

Medicina i tehnologija/ ON DISTANCE DIAGNOSIS OF OPEN
Medicine and technology ANGLE PRIMARY GLAUCOMA
IN THE EARLY DISEASE STAGE

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**DIJAGNOZA NA DALJINU PRIMARNOG
GLAUKOMA OTVORENOG UGLA U RANOJ
FAZI BOLESTI**

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Key words

primary open-angle glaucoma (POAG),
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Ključne reči

glaukom otvorenog ugla, arteficialna
neuronska mreža, dijagnoza

Abstract

Usage of technology for on-distance diagnosis of open angle glaucoma in early stage is presented in this paper. Early diagnostic of primary open angle glaucoma is current world-wide problem that strongly depends on the recent achievements in ophthalmology. The solution of problem was offered in Russia health centers, particularly at Krasnoyarsk territory. Central medical-sanitary part Geleznogorsk city of Krasnoyarsk Region tried to solve the problem using the self-developed methods of artificial neural network. The study included 344 patients with suspected open angle glaucoma. The diagnosis was confirmed in 55.2 % of cases and was rejected in 28.8 %. The suspicion on glaucoma remained at 16% of cases.

INTRODUCTION

The problem of early diagnosis of primary open angle glaucoma (POAG) is important to be solved not only from the point of the proper and reliable diagnosis but also due to consistent and efficient treatment. The reasons of a divergence included the absence of obvious clinical symptoms even some indicators pointed to the existence of changes in the eye's apple. It is, also, impossible to specify reliable symptoms related to glaucoma only, especially by using tests that do not have sufficient sensitivity. Some kind of "illegibility" of some glaucoma attributes were observed- they could belong to healthy and sick patients. Some parameters could be in the frame of "norm" values so they do not indicate a clear line between a healthy state and the beginning of the disease. [11, 12, 13, 20]

The ambiguities of classification character and relativity of all specifications create additional complexities in definition of reliable criteria for early diagnostics of POAG. Each physician diagnoses initial POAG in his own way and this is a possible explanation for large differences in the POAG frequency (0.5 % - 8.0 %) obtained during the routine inspections. The features of current POAG in an initial stage make diagnostics difficult even for the skilled doctors. Generally, glaucoma begins imperceptibly and precedes individually so the late diagnostic could effect negatively on the illness stage. Traditional diagnostic assumes long super-

vision of the patient which is expensive and unreliable method for early revealing of glaucoma (Interregional symposium "Liquidation of eliminated blindness: the world initiative a CART" 2003).

V.V. Volkov reported the description of a hypothetical history of illness for women with suspicion on POAG and proposal of possible response (*The Annals of Ophthalmology*, 1986). It is also reported that the sensitivity of ideal trouble-shooting test was 100 %. However, the probabilities of existence of such test are very low all have counted low. Thus, the reasons of distinction of opinions are the features of current early POAG, a nature of disease, heterogeneity of glaucoma, slow development and often uncertain character of symptoms in an initial stage, existence of glaucoma with normal pressure and good-quality of eye increase intraocular of pressure, other objective and subjective reasons.

Despite of an abundance of trouble-shooting tests, early diagnostics glaucoma is difficult even for the skilled doctor [10]. The existing specifications for intraocular pressure and other diagnostic parameters carry out statistical properties. The period in which it is possible to diagnostic the suspicious POAG is fairly long and the state of additional micro symptoms is required [4,5,6]. A.P. Nesterov [10] marked the three main POAG symptoms as are: increase of intraocular pressure; changes of sight field characteristics and neuropathy of a visual nerve. Last two symptoms could not be predicted in the initial stage of disease. It is necessary to note

the symmetry of changes on eyes at increased intraocular pressure, while the pathological process glaucoma seldomly happens completely symmetric. V.V. Egorov regarded asymmetry in a condition of eye as one of criteria for the differential diagnosis of POAG [3]. A.P. Nesterov has reported that approximately 30 % of skilled ophthalmologists were not capable to distinguish increased intraocular pressure from initial POAG [10]. In 1932 Bell (1940) marked, that the beginning POAG can be imperceptible without predictable results.

V.V. Volkov et al. [19] reported that the attempts of recognition of disease based upon only one symptom would not lead to the increase of efficiency of early diagnostics of disease. In its opinion, glaucoma was characterized by a triad of symptoms. A.M. Shamshinova et al. [15] based their conclusions on the recent literature and stated that pathological physiology of process included genetics, internal development of diseases, change of drainage system, gradient of pressure, biomechanical factors, biochemical infringements and many other things.

The large progress in understanding of mechanisms underlying visual infringements at glaucoma, has taken place as a result of use of modern electrophysiological and psychophysical of methods of research [15,18,19], which were based on neurophysiology of a visual way. E.I. Ustinova in 1966 informed, "...that there are more than 100 various methods of early diagnostics glaucoma, but none of them can apply with absolute reliability. There is no ideal methods for early diagnostics of glaucoma..... therefore at inspection of the patient with suspicion on glaucoma the complex application of diagnostic methods is necessary" [17]. For subsequent 40 years, the methods for early revealing of POAG stayed on the level of the basic concept including complexity of visual function researches.

The literal meaning of the term "forecast" is "knowledge beforehand", "prediction", and it is derived from the Greek language. The term is originally designated as a prediction of changes or outcome of disease. In medicine the forecast, as a rule, is not realized. Nevertheless, we believe, that the need for the authentic forecast is significant. The incurable blindness still disturbs minds of ophthalmologists [16]. Successful treatment of glaucoma and safety of visual functions are determined by the timely diagnosis and forecasting. The opportunities in this sphere considerably have increased with introduction of computer technologies.

It was estimated that the annual risk of POAG for of Krasnoyarsk Region was on the level of 3000 inhabitants. [7]. In 1998 it was reported that 17.7% patients lost their sight due to glaucoma and this figure increased on 29.9 % in 2010.

It is possible to use artificial neural network in ophthalmology [14], but the problem of necessary reduction of duration of the diagnostic period as well as health care expenses still remain opened. We used an artificial neural network developed at Institute of Computing Modeling of the Siberian branch of the Russian Academy of Sciences and Laboratory of medical computer science and neural of technologies Krasnoyarsk State Medical University [7,8,9,14].

Artificial neural networks have universal opportunities and advantages. They enable classification of tasks, self-training and additional training in process of accumulation

and processing of the data in practical medicine. Thus, it is possible to use set of training attributes (clinical parameters) and clinical examples, and to work on the usual personal computer. Additionally, there is no possibility to "substitute" the physician (ophthalmologists) by the computer, as the answer (diagnosis) is not categorical. The presented method enable development of new medical technology for early and remote diagnostics of POAG based on the application of artificial neural networks and high technologies (OCT, HRT).

MATERIALS AND METHODS

It is estimated that about 25 % of the hundred thousands residents city Geleznogorsk of Krasnoyarsk Region are older than 40 years. About 2.4 % of them suffer from glaucoma. Among the inhabitants older than 60 years even 20% suffer from glaucoma. The number of patients that suffer from glaucoma increased from 592 in 2002 to 829 in 2006. The number of patients with suspected glaucoma was 10 in 2003, than 112 in 2006 and 60 patients in 2009. It was estimated that the 19% of vision loss was caused by glaucoma so it became the urgent problem for the cities, which population progressively grows old.

RESULTS

The purpose of the present paper is the analysis of results of early on distance diagnostics of POAG using self-learning artificial neural networks in the Central medical-sanitary part of city Geleznogorsk of Krasnoyarsk Region since 2003. This system was developed in our institutions. [8]. The inspection of the patients with suspected glaucoma was performed using simplified method which included development and fulfillment of individual map for each patient. This review included survey of an eye apple, measurement of intraocular pressure, research of sight fields, research of eye hydrodynamics and measurement of blood pressure. The special attention was paid on micro symptoms of glaucoma. Asymmetry of all eye parameters was taken into account. The fulfilled map of the patient was sent on Faculty of ophthalmology of Krasnoyarsk state medical university for neuron diagnostics of glaucoma. The obtained results were put in computer database and processed with the help of trained earlier artificial neural networks.

As a result it is possible to get "answer" that the patient "has glaucoma" or that patient is "health" with a different degree of reliability of the received result. The previous training artificial neural networks was spent on the clinical data belonging 350 patients by an initial stage POAG (562 eyes) and 125 conditionally healthy persons without attributes glaucoma (185 eyes) of representative age.

The motives of creation of a remote method of early diagnostics of glaucoma were dictated by the life. Huge extent of Krasnoyarsk Region, long and cold winters, low material maintenance of the village population and the insufficient diagnostic opportunities of regional hospitals do not promote early diagnostics of glaucoma. For realization of remote diagnostics methods the complex of appropriate inspections were developed.

In the period of three years from 2005 till 2008 about 344 patients with suspicion on glaucoma were surveyed in Geleznogorsk city. Using neural networks in 55.2 % cases

diagnosis of POAG were confirmed, in 28.8 % of cases it was rejected and in 16 % of cases it was remained as suspected. Remote diagnostics of glaucoma saved around 100 thousand rubles in 2005 and around 78 thousand rubles in 2006 (totally 178 thousand rubles for two years). This method gave the decrease the imperceptible effects by 84 % that, undoubtedly, promotes increase of quality of life of these people at the expense of liquidation of chronic stress as threat for glaucoma, for "nothing frightens more than uncertainty ...". The patients with the confirmed diagnosis of glaucoma were treated appropriately. To the patients with the diagnosis "the suspicion on glaucoma" is recommended repeated remote testing in 6 months of supervision.

CONCLUSION

The advanced technology of remote diagnostics of glaucoma using artificial neural networks allow diagnostics on distance, quickly and early diagnosis, inclusion of ophthalmologists in the diagnostic process if the answer is not categorical, storing and data processing and forming appropriate database with control access.

Apstrakt

Cilj rada je utvrđivanje rezultata korišćenja tehnologije u dijagnostici na daljinu Glaukoma otvorenog ugla u njegovoj ranoj fazi nastanka.

Rana dijagnostika glaukoma otvorenog ugla, uprkos značajnom napretku u oftalmologiji, i dalje ostaje problem u čitavom svetu. Uopšteno ovaj problem postoji u čitavoj Rusiji, a na teritoriji Krasnojarska posebno.

Uz pomoć sopstvene artefijelne neuronske mreže, dijagnoza na daljinu primarnog glaukoma otvorenog ugla bila je sprovedena u Medicinskom centru Gelenogorske u Krasnojarskoj oblasti. Ova dijagnostika je bila sprovedena kod 344 bolesnika sa sumnjom na glaukom. Od tog broja je primarni glaukom otvorenog ugla potvrđen je kod 55,2% slučajeva, sumnja na glaukom je ostala kod 16,0% i kod 28,8% slučajeva dijagnoza nije potvrđena.

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