Colour imaging in the monitoring and documentation of choroidal naevi. Are Optomap colour images adequate for this purpose?

Abstract

Purpose

An audit project to evaluate and compare three different imaging systems used to photograph choroidal naevi, and to determine whether the Optos Optomap® can be used as the only colour image capture system for monitoring and documenting choroidal naevi. A further aim was to assess if existing protocols could be improved to accurately document position and appearance of choroidal naevi.

Patients and Methods

20 patients with choroidal naevi were photographed on three different colour image capture systems. Colour images were taken on the Optomap® wide field P200MA camera; the Zeiss FF450plus® mydriatic camera and the Topcon TRC-NW6S®. All images were reviewed retrospectively by a medical retina consultant (SD) who completed a questionnaire to determine the most effective photographic system(s) in demonstrating the location of the naevi and the features of the condition.

Results

The Optomap® was the most effective in pinpointing the location of the naevus and the Zeiss FF450plus mydriatic camera best captured the features of the naevus. The non-mydriatic camera was rated the least satisfactory for both tasks.

Conclusion

The location of the naevus on the retina should determine the choice of modality. If it is possible to photograph the lesion and include the optic disc or central macula, then the mydriatic camera is considered the best modality for recording both the
position and features of the pathology. However, if it is not possible, because of
the location, to include both the disc or central macula with the lesion in the same
frame, then the Optomap® should be used to photograph the naevus to record its
position and ideally a colour image on the mydriatic camera should also be taken
to record the appearance of the lesion.

Introduction

Documenting the appearance of the fundus has been historically one of the main
roles of the ophthalmic photographer and it is their responsibility to accurately
record what has been clinically observed. The fundus camera is considered the
gold standard and is used to document ocular features in health and disease
(Manivannan et al, 2001), recording a view of between 20 to 50 degrees
depending on the capability of the imaging system. Fundus photography is
commonly used to record the central macular region, but documentation of
peripheral retinal areas is also often required. Imaging the periphery, which, for the
purposes of this study is defined as the area external to the arcades, can be
achieved by tilting and pivoting the camera head, or getting the patient to look
away from the camera in one of the standard nine positions of gaze.

However, there are limitations to what the camera can record peripherally because
of the restricted field associated with the 50 degree view. Also the quality of the
image is dependent on the location of the pathology, the skill of the photographer
and patient cooperation. Obtaining good peripheral images becomes easier with
experience.

A new technology that has emerged relatively recently is a camera (Optos
Optomap®) which has been reported to give a 200 degree view of the retina in a
single image providing the clinician with a significantly wider view of the retina
(Figure 1).

The Optos Optomap® uses an elliptical mirror to capture the 200 degree view and
the image is created using two monochromatic lasers. Within the clinical setting
the Optomap® has become the first choice for documenting many disorders of the
retina, and because it has the ability to record early signs of many ophthalmic
disorders that are located peripherally, it is particularly useful for ocular oncology,
peripheral vascular anomalies and documenting the extent of inherited retinal dystrophies. This imaging is especially useful for the documentation and follow up of choroidal naevi because they are not restricted to the central macular region and can be located anywhere on the retina, including in the periphery. Choroidal naevi, like naevi found on the skin are monitored to determine any change in shape, size or and features such as pigment, drusen and lipofuscin, as a change may be an indication that the lesion has developed features of a malignant melanoma (The Eye Cancer Foundation 2015). A digital image of a choroidal naevi provides clinicians with an accurate representation of the appearance of the lesion and its location on the retina, rather than relying on fundus drawings. Providing baseline photographs enables clinicians to sequentially monitor potential changes in the condition.

This highlights the importance of standardised imaging and producing an accurate representation of the lesion as these images are used in management decisions. Without capturing the image in the same field and ensuring that the whole lesion is photographed, comparisons to previous photographs can be difficult to achieve.

The wider field of view of the Optomap® has led to the adoption of this imaging system for documentation of choroidal naevi in units that have access to this technology. In addition to the wider field of view, a key advantage of using the Optomap® is a quick image capture time when compared to a camera with the standard 50 degree view.

There are however observed differences with regards to the colour image (Figure 2) with the Optomaps® monochromatic lasers. This is particularly true of lesions which have varying degrees of pigment within the lesion.

This paper presents the findings of an audit project that evaluated the clinical value of the Optomap® compared to two other colour fundus imaging modalities (mydriatic and non-mydriatic camera) used within the author’s (JB) department. In evaluating these modalities the aim was to assess if existing protocols could be improved to accurately document position and appearance of choroidal naevi.

Methods
Over a three week period any patients referred for Optomap® imaging for a suspected choroidal naevus were imaged by the author (JB). Dilated photography was carried after instillation of G.tropicamide 1% and G.phenyl ephrine 2.5% once the pupil had dilated sufficiently. The order in which colour images were obtained was 1) on the Optos Optomap® P200 camera, 2) the mydriatic Zeiss FF450plus® 3) the non-mydriatic Topcon TRC-NW6S®.

A set of images from each patient were imported into Photoshop® and added to a template that included the photographs from each device to allow for direct comparisons to be made (Figure 3). Contrast and colour values were not altered in any of the images. Each page containing a patient’s set of images was inserted into a PowerPoint® presentation where they were reviewed by a medical retina consultant (SD) to assess 1) which modality was of most clinical value in documenting the appearance/features of the pathology and 2) which modality was the most useful in identifying the location of the choroidal naevus.

**Results**

Out of the 20 patients photographed over the three week period the Optomap® was considered the most effective modality for documenting the location of the naevus with 17 of the photographs being rated as excellent, 2 were considered acceptable with 1 being rated as poor (Figure 4). The mydriatic camera was rated excellent for identifying the location in 11 photographs with 1 image being acceptable and 8 being poor. Fewer images were rated as excellent (4/20) in showing the location of the naevus with the non-mydriatic camera, 10 images were regarded as acceptable and 6 poor.

The mydriatic camera was considered the most effective in documenting the features of the naevus. 17 out of 20 images were regarded as excellent, with 2 being acceptable and 1 being poor (Figure 5). Overall the Optomap® was rated as being acceptable (15 out of 20), 4 as poor and only 1 as excellent. There was a wider distribution of results with the non-mydriatic camera, 9 images were regarded as being acceptable, 6 poor and 5 as excellent.

**Discussion**
Standard practice in photographing a choroidal naevus may involve taking a single image of the lesion whether it is located in either the central macula or peripheral retina. In some cases imaging of both regions is required because the pathology is not restricted to a single area. Analysis of the results of this audit comparing the three colour image capture systems in documenting the location of the lesions revealed that the Optomap® was considered the most effective modality with the mydriatic camera second and the non-mydriatic camera third. However it also showed that features of the lesion were better represented by taking an image of the lesion on the mydriatic camera. Optomap® imaging enables a larger area of the retina to be photographed which can be used as a guide to the location of the pathology. This is useful as the diagrams drawn by the clinicians in the patients notes are often misleading and do not accurately represent the accurate position of the lesion and its relationship to other structures within the retina (e.g. blood vessels/optic nerve). This often means that for follow up imaging, the photographer occasionally has to search for the location (Figure 6).

The reason that the Optomap® was the highest scoring modality for recording the location of choroidal naevi is due to the wide field of view allowing geographical landmarks to be located in relation to the naevus. Gordon-Shaag et al (2014) found that due to the wider field of view the Optomap® detected a higher prevalence of naevi in patients’. This means that this is more clinically valuable than the standard 50 degree view available on most mydriatic cameras. Wide field imaging has improved the experience for both patient (Figure 7) and photographer due to the ability to record more information in a single image than was previously possible using traditional methods.

The mydriatic camera also scored highly because this was also able to record areas of reference such as the optic disc to guide the clinician in understanding the position of the naevus on the retina. This was partly due to its ability to pivot and tilt the camera head to position the naevus in the frame and include areas of reference. The non-mydriatic camera has a fixed head and limits the photographer to using the external fixation to move the eye. Being able to move the camera
head gives the photographer extra control over the composition of the image and the ability to include geographic feature not accessible with the non-mydriatic camera. Where the Optomap® excelled was in the photographing of a peripheral naevus (Figure 9). Although the mydriatic camera could document the lesion it was unable to record any other geographic information, therefore was not able to show the location and may not include the lesion in its entirety.

This audit would suggest that the positioning of the naevus on the retina should determine the choice of modality. Where the naevus is peripheral the Optomap® should be used to photograph the naevus to show its position, and a photograph on the mydriatic camera should also be taken to record the clinical features as shown in Figure 9. However the results from this small study suggest that if it is possible to photograph the lesion and include the optic disc or central macula as shown in Figure 8, then the mydriatic camera is considered the best modality, particularly as it is also the most suitable for recording the features of choroidal naevus (Figure 5).

This is possibly due to the mydriatic camera producing photographs that accurately represent the appearance of the lesion. As highlighted in Figure 2 the images from the non mydriatic camera and Optomap® have a slight colour cast which may mislead the clinician when evaluating the appearance of the naevus. Choroidal tumours can be defined by their colour; melanomas tend to be brown, grey and black and haemangiomas orange and red (Schalenbourg and Zografos 2013b). When Optomap® images are compared to the photographs from the standard fundus camera there is a generally noticeable difference in the colour values. This is due to how the image is created by using two monochromatic lasers (red and green) which in turn create a false colour image. It is important to produce a clinically accurate photograph because the colour of the lesion is an important diagnostic feature. Therefore if a camera is casting a colour over the image, it will not be a true representation of the naevus appearance. This was reported by Heimann et al 2013 and by Schalenbourg and Zografos (2013a) who noted that the Optomap® produces fundus photographs that have an unnatural colour because of how the image is constructed, and as the clinician is looking for any subtle changes in the pigment of the naevus, any false colours may mislead them and might lead to an incorrect diagnosis. This is also evident on the non-
mydriatic camera, as there is an orangey-red cast to the image which may be due to the factory settings on the attached digital camera, which may be adjusted and optimised. A further study would be required to establish whether altering the custom settings can produce a true colour representation.

In light of these findings new protocols for imaging choroidal naevi have been established within the author’s (JB) place of work. The protocols recommend that the fundi of both eyes should be captured on the Optos for reference purposes, and where possible the lesion should also be captured on the mydriatic camera. It is important that the naevus is monitored, if possible with the same imaging modality. Further additions to the protocol include OCT line scans through the naevus and autofluorescence (AF) of the lesion to assess suspicious features. Enhanced depth imaging (EDI) OCT may be requested further define the lesion (Figure 10) (Medina et al 2014). AF is used to helpful in documenting lipofuscin levels (Lavinsky et al 2007). Areas of increased signal as shown in Figure 10 correlate with areas of oedema as shown on the OCT, which would have not been visible with colour fundus photography, and can help in assessing risk features of choroidal naevi.

During this audit when reviewing the images JB noted that the fixation of the patient can create a distorted image. The Optomap® images of (Figure 11) gave the impression that the lesion had changed size when the patient followed the internal fixation light. These images were taken on the same camera at the same time getting the patient to look inferior in image A, straight head in image B and nasal in image C. The results show the lesion appears to grow in size in relation to the optic disc which remains the same. As stated in Witmer et al (2013b) the ellipsoid mirror used by the Optomap® results in far temporal and nasal views appearing distorted. As the growth of a suspicious choroidal naevus would create cause for concern the accuracy in the repeatability for documenting raised lesions on the Optomap® should be taken into account. The Royal College of Ophthalmologists (2009) state that patients with suspicious melanocytic choroidal tumours with documented growth should be referred to an adult ocular oncology centre. A further study on the amount of the distortion created would need to be undertaken to assess which views are anatomically correct, and if this is the cause of the apparent increase in size. This also highlights the importance of taking a
second image, if possible using the mydriatic camera when monitoring for changes in size of choroidal naevi to enable size measurements for comparison over time. Recently Optos has released a new machine (California) for which it is claimed that there is reduction in distortion by introducing built in software (ProView) and improvement in the image quality (Optos 2016).

A further project that would provide helpful information would be to compare the California new model against the existing modalities used in clinic.

Conclusion

The advantages of imaging a wider field of view in patients with choroidal naevus and other pathologies such as retinitis pigmentosa and diabetic retinopathy are unquestionable. The imaging of choroidal naevi using Optomap® has allowed far peripheral lesions to be documented, something that is not possible using the traditional fundus cameras. This provides the clinician with extra information in a single image and it is easier for the patient as it takes a fraction of the time to document the equivalent area compared to the time taken when using a 50 degree traditional fundus camera. However, despite the additional information that the wider view confers, this imaging modality may compromise the accuracy and quality of the image. This possibility must be taken into account when evaluating an image, particularly when monitoring choroidal naevi, or other tumours, as an accurate representation is required for comparison purposes. Wide field imaging has proven to be an extremely valuable tool for documenting the retina but should be used not as a replacement but to complement existing modalities.
Revised imaging protocol for the documentation of choroidal naevi.

Choroidal naevus suspected.

↓

Take optos images as baseline for both fundi. If lesion is within posterior pole, carry out imaging with mydriatic camera (check that landmarks are visible for location of naevus).

↓

↓

In addition OCT scan and AF of lesion, with an ultrasound as required.
References


The Royal College of Ophthalmologist 2009 *Referral Guidelines for adult ocular tumours including choroidal naevi* [Online]. Available at: www.rcophth.ac.uk/core/core_picker/download.asp?id=1693&filetitle=Referral+Guideline+for+adult+ocular+tumours+including+choroidal+naevi [Accessed 2th January 2015]

Figure 1 This composite of two images of the same patient illustrates the wider angle of view the Optomap® offers (200°) to the clinician when compared to the standard view (45°) from the traditional fundus camera allowing a greater area of peripheral retina to be captured.

Figure 2 These three photographs of the same lesion highlight the differences in the colour values between imaging modalities. Photograph A was taken on a mydriatic camera, photograph B was taken using the Optomap® at a narrower angle of view and C using a non-mydriatic camera.
Figure 3 Images of 20 patients were imported without altering the colour, brightness or contrast and presented together in a PowerPoint presentation for direct comparison. This example shows how the images were presented for the MR specialist to evaluate their clinical usefulness in demonstrating the features and geographical location of the naevus.

Figure 4 The questionnaire evaluated the usefulness of each modality in documenting the features of the lesion. The Optomap® was rated acceptable in 15 out of the 20 images and the mydriatic camera was rated excellent in 17 of the 20 images that were reviewed, there was a wider distribution of results for the non-mydriatic camera.
Figure 5 The usefulness of each modality in identifying the location of the lesion was evaluated. The Optomap® was rated excellent in 17 out of the 20 images, the mydriatic camera scored excellent in 11 cases and the non-mydriatic 4.

Figure 6 This drawing was photographed directly from the patient’s notes to illustrate how the clinicians mark the location of the naevus on the retina. This is accurate enough for the photographer to estimate where the lesion is and chose the appropriate modality. Smaller lesions can be more difficult to find which is where the Optomap® excels by encompassing a larger area, thus enabling the photographer to locate and record the lesion at follow up.
Figure 7 Image A shows five photographs taken on the mydriatic camera with the patient looking in different positions of gaze. Image B is from the same patient using the Optomap® which illustrates how in a single image more information can be obtained when compared to the mydriatic camera. By capturing the whole picture in a single image it reduces the light levels exposed to the patient.

Figure 8 Image A shows that in this particular case both the mydriatic and the optos can show the exact location of the naevus. However the features of the lesion are better displayed by the mydriatic camera.
**Figure 9** The image on the left (image A) does not give the clinician enough information to identify the location of the naevus on the retina. An Optomap\textsuperscript{®} image (Image B) would need to be captured to highlight the location of the lesion in relation to geographical landmarks, such as the optic disc or arcade vessels. A photograph on the mydriatic camera is helpful to document the features of the lesion.

**Figure 10** An increased signal seen on the autofluorescence imaging as shown in image A, correlates with areas of intraretinal fluid as shown on the OCT scan (image C).
Figure 11 These three photographs were taken on the same camera within a few minutes of each other. It is presumed that it is the distortion from the ellipsoid mirror that gives the impression the melanoma has grown in size when comparing image A to image B and C.