Use of smartphones to aid the teaching of equine ocular fundus examination

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Abstract

Background Teaching and learning how to perform examination of the ocular fundus is challenging. Smartphones can support to enhance students' confidence and experience.

Methods Following an optional year-4 ophthalmoscopy practical using hand-held ophthalmoscopes, students completed a questionnaire using a visual analogue scale (VAS) investigating if students felt smartphone use aided learning and if student's self-assessed confidence in visualising the ocular fundus had improved. VAS scores were compared using the Wilcoxon signed rank test (significance: P<0.05).

Results All 30 year-4 students attending the practical participated to the study. Confidence in performing direct ophthalmoscopy significantly increased after the practical. Confidence after the practical was 65.3 (±19.8) per cent compared with before the practical when confidence was 20.1 (±15.6) per cent (P<0.001). The perceived usefulness of traditional teaching was 62.3 (±23.8) per cent. The perceived usefulness of the teaching with the smartphone was 91.1 (±8.6) per cent. While students found both methods useful, they perceived the use of the smartphone to be significantly more useful (P<0.001). Free-text comments on the use of the smartphone were all positive and included 'useful', 'fun' and 'good teaching tool'.

Conclusions This study shows that students positively received the use of the smartphone, which can be a useful tool to teach the equine ocular examination to undergraduate veterinary students.

Introduction

Teaching procedural skills is one of the greatest challenges in veterinary medical as well as medical education. To develop a specific procedural skill, a student is required to combine relevant theoretical knowledge with the development of the practical dexterity involved with the procedure. While no data are available specifically for veterinary students, surveys among medical students have highlighted poor confidence in the ability to perform simple procedures including the ophthalmic examination.[1 2] Another study, looking specifically at teaching the ophthalmic examination to medical students, showed that a short 40-minute session can have a positive impact on students' confidence about this procedure.[3] When teaching the ophthalmic examination, the greatest challenge is that students often rely on description to correctly interpret what they see with direct ophthalmoscopy and this can often result in misunderstanding which ultimately undermines students' self-confidence.[4] Teaching procedural skills in veterinary medicine poses the added challenges of patient cooperativeness and students' confidence around handling a certain species. Hand-held tools that allow visualisation of the ocular fundus on a screen visible to more than one operator could aid teaching the ophthalmic examination to veterinary students. By examining the fundus via a screen, the teacher can show the student how moving the instrument will visualise different areas of the fundus. The students subsequently can replicate such movements with the ophthalmoscope and complete the examination aware of what the fundus of that particular animal looks like. Smartphone usage has increased massively over the past decade with currently more 90 per cent of people under the age of 30 owning one.[5 6] It has also been shown that smartphones can enhance

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Figure 1 iPhone 6 back camera before (left) and after (right) flash was covered with some paper tissue. The thickness of the paper tissue used will determine the number of layers of paper to be used. The target was to have a faint flashlight that would be tolerated by a non-sedated horse.

engagement and the quality of the overall learning experience.[7] In veterinary medicine, smartphones have been evaluated to image the ocular fundus of dogs, cats and rabbits by means of an external optical device added on the optical system of a smartphone's camera.[8] Authors' personal experience has shown that no such device is necessary with horses, likely due to the larger size and elliptical shape of the equine pupil.

The aims of this study were to: (i) establish whether students would find useful using a smartphone in addition to traditional teaching the ophthalmic examination compared with traditional teaching alone and (ii) establish whether the use of the smartphone had a positive impact on student confidence.

Methods

Fourth year undergraduate veterinary students from the School of Veterinary Medicine and Science at the University of Nottingham participating in an optional small group revision practical on equine ophthalmology were recruited. The students were notified about the study at the start of the practical and their participation was not mandatory. The optional practical consisted in four successive 45-minute sessions and took place on the same afternoon. Each student was encouraged to examine at least three to four horses. A total of eight horses were available for the practical.

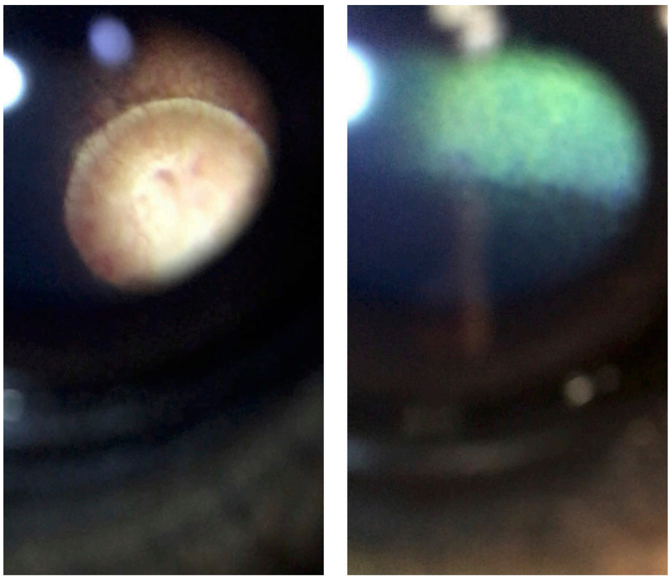

Figure 2 Still frames of the optic disc and related blood vessels (left) and tapetal and non-tapetal fundus (right) obtained from a non-sedated horse visualised with the smartphone.

Traditional teaching

The practical included an introductory session which included a brief review of ophthalmic anatomy as well as a practical demonstration of how to use a hand-help direct ophthalmoscope (Standard Ophthalmoscope, Welsh Allyn) with live, non-sedated, teaching horses in a stable environment. Following the initial demonstration, each student would subsequently practice the ophthalmic examination supervised by a teacher with considerable experience in performing and teaching the procedure. The students would subsequently describe the structures visualised to the teacher. The learning objective of the session was to visualise tapetal fundus, non-tapetal fundus, optic disc and associated blood vessels. If the student failed to meet the learning objective a discussion and further demonstration with the teacher would take place. The traditional teaching session was completed only once all students in the group met the learning objective of the practical.

Smartphone aided teaching

The smartphone (iPhone 6s, Apple) was used only after the traditional teaching session was completed. The smartphone was set with the camera app set on video with the flashlight turned on. No added optical device was added in front of the back camera lens of the smartphone; however, brightness was dimmed markedly by adding some layers of paper in front of the flashlight (figure 1) so that the light source would be well tolerated by a non-sedated horse. The teacher would then demonstrate to the student how changing the position and direction of the smartphone would influence the structures visualised. A video was recorded and a still-frame used (figure 2) to subsequently discuss the findings with the students. At that point, students would attempt again with the direct ophthalmoscope until all structures were visualised or the animal would no longer tolerate the procedure. The aim of the use of the smartphone was to improve the students' understanding of what and how they should visualise different structures of the ocular fundus. The smartphone was not proposed as a substitute to direct ophthalmoscopy.

Questionnaire

At the end of the practical, each student willing to participate filled in a questionnaire (online supplementary material). The questionnaire included the following questions about the ophthalmic examination: (1) how confident the student felt before the practical; (2) how useful was traditional teaching; (3) How useful was the use of the smartphone; (4) how confident was the student after the practical. Answer to each question was obtained by means of a visual analogue scale (VAS). At the end, there was a section for free-text comments from the student.

Data analysis

Data obtained using the VAS were measured in millimetres and converted into a proportion of the length of the VAS. Ultimately, data used for analysis were continuous between 0 and 100. Data obtained did not have a normal distribution; therefore, analysis was performed using the non-parametric Wilcoxon signed rank test to compare question 1 to question 4 and question 2 to question 3 (significant difference set for $P<0.05$). Answers from the free text were also analysed for the frequency of the comments and a word-cloud was produced to illustrate the general perception of the use of the smartphone (figure 3).

Results

A total of 30 students (out of a total 117 year-4 students) attended this optional practical and they all participated in the study completing the questionnaire at the end of the session (response rate 100 per cent). Each horse underwent a between 10 and 15 examinations in total and they all tolerated the procedure well. Students reported confidence around this procedure was significantly greater after the practical ($P<0.001$; figure 4). Students found that teaching the ophthalmic examination in a traditional way with the addition of the smartphone was more useful than traditional teaching alone ($P<0.001$; figure 4). The vast majority of the comments confirmed the finding that the practical was useful but significantly more so with addition of the smartphone. In particular, students pointed out that through the smartphone, the teacher could really show what structures and how students were expected to visualise with direct ophthalmoscopy and this really helped their confidence in knowing they performed the procedure correctly.

Discussion

The results of this study indicate that addition of smartphones to the traditional teaching of the equine ophthalmic examination has a positive effect on student confidence and learning. Traditional teaching of the ophthalmic examination has shown to have positive impact on students' confidence. However, some students commented that the ability to visualise the structures they were supposed to identify through the phone really helped them understand what they had to see with the ophthalmoscope. It is possible that the students did not remember well what the structures of the ocular fundus of a horse looked like. Revision before the practical or availability of illustrations during the practical could also have been used as supportive alternative. However, using the smartphone in real-time on the animal in front of the students did not rely on the students actually revising before the practical. Further, this reassured the teachers that all students knew exactly what the structures they were supposed to identify looked like on that specific animal. The teacher could also use the smartphone to show students how to change the orientation of the camera to visualise each structure, which contributed in up skilling students' dexterity.

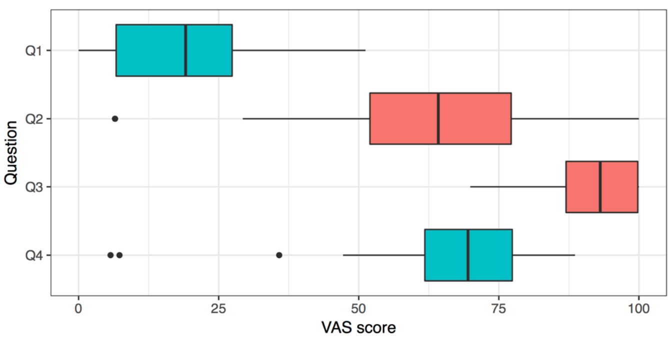

Figure 3 Box-plot of the responses to the questionnaire. Significant differences were present in VAS scoring between answers to question 1 and question 4 ($P<0.001$) and between answers to question 2 and question 3 ($P<0.001$). Single dots represent outliers. VAS, visual analogue scale.

Figure 4 Word-cloud of the free-text comments. The size of word in the figure is proportional to the number of times that word was used by the students in the free-text comments.

The study suffered some limitations that may have somewhat affected the results. While all students participating in the practical session filled in the questionnaire, this was an optional activity and only about a quarter of the cohort attended the activity. Some year-4 students had already prior experience with this activity, as a similar optional practical is taught in year 1. Further, some students might have practiced the procedure while on extra mural studies in clinical practice. This might have biased the selection of students attending the study, as students with an interest in ophthalmology or students with very little experience might have been more likely to attend. The reason why three quarters of the year did not attend the practical was not investigated, as it was not an aim of this study. However, the first question was aimed at evaluating the confidence of the student around the procedure and the vast majority of the students had low confidence at the start of the practical (figure 3) consistent with minimal previous experience.

Another limitation was the use of non-sedated animals, which can become progressively more resilient to the procedure during the session. To prevent this, care was taken that the light of the ophthalmoscope was not excessively bright but bright enough that the structures of interest could be visualised and so to elicit a weaker direct pupillary reflex. Food was also available, so animals could be kept occupied while not being examined. Mydriatics were also not used to dilate the pupil to facilitate visualisation of the ocular fundus, and this meant that some degree of myosis would occur as a consequence of flashing the light of the ophthalmoscope during the examination. While using sedative and mydriatic agents could improve animals' cooperation and positively impact the opportunity for the student to carry out an thorough examination, it was also deemed ethically unacceptable to administer drugs to animals for the sole purpose of teaching. The fact that the lights were dimmed to the minimum and that horses tolerated well the procedure was considered indication that this study was performed within acceptable ethical principles and had in fact been approved by the local Ethics Review Panel. Flashing a dimmed light in the horse's eye for the study had ethical approval, as smartphones would have been used regardless of the study during this practical.

A further potential for bias was around the timing the questionnaire was completed. Study design would have been more robust had students been asked about their confidence level immediately after the end of traditional teaching, before using the smartphone. The results of the questionnaire filled in only at the end of the practical might have been influenced by how traditional teaching compared with teaching using smartphones. However, asking students to fill in the form during the practical would have been disruptive to the learning process and it was decided to ask them to complete this only at the end.

This study used a specific brand and model of smartphone and did not evaluate the use of other models. However, from the authors' experience suitable visualisation of the fundus has been obtained with other models as long as flashlight and camera are a maximum of 1 cm apart. This is related to the size and elliptical shape of the equine pupil so that light source and camera are virtually parallel. For smaller pupils, devices that align light source and camera might be necessary.[8]

This study also did not have a control group including students that repeated the examination with the ophthalmoscope twice without the aid of a smartphone. The positive outcome may be due to increased learning opportunity rather than a true positive effect of the smartphone. However, the scope of the study was to evaluate whether students perceived the use of the smartphone as helpful and engaging.

In the future, further studies could include using this technology to create a bank of clinical cases to use for teaching clinical reasoning in ophthalmology. Studies in medical students have shown that using such resources to create virtual cases to stimulate discussion and reasoning is greatly beneficial to engagement and early clinical exposure in ophthalmology.[9] Further applications of smartphones to evaluate the equine ocular fundus include enhancing accessibility in rural locations, where there might not be access to an ophthalmoscope, which, however, remains the gold standard equipment to perform the ophthalmic examination. Alternatively, smartphones might assist with telemedicine where a surgeon could seek a second advice from a specialist by sharing a video collected with the phone, while previously such activity would be based mostly on a wordy description.[10]

In conclusion, smartphones proved to be a very useful addition to teaching the ophthalmic examination and we have adopted this as standard to our teaching equine ophthalmology throughout the undergraduate curriculum. Smartphones should not substitute ophthalmoscopes, which remain the gold standard equipment necessary to perform the examination, but merely helps students understand better how to orient the ophthalmoscope to visualise different areas of the fundus and also so the teacher can show students what structures they should be able to visualise with the ophthalmoscope.

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Contributors ES was involved in study design and manuscript preparation. JHB was involved in study design and data analysis. MB had the initial idea for the study and was involved in study design, data collection and interpretation. MD was involved in data collection, interpretation, analysis and manuscript preparation. All authors reviewed and approved the submitted version of the manuscript.

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Competing interests None declared.

Ethics approval The study was approved by the Ethical Review Panel at the School of Veterinary Medicine and Science at the University of Nottingham.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

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Q1. How confident did you feel about performing and ophthalmic examination in the horse before the practical?

No confidence Max confidence

Q2. How useful did you find the traditional teaching of the ophthalmic examination using a portable ophthalmoscope alone?

Not useful Max useful

Q3. How useful did you find teaching of the ophthalmic examination using a smartphone?

Not useful Max useful

Q4. How confident did you feel about performing and ophthalmic examination in the horse after the practical?

No confidence Max Confidence

Further comments: