

Title: The use of Peer Optic Nerve Photographs for Teaching Direct Ophthalmoscopy

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ABSTRACT

Objective – To use a novel teaching exercise to encourage students to practice ophthalmoscopy and to measure the learning effect both subjectively and objectively.

Design – Comparative case series.

Participants – One-hundred thirty-one fourth-year medical students on their one-week ophthalmology rotations with 89 in the experimental group and 42 in the control group.

Methods – Those in the experimental group had one eye dilated and their optic nerve photographed on the first day. The next day, these students received an unlabeled optic nerve photograph belonging to one of their peers (typically 8-10 per group) and were given three days to identify the student matching the photograph. The students in the control group were simply encouraged to practice ophthalmoscopy on each other without the use of photographs.

Main Outcome Measures – Both objective and subjective changes from the beginning to the end of the rotation were measured and compared between the two groups.

Results – In the 89 students who used peer optic nerve photographs, 75 (84.3%) showed improvement in direct ophthalmoscopy skills over the course of the week. In contrast, only 12 (28.6%) of the 42 control students demonstrated an objective improvement ($P < 0.001$). The subjective confidence levels were likewise more improved in the students who took part in the optic nerve photograph exercise.

Conclusions – These results suggest that the task of matching an unknown optic nerve photograph to the correct eye of a peer leads to increased self-confidence and more proficient use of the direct ophthalmoscope.

Direct ophthalmoscopy is one of the critical physical examination techniques required of all medical school graduates.¹ It is an invaluable tool that enables physicians to recognize common ocular abnormalities, ocular manifestations of systemic disease, as well as sight- and life-threatening conditions. Despite the importance of developing sufficient skill in performing ophthalmoscopy, both students and physicians have displayed a lack of confidence in proper performance and identification of structures within the eye. In one study,² 208 medical students were surveyed regarding their confidence with direct ophthalmoscopy. Eighty-two percent of first- and second-year medical students (i.e., junior students), stated they were “not at all” or only “a little” confident in performing direct ophthalmoscopy in an undilated eye. When questioning third- and fourth-year medical students (i.e., senior students) who had obtained additional clinical experience, the confidence level was improved, but still discouraging. Many senior medical students reported they were “not at all” or only “a little” confident in performing direct ophthalmoscopy on an undilated eye (47%), focusing on the optic nerve head (33%), focusing on the fovea (64%), following vessels (36%), and differentiating a healthy from a pathological retina (48%).²

The lack of proficiency in performing ophthalmoscopy is likewise reflected by the fact that it is frequently left out from a general physical exam. One study³ reviewed 364 notes that were routinely turned in by third-year medical students as part of their curriculum. Only 11% of notes documented any attempt at ophthalmoscopy with less than 2% suggesting actual visualization. Another study⁴ reviewed 100 case notes from general internists and geriatricians and found only three notes documenting

ophthalmoscopic examination. Of the 72 physicians surveyed at the facility, 41 agreed to a questionnaire of which only 18 (44%) were confident in performing ophthalmoscopy properly.

A number of innovative approaches for enhancing the instruction and practice of ophthalmoscopy have been reported.^{3,5-10} Most have used non-human devices such as cylindrical plastic canisters,⁵⁻⁷ modified table-tennis balls,^{8,9} or a simulation mannequin³ to help students master the ophthalmoscopic exam. These devices typically use a photographic representation of a normal or pathologic fundus, which must be viewed by ophthalmoscopy through an adjustable pupil.⁷⁻⁹ While these techniques are highly beneficial for teaching the basic skills of direct ophthalmoscopy and assessing them objectively, they cannot completely reproduce the experience of examining a live subject which poses additional challenges such as eye movement and blinking. In a previous pilot study,¹¹ we reported the use of a novel approach for assessing ophthalmoscopy skills in medical students using optic nerve photographs and volunteer subjects. Ophthalmoscopy skills were assessed by asking students to examine volunteer subjects and identify the optic nerve photograph corresponding to each subject -- among three other decoy pictures (Figure 1). Asman and Linden¹² similarly described a computer-based assessment method using optic nerve photography. These methods allow for the use of human subjects while at the same time providing a means for objective assessment. In the present study, we have introduced a novel teaching exercise using peer optic nerve photographs to encourage practice of ophthalmoscopy among medical students on an ophthalmology

rotation. We have shown that this particular exercise can significantly enhance ophthalmoscopy skills in medical students both objectively and subjectively.

METHODS

The study was conducted at the University of Illinois at Chicago (UIC) Medical School involving fourth-year medical students rotating through their required one-week ophthalmology clerkship. Prior to this rotation, all students had received formal instruction on direct ophthalmoscopy during their second year of medical school including hands-on demonstration of the use of the direct ophthalmoscope with supervised practice on fellow students. Additionally, most students had experienced a variable amount of non-structured exposure to direct ophthalmoscopy during their third-year core clerkships. On the first day of their ophthalmology rotation, all students received an additional one-hour tutorial with instructions on the use of a co-axial direct ophthalmoscope. Furthermore, it was determined by convenience sample whether or not each clerkship week would be in the study group or control group. Primarily, when fundus photography was not available on the first day of the rotation (e.g., camera not working or photography service too busy), then those students would be assigned to the control group, while the remaining weeks would be included in the study group utilizing the novel teaching exercise. The study was approved by the Institutional Review Board at UIC and was compliant with the Health Insurance Portability and Accountability Act (HIPAA).

The novel teaching exercise involved photographing the students' optic nerves and then providing each student with an anonymous picture of one of their peers, which they had to correctly identify during the rotation. This exercise was implemented in 10 rotation weeks (89 students). After obtaining verbal informed consent from the students on the first day of the rotation, all students had one eye dilated and their optic nerve photographed using a Zeiss FF3 camera. Any student who declined dilation was excluded from the study. The next day, each student received an unlabeled optic nerve photograph belonging to one of their 8-10 peers and was given three days to identify the student that matched their picture. The instructor was intermittently present to provide feedback and to ensure participation of all students. In contrast, the students in the control group were simply encouraged to practice ophthalmoscopy on each other throughout the week with the instructor available for guidance and questions as deemed necessary by the students. A total of 5 rotation weeks (42 students) were studied as part of the control group. In total, there were 131 students included in the study from an approximately 180 potential fourth year students. The students that were not included in this study had either declined to be dilated (5-10 students total), or had rotated during particular weeks when the study could not be implemented (e.g., due to the lack of volunteer subjects for the objective testing). All students involved in the study were encouraged to use a co-axial ophthalmoscope (i.e., not pan-optic) in part because the objective test at the end of the rotation was based on this type of ophthalmoscope. We hypothesized that our novel teaching activity would encourage more practice among those students and would result in a more pronounced enhancement in their ophthalmoscopy skills.

Our previously described assessment method¹¹ was used to objectively assess ophthalmoscopy skills at the beginning (i.e., prior to exposure to the novel teaching strategy) and end of the rotation for both the “experimental” and the control group. This required each student to examine the undilated eye of two separate and never-before-seen volunteer subjects (one left and one right eye). For each volunteer subject, the student attempted to identify the one correct optic nerve photograph --out of an array of four total pictures— that matched the examined eye (Figure 1). The students would receive a score of 2 (both eyes correctly identified), 1 (one eye correctly identified) or 0 (both eyes incorrectly identified). A one-point increase in this score from the beginning to the end of rotation was considered an improvement. Along with this objective assessment, the students were asked to subjectively grade their own confidence level in performing direct ophthalmoscopy using a five point scale: not confident, a little confident, somewhat confident, quite confident, and very confident. These objective and subjective evaluations were completed by all students both at the beginning (pre-test) and at the end (post-test) of the rotation.

Statistical analysis was done using the SPSS software (Chicago, Illinois). The data between the two groups were compared using either the *Chi-square* test (categorical data), t-test (data with normal distribution) or Wilcoxon rank-sum test (for data not normally distributed).

RESULTS

A total of 131 fourth-year medical students completed the study including 89 students in the peer optic nerve photograph group and 42 students in the control group. The students' performance on the objective pre- and post-tests was analyzed and compared. As shown in Table 1 and Figure 2, both groups demonstrated improvement in their performance from the beginning to the end of the rotation. However, the peer optic nerve photograph group showed a more marked improvement with 84.3% of students performing better than their pre-test, compared to 28.6% of students in the control group ($P < 0.001$). The distribution of the outcomes for the pre- and post-tests showed a similar trend (Figure 2). While the baseline (pre-test) ophthalmoscopy skills were similar between the two groups ($P = 0.57$), objective testing at the end of the rotation revealed the peer optic nerve photograph group to be significantly more competent with approximately 60% of the students correctly identifying both optic nerves versus only 12% in the control group ($P < 0.001$) (Figure 2). Likewise, 47% of the control group was unable to correctly identify either eye in the post-test, whereas only about 7% of the peer optic nerve group failed to correctly identify at least one eye (Figure 2).

All 131 medical students also subjectively graded their confidence level in performing direct ophthalmoscopy at the beginning (pre-test) and at the end (post-test) of the one-week ophthalmology clerkship. The pre-test confidence levels were not statistically different between the two groups with the most common response in each group being "a little confident" and no students reporting feeling "very confident" with direct ophthalmoscopy (data not shown). At the end of the rotation, both groups

subjectively reported increased confidence compared to baseline, however the peer optic nerve photograph group was distinctly more confident than the control group ($P < 0.003$). The vast majority of responses in the peer optic nerve photograph group were “somewhat confident” or “quite confident” with approximately 10% of students feeling “very confident” with their direct ophthalmoscopy skills. In contrast, the control group improved less dramatically with most students feeling “somewhat confident” or “a little confident” with no “very confident” responses (Figure 3).

DISCUSSION

Medical students and physicians have repeatedly proven to have low self-confidence and poor performance in their use of the direct ophthalmoscope.²⁻⁴ There are many reasons why students do not acquire this skill as part of their training. At a fundamental level, this could be attributed to the fact that ophthalmology is often under-emphasized in the curriculum and, for instance, it is no longer a required clerkship in most US medical schools.³ However, even when sufficient time is dedicated to ophthalmology, most medical schools do not have a structured teaching method to help student master the use of an ophthalmoscope. Thus, there is a need to promote the use of direct ophthalmoscopy by further enhancing the learning process and increasing the confidence level in this examination technique. As mentioned earlier, a variety of innovative approaches have been reported for teaching ophthalmoscopy to medical students and physicians.^{3,5-10}

In this study, we have reported an interactive and engaging learning exercise that requires the students to repeatedly perform ophthalmoscopy in order to match an unlabeled optic nerve photograph to the correct peer. The results demonstrate that this novel teaching strategy improves both objective proficiency and subjective self-confidence in the performance of direct ophthalmoscopy.

There are a few features of this novel teaching exercise which are worth noting. While a number of methods for teaching physical examination skills have been described, one of the keys to successfully mastering any examination technique is practice and repetition.¹³ However, it is often difficult to keep students actively engaged and motivated in a repetitive learning process particularly when there is no obvious purpose or endpoint. One of the advantages of the peer optic nerve photograph exercise is that it requires the students to repeatedly perform ophthalmoscopy on a number of their peers while having a well-defined purpose and objective. The optic nerve photograph not only provides the students with an observable guide to define the level of detail which they should be able to visualize during examination, but also promotes a more active learning process which is essential for a competency based education¹⁴ Although having an instructor to intermittently guide the students enhances this exercise, this learning strategy also takes advantage of peer-to-peer teaching, which has previously been shown to be effective in medical education.¹⁵ In addition to sharing examination tips, the subjects can give immediate feedback to the examiner on whether the light beam is directed in the right location. Finally, the group nature of the activity also increases the “fun” factor based on student reviews of the rotation (data not reported).

The described teaching method does have several limitations. One limitation is the fact that ophthalmoscopy was performed on young and healthy subjects without ocular pathology who are also typically more cooperative and have larger pupils compared to many older patients. However, the increased confidence and skill level established through this exercise could potentially increase the likelihood of future use of ophthalmoscopy on real patients. Another limitation is that the exercise is focused on visualization of the optic nerve head and surrounding vessels. Although this does not include all of the skills required for direct ophthalmoscopy, it does represent a difficult and important portion of the technique. To be more encompassing, this mode of encouragement should be combined with further methods of teaching to emphasize additional aspects of the exam, pathology recognition, and clinical decision making.³ One such method was described by Lippa¹⁶ who has introduced a novel “disc mantra” (“CCCMV” - cup, color, contour, margins, vessels) to reinforce key aspects of the fundoscopic exam. Their grading algorithm for fundoscopy involves a 25 point scale which examines the students’ ability to correctly assess the CCCMV, identify any retinal pathology, and reach a final diagnosis with a list of differential diagnoses. Other additional measures that may be added to make the peer optic nerve exercise more robust include asking the students to also draw the optic nerves of their peers, documenting the number of times each student performs ophthalmoscopy and finally a longitudinal follow-up study to determine whether this teaching exercise will lead to continued use of direct ophthalmoscopy in residency and ultimately in clinical practice. Also, while this

current study only used co-axial direct ophthalmoscopy, it could be expanded to include panoptic ophthalmoscopy as well.

In summary, we have reported a novel teaching activity using peer optic nerve photographs, which can be implemented easily in programs that have access to fundus photography. This teaching exercise was found to increase ophthalmoscopy skills and confidence levels among students, which in turn may increase the likelihood of performing ophthalmoscopy in future patient encounters.

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