online]. ISBN 978-80-970712-8-8.
2. **Chhablani, J., Kaja, S., Shah, V.A.:** Smartphones in Ophthalmology. Indian J Ophthalmol, 2012; 60(2): 127–131.
3. **Maamari, R.N., Keenan, J.D., Fletcher, D.A., et al.:** A Mobile Phone-based Retnal Camera for Portable Wide Field Imaging. Br J Ophthalmol, 2014; 98(4): 438–441.
4. **Mašek, P., Winklerová, S.:** Fotografie v očním lékařství. Čs Oftal, 1984; 40(4): 218–220.
5. **Meyer, CH.:** Smart ophthalmologists: Smartphones for nothing and the Apps for free? Ophthalmologe, 2012; 109(1): 6–7.
6. **Michelson, G.:** Teleophthalmology in Preventive Medicine. Berlin: Springer -Verlag Heidelberg; 2015: 51.
7. **Němčanský, J., Kopecký, A., Timkovič, J., Mašek, P.:** Mobilní telefony jako nástroj pro dokumentaci očního pozadí, Česká a slovenská oftalmologie, 2014, 70(6): 239–241.
8. **Oluleye, T.S., Rotimi-Samuel, A., Adenekan, A.:** Mobile phones for retinopathy of prematurity screening in Lagos, Nigeria, sub-Saharan Africa. Eur J Ophthalmol 2016; 26(1): 92–94
9. **Sharma, A., Subramaniam, S.D., Ramachandran, K., Lakshmikanthan, C., Krishna, S., Sundaramoorthy, S.K.:** Smartphone-based fundus camera device (MII Ret Cam) and technique with ability to image peripheral retina. Eur J Ophthalmol 2016;26(2):142–144.
10. **Slobodníková, J., Furdová, A., Králik, G., Šramka, M.:** Moderné zobrazovacie, diagnostické a liečebné metódy, Samosato, s.r.o., 2012; s. 69–77.
11. **Tietjen, A., Stanzel, B.V., Saxena, S., et al.:** New options for digital photo documentation during routine examination for ophtalmologists. Klin Monbl Augenheilkd, 2013; 203(6): 604–610.