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Comparison of optic disc evaluation methods in neurology emergency patients

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ABSTRACT

Background

The optic disc examination is critical for the diagnostics of several acute neurological disorders. However, dilation of the pupil is not recommended for neurological patients, which complicates ophthalmoscopy.

Aims of the study

Present pilot study compared a portable fundus camera to an ophthalmoscope in fundus examinations of neurological emergency patients. To our knowledge this is the first comparative study of the subject. The fundus photos were later reviewed with an ophthalmologist.

Methods

The study included 60 adult, volunteer neurological emergency patients with either headache, cerebrovascular disorder or acute confusional state (delirium).

Patients' non-mydratic fundus examination was conducted with an ophthalmoscope and a Smartscope Pro fundus camera.

Results

Fundus photography succeeded in 56 (93%), partially succeeded in 2 (3%) and failed in 2 (3%) cases compared to ophthalmoscopy that succeeded in 35 (58%), partially succeeded in 14 (23%) and failed in 11 (18%) cases ($p < 0.0005$). The researcher and the ophthalmologist agreed in the findings in 54 out of 58 cases (93%). In six cases (7%), the researcher had failed to detect a non-critical ophthalmic finding.

Conclusions

The neurological fundus examination by fundus camera seems to be superior to regular ophthalmoscopy in defining the critical optic disc findings in emergency patients.

BACKGROUND

Examination of the optic disc is a vitally important part of the diagnostics of several acute neurological disorders. However, direct ophthalmoscopy is a technically difficult examination which requires time, practice and patience ^{1 2}. Typically, only ophthalmologists have received adequate training in direct ophthalmoscopy to truly master it ^{2 3}. Additionally, dilating the patient's pupils hinders neurological monitoring, and is thus contraindicated, making direct ophthalmoscopy even more challenging. Due to a failed ophthalmoscopy, even severe findings that would require immediate treatment may remain unnoticed, and the patient's sight or even life may be threatened ⁴. Fundus examination can provide information on, for example, increased intracranial pressure and cerebrovascular disorders requiring further evaluation and timely treatment.

Fundus photography is a quick examination that doesn't require the dilation of the pupil. Fundus photography can also be taught to nurses easily, speeding up the treatment process ⁵. According to previous studies, fundus photography provides diagnostically high-quality images that help detect findings that have been missed by physicians carrying out traditional direct ophthalmoscopy ^{6 7}. Admittedly, in these studies the patients have been co-operative. This study may provide additional information on the suitability of more difficult patient groups for fundus photography.

In this qualitative pilot study, we aimed to investigate the suitability of a non-mydriatic fundus camera for the examination of neurological emergency patients compared to traditional direct ophthalmoscopy. We also evaluated the diagnostic differences in the interpretations of the fundus images by an on-call physician and an ophthalmologist. Our hypothesis is that a fundus camera provides a better picture of the condition of the patient's fundus than direct ophthalmoscopy.

Several studies have already been conducted on the benefits of using a fundus camera. On the other hand, there are hardly any previous studies on the assessment of the status of the fundus in patients with decreased level of consciousness or in patients who are poorly co-operative. This study investigates the applicability of fundus photography in the examination of difficult-to-examine patients. Based on the results, further research can be planned for larger patient populations and consideration can be given to the introduction

of fundus cameras as part of the routine examination of neurological emergency patients in support of conventional ophthalmoscopy.

METHODS

The study followed the tenets of the Declaration of Helsinki and it was conducted with the approval of the Oulu University Hospital Research Committee. Data consisted of 60 adult volunteer neurological patients who were treated in the neurological emergency department at Oulu University Hospital between August 2016 and May 2017. The patients with symptomatic headache, cerebrovascular disorder or acute confusional state fulfilled the inclusion criteria. Patients were asked for a written consent to be examined and if patients were unable to give consent due to their condition, we asked for a written consent from the next-of-kin. Some patients met multiple inclusion criteria. To evaluate the co-operative ability of the patient a Glasgow coma scale (GCS) and modified Rankin Scale (MRS) score were used. The criteria for acute confusional state was a lower-than-normal (15) GCS.

Both eyes were examined first by a non-mydratic direct ophthalmoscopy (Welch Allyn 97200-BIL Elite LED ophthalmoscope), and then by a hand-held, non-mydratic fundus camera, Smartscope Pro (Optomed Oy, Finland). Both the ophthalmoscopy and fundus photography were assessed using three categories: successful, partially successful and failed. The criterion for a successful fundus examination was the successful examination of the optic disc in both eyes. In a partially successful examination, the optic disc of at least one eye was examined completely. In a failed examination, neither of the optic discs could be examined completely. The fundus photographs were primarily analyzed by the researcher and secondly by an ophthalmologist for the comparisons of the diagnostic differences. The researcher also reported the findings and provided the fundus photographs to the on-call neurologist responsible for the patient's treatment. In two cases the on-call neurologist requested an urgent ophthalmologist consult of the fundus photographs.

RESULTS

28 of the examinees had symptoms of the cerebrovascular disorders, 30 had headache, and seven were in the acute confusional state. Some had multiple symptoms. 17 (28%) patients were men and 43 (72%) women. The median age of the examinees was 59.5 ± 18.9 years (range 18-88).

Fundus photography succeeded in 56 of the total of 60 patients (93%), partially succeeded in 2 (3%) and failed in 2 (3%) cases, whereas ophthalmoscopy succeeded in 35 (58%), partially succeeded in 14 (23%) and failed in 11 (18%) cases. The differences were statistically significant in all success groups ($p < 0.0005$, Marginal homogeneity test and MacNemar-Bowker test). Most patients (71-93%) in different symptom categories had high-quality fundus images successfully taken, whereas ophthalmoscopy succeeded in most patients with headache (73%) but in only less than half (43%) of the patients with more severe neurological symptoms (Table 1). The successful result was achieved more rapidly by photography compared to regular ophthalmoscopy.

The researcher and the ophthalmologist agreed in the ophthalmic findings in 54 cases of the 58 fundus images taken (93%). In six cases (7%), the researcher had failed to detect a non-critical ophthalmic finding, such as benign choroidal nevus. The most common causes of ophthalmoscopy and fundus photography failure were miotic pupils, oculomotor disorder, ptosis and light sensitivity.

DISCUSSION

In our knowledge, our results revealed for the first time a statistically significant difference between the fundus camera and ophthalmoscope in respect of the success of the fundus examination in neurological emergency patients. The clinical significance of the result is indisputable. Previous studies have also concluded that digital funduscopy has a high

sensitivity in detecting optic disc edema, making it a potentially valuable tool in the emergency department ^{1 2}.

The fundus evaluation by a hand-held camera with autofocus properties helping image capturing was less time-consuming than regular ophthalmoscopy. In agreement with previous studies, it may be reliably completed by an emergency physician or a nurse ^{5 6}. Also, the fundus images were saved as documents of the acute phase and transferred to patient records by the software with full DICOM and PACS compliance that ensure seamless interoperability with hospital networks. This significantly sped up and eased both the consultation process and the follow-up of the patients.

In addition to speeding up the diagnostic process, remote consultation by an ophthalmologist may prove crucial for screening common diseases with fundus findings, such as diabetes, glaucoma and macular degeneration ⁸. Modern portable fundus cameras can take high quality pictures which allow accurate diagnostics with high sensitivity ^{9 10}. The sensitivity is increased even more if the ophthalmologists are provided with the clinical findings and a brief anamnesis of the patient ⁹. In the long run, early diagnosis of these diseases may bring major economical savings in reduction of complications and improve patient's overall quality of life.

Based on our results, the fundus camera seems to be well suited to the requirements of neurological emergency department and even to examining challenging patients. The examination of the optic disc succeeded in 96% of the patients by the fundus photography, whereas the fundus analysis failed in 18% of the cases when examined by regular ophthalmoscopy. These results are in line with previous studies revealing that some of the diagnostic findings in fundus may be missed in direct ophthalmoscopy ^{6 7}.

The fundus images could be reliably and quickly interpreted by an on-call physician in most cases. Previous studies have also found that ocular fundus abnormalities are easier to detect and interpret from fundus photographs compared to direct ophthalmoscopy, even when the doctor hasn't received additional training about the subject ¹⁰. This supports the timely analysis of the optic disc status in certain critical neurological

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conditions and could thus improve the prognosis of those patients demanding immediate intervention or treatment.

The relatively small number of the study patients is a limitation of the current study. The research permit stipulated that the examinees or their next-of-kin give their written consent for participation, perceptibly limiting access of more challenging patients. More research is therefore needed especially on fundus photography of non-co-operative patients. With regard to potential sources of error in the study, one should bear in mind that the success of ophthalmoscopy, as well as fundus photography, depends on the skills and experience of the clinician.

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Disclosure of conflict of interest

The authors declare no financial or other conflicts of interest in relation to this work.

The data value statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Table 1.

Success of fundus examination by fundus photography or ophthalmoscopy in different symptom categories in neurological emergency patients. Some patients had multiple symptoms.

Fundus camera	Cerebrovascular disorder (%)	Headache (%)	Confused (%)
Success	26 (93)	29 (97)	5 (71)
Partial success	0 (0)	1 (3)	1 (14)
Failed	2 (7)	0 (0)	1 (14)
Ophthalmoscope			
Success	12 (43)	22 (73)	3 (43)
Partial success	9 (32)	5 (17)	0 (0)
Failed	7 (25)	3 (10)	4 (57)