COMPARISON OF THE OPTYSE LENS FREE OPHTHALMOSCOPE WITH THE CONVENTIONAL DIRECT OPHTHALMOSCOPE

by

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Submitted to the University of Cape Town in partial fulfilment of the requirements for the degree of M Med (Ophthalmology)
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Date of submission: February 2009

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DECLARATION

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ABSTRACT

Purpose:
To measure the ease of use, acceptability and performance of the Optyse™ lens free direct ophthalmoscope compared with a conventional direct ophthalmoscope by fifth year medical students.
To evaluate the skill of the fifth year medical students of the University of Cape Town in performing ophthalmoscopy.

Methods:
Design: Prospective comparative study.
Setting: Groote Schuur Hospital.
Subjects: Fifth year medical students during their Ophthalmology rotation in 2006 and 2007 at the University of Cape Town, performing fundoscopy with the two ophthalmoscopes on teaching mannequin heads.
Outcome measures: Ability to see the fundus, ability to recognise pathology, rating on ease of use, indication of ophthalmoscope preference.

Results:
The two ophthalmoscopes were comparable in efficacy in terms of visualising the fundus and making a diagnosis.
The conventional ophthalmoscope was considered easier to use and was the preferred instrument.
The students were competent in identifying diabetic retinopathy, but performed less well in the diagnosis of other disc and macular pathologies.

Conclusion:
The practical ophthalmology rotation period of the medical students needs to be longer.
Although the conventional direct ophthalmoscope is the preferred ophthalmoscope to use, the Optyse™ lens free ophthalmoscope proved to be an effective alternative tool to screen for, and diagnose, optic disc and macular pathology. If the lens free ophthalmoscope can be purchased at a much lower price than the conventional ophthalmoscope, it could be a useful screening and diagnostic tool in a primary care setting.

CONTENT

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CHAPTER 1

INTRODUCTION

This study evaluates the use of the Optyse™ lens free ophthalmoscope, a simplified version of the conventional direct ophthalmoscope. It has recently been developed and advertised as a cost-effective alternative to the conventional direct ophthalmoscope. We compare the Optyse™ with the Welch Allyn direct ophthalmoscope in terms of efficacy, acceptability, and ease of use, by involving the fifth year medical students at Groote Schuur Hospital, University of Cape Town, during their ophthalmology rotation.

Ophthalmoscopy is an essential skill needed in assessing patients across a whole spectrum of medical disciplines, therefore requiring non-ophthalmologists to be trained in ophthalmoscopy. In the primary care setting and in casualty, a significant proportion of patients require fundoscopy to establish a diagnosis. Regular examination of the fundus of diabetic patients in the primary care setting is important for the early detection of diabetic retinopathy and for the prevention of visual loss. A significant number of systemic diseases manifest with ocular findings, which makes ophthalmoscopy a vital part of internal medicine.

Resource limitations in the South African primary health care clinics are a reality. Clinics often function with a very limited budget, which necessitates careful decision-making and prioritisation on the purchase of equipment and consumables.

The principle aim of this study is to establish if the Optyse™ lens free ophthalmoscope can serve as a more affordable but still effective alternative to the conventional direct ophthalmoscope.

A second aim is to determine which ophthalmoscope is preferred by trainee clinicians.

Mastering the skill of ophthalmoscopy requires practise, and may be the most challenging component of the physical examination to learn. The amount of teaching and training medical students get in ophthalmoscopy varies greatly between different medical schools locally and internationally. For this reason, the standard of ophthalmoscopy can vary significantly between medical students from different teaching units. In order to know if the allocated teaching and training time in ophthalmoscopy in a unit is adequate, the students need to be evaluated on this skill.

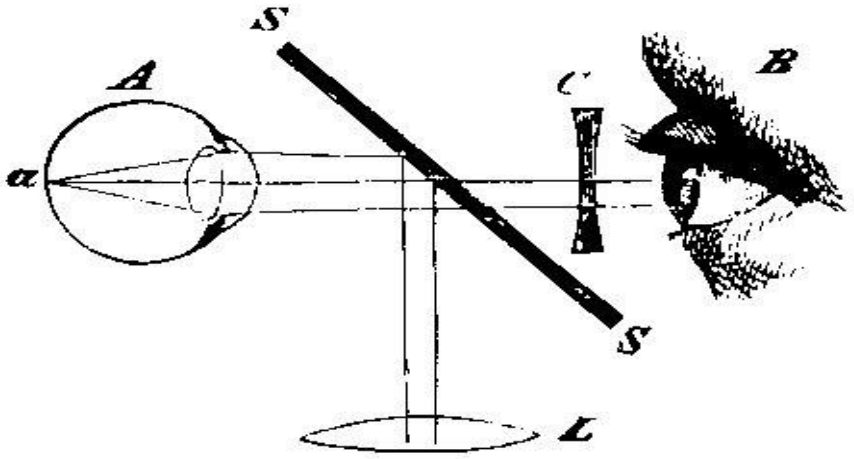
A third aim of this study is to evaluate if medical students at the University of Cape Town can master, within their allocated period for practical ophthalmology training, the skill of ophthalmoscopy, in terms of being able to see the fundus and to recognise specified fundal pathologies.

1) History of the direct ophthalmoscope

Although Helmholtz is universally known for the invention of the ophthalmoscope, some credit must be given to Evangelista Purkinje. His original description of viewing the fundus arose from his observation of the red reflex produced by the reflection of a candle from his myopic spectacle lenses directed into the eyes of dogs in 1823. He later extended this observation to humans.

In 1850, Hermann Helmholtz, a Prussian physiologist, invented the basic ophthalmoscope, the principles of which are still applied in modern ophthalmoscopes. He designed a co-axial condition between the patient and observer, by making use of a light source reflected into the patient's eye via a partially silvered mirror. The upright and virtual image created was then reflected back and viewed by the observer through a hole in the mirror (3, 4) (*Figure 1*).

The rotating lens bank, to allow focusing of the image, was later added to create the basic direct ophthalmoscope as we know it today (4).



Helmholtz's sketch of the ophthalmoscope -- a device for examining the interior of the eye. Light from a source is collected by lens (L) and bounced off a half-silvered mirror (S) into the subject's eye. Light reflected out of the subject's eye passes through the mirror into the examiner's eye, where an image of the subject's fundus is formed on the examiner's retina.

Figure 1 (Courtesy of www.geocities.com)

2) Background of the lens free direct ophthalmoscope

In 2000, Mr Armour, a retired consultant surgeon in the United Kingdom, used these basic principles to design a simplified, home-made ophthalmoscope. He wrapped black card around a pen torch, bevelled the top part of the card, pasted reflecting mirror card onto it, made a viewing hole through it, and folded this bevelled piece over the top end of the pen torch. Mr Armour made this for under £1,00 (1). This concept has been developed to become the Optyse™ Lens Free Ophthalmoscope {Ophthalmos Ltd, Cambridge, UK} (see Figure 2).

The Optyse™ is a direct ophthalmoscope with no focusing lens system, and no altering light intensity. It measures about 15 cm in length, and has a plastic rotational cover to protect the optical head. It has an on-off switch, and uses two AAA batteries and a miniature 2, 5 volt bulb as its light source (2). The light then passes through a small prism into the patient's eye, and the reflected retinal image is viewed by the observer through a viewing hole just above the prism (5). On its website, it is being advertised as "easy to use", the cost "a fraction of that of its traditional rivals" and that it "would be of benefit to most healthcare workers" (6).

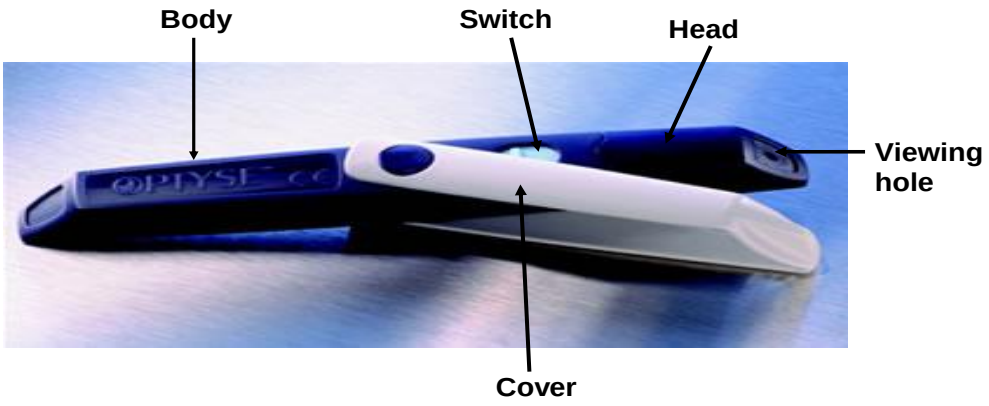


Figure 2: The Optyse™ lens free ophthalmoscope

(courtesy of www.oasismedical.com)

3) Uses of the direct ophthalmoscope

The usefulness of the direct ophthalmoscope is multifold. By viewing the patient at arms length, the red reflex can be evaluated. Furthermore, media opacities can be evaluated against the red reflex to determine its location in the eye by its direction of motion ("against" motion if anterior to the iris plane, "with" motion if in the lens or beyond) and by its speed (faster if more posterior). Iris transillumination can also be evaluated against the red reflex. By using its magnifying properties, the direct ophthalmoscope can also evaluate the anterior segment (4). However, its fundamental use is for fundal examination and screening.

Fundal screening for eye diseases, or systemic conditions with potential ocular manifestations, that might prevent visual loss or blindness, should form an integral part of any primary health care programme. Two such diseases, namely glaucoma and diabetic retinopathy, have been prioritised in the Vision 2020 programme as (amongst others) diseases to be addressed in an attempt to eliminate the causes of avoidable blindness in the world by 2020. The impact of these two diseases on global visual impairment and blindness is significant. In 2002, of the estimated 36.9 million people who were blind, glaucoma was the second, and diabetic retinopathy the fifth leading cause of global blindness, affecting 4.5 million (12%) and 1.8 million (4,8%) people, respectively. In South Africa, of the 269 000 blind people, glaucoma is rated the second (36 000 people), and diabetic retinopathy the third biggest cause of blindness (7).

A study done at Groote Schuur Hospital in Cape Town evaluated the use of different screening modalities for the case detection of glaucoma. Examination of the optic disc with a direct ophthalmoscope using a cut point of 0.7 for the vertical cup: disc ratio, gave a sensitivity and specificity of over 90% in eyes in which the disc could be seen. Combining this with testing for an afferent pupillary defect gave a sensitivity and specificity of over 90% in all eyes, including those in which the disc cannot be seen (8).

Concerning diabetic retinopathy, much of the visual impairment is preventable, and economically advantageous, if the condition can be identified by screening and treated at the appropriate early stage in its progression (9,10,11). One study found that screening and early treatment could reduce the risk of blindness by an estimated 56% (12).

In recent years the direct ophthalmoscope has been surpassed by more sophisticated instrumentation for fundal examination and screening (i.e. slit lamp biomicroscopy, the binocular indirect ophthalmoscope, fundus camera and tele-ophthalmology). The reason for this is mainly due to its limitations of restricted field of view and lack of a stereoscopic image. However, it does have some advantages. It is more

portable, has a higher magnification and costs less. It also has an easier learning curve, and is easier to use on undilated pupils compared to the binocular indirect ophthalmoscope. For these reasons, the direct ophthalmoscope is still the preferred choice for many non-ophthalmologist health care professionals (i.e. general practitioners, primary health care nurses, etc.).

In developing countries, cost implications play a major role in the choice and availability of medical equipment. On economic grounds alone, the eye care delivery programmes of developed countries cannot be replicated in the developing world (13). Digital photography and tele-ophthalmology have been effectively implemented in the health care systems of many developed countries (14). However, its use in developing countries is precluded, mainly due to cost implications (15, 16), but also due to the lack of expertise and the capacity to use such a facility (17). Locally, the South African government has identified telemedicine as a strategic tool to deliver equitable health care services to all South Africans, in particular in rural areas (18). However, the Western Cape is the only province that makes use of tele-ophthalmology in the primary health eye care clinics in South Africa, where it has only recently been introduced as a screening tool for diabetic retinopathy (19). This is funded by private sponsors, and therefore does not form part of the provincial health budget. The health budget is distributed by the provincial departments of health to each district on a pro rata basis, according to the population of each of the districts. Budget constraints preclude the general use of fundal photography and tele-ophthalmology for diabetic retinopathy screening, and therefore the direct ophthalmoscope remains the method generally used in most districts by primary care physicians for fundus examination. The direct ophthalmoscopes that are currently available might be considered as expensive items of equipment for use in primary care settings, and the Optyse™ lens free direct ophthalmoscope may be an acceptable and affordable alternative.

4) Ophthalmoscopy training of medical students

As with many other skills in medicine, ophthalmoscopy is a skill which needs to be practiced and which improves with repetition. The first challenge in acquiring this skill is to be able to obtain a decent view of the fundus, which requires the correct positioning of the examiner in relation to the patient, correct handling of the instrument, avoiding disturbing corneal light reflexes, encountering sometimes less than clear media (i.e. early nuclear sclerosis) and seeing through an undilated pupil. Having mastered this and having obtained a view of the fundus, the student needs to develop a baseline understanding of what are normal fundal appearances and what are pathological fundal appearances. The third step in the learning process is to put the fundal signs together to be able to place them into a diagnostic category, e.g. "swollen disc", "diabetic retinopathy", etc.

Currently, the medical students at the University of Cape Town receive their ophthalmology training in their fifth year. The ophthalmology rotation consists of a total of four weeks, which is shared with dermatology and otolaryngology. During this time, they receive all their ophthalmology lectures, and one of these four weeks is allocated as a practical ophthalmology week. At the beginning of this week, they receive a tutorial and demonstration on ophthalmoscopy. They are then expected to practice this skill during their time in the eye clinic, which includes one morning session in the diabetic eye screening clinic.

There have been a number of studies evaluating ophthalmoscopy skills amongst medical students and general practitioners. One study has shown the benefit of formal ophthalmoscopy training of medical students, compared to their peers who had no formal instruction (20). Another study found that, after initial acceptable performance of medical students following formal ophthalmoscopy training, there

was a worrisome erosion of this skill in the following year of testing. After a reinforcement course, however, there was a marked improvement in skills (21). Another study found that the confidence of medical students to adequately perform fundoscopy was low after their brief exposure to formal instruction, and that there was a need for more practice and training in ophthalmoscopy (22). Two studies looked at the ability of general practitioners to screen for diabetic retinopathy with a direct ophthalmoscope. In the first study, the general practitioners had no further training after their medical studies, and were found to be below standard and in need of further training before they could be involved in screening (23). In the second study, the practitioners had a further short period of training, and they were found to be of an acceptable standard to partake in a diabetic screening programme (24).

It seems, therefore, that there are a number of questions that need to be answered. Is the allocated practical ophthalmology training time at University of Cape Town sufficient for the students to acquire an acceptable level of skills in ophthalmoscopy? Are they able to recognize the pathologies they should be able to recognize as primary care physicians? How long are their skills retained after their training? This study attempts to answer the first two of these questions.

CHAPTER 2

METHODS

A prospective controlled trial was designed, to compare the use of the Optyse lens free ophthalmoscope to the Welch Allyn direct ophthalmoscope by medical students, on mannequin heads containing slides of various fundal pathologies.

Ethical approval was obtained from the University of Cape Town Health Science Faculty's Research Ethics Committee.

There are various models available of the direct ophthalmoscope. However, in order to minimize any study variables, the Welch Allyn direct ophthalmoscope with the 3.5V coaxial halogen ophthalmoscope head was chosen as a comparative model for the Optyse™ in this study (figure 3). The reason for this choice was because it is the model that is readily available in the Groote Schuur Hospital eye clinic, and therefore easily accessible for our study once a month.

Figure 3: The Optyse™ and Welch Allyn ophthalmoscopes used in this study

The subjects chosen to take part in the study were fifth year medical students, on the last day of their ophthalmology rotation. Each group consisted of between fifteen to twenty students. On the first day of their ophthalmology rotation, the students received a tutorial on the use of the direct ophthalmoscope. They were also informed about the comparative study between the Optyse™ lens free ophthalmoscope and the conventional ophthalmoscope, and were therefore encouraged to practise with both. They were then shown how to use the Welch Allyn and Optyse™ ophthalmoscopes.

Mannequin heads, specifically designed for teaching and practicing ophthalmoscopy, were used for the study (figure 4). The mannequin heads have a casted face, with two plastic eyes. Each eye has a translucent centre, the size of a widely dilated pupil. The posterior part of the mannequin head is separate from the anterior part, and contains a platform where slides of fundal photographs can be inserted. This then slides into the anterior part of the mannequin head and is attached to it with a Velcro strip. By looking with an ophthalmoscope through the plastic eye, the slide can be viewed.

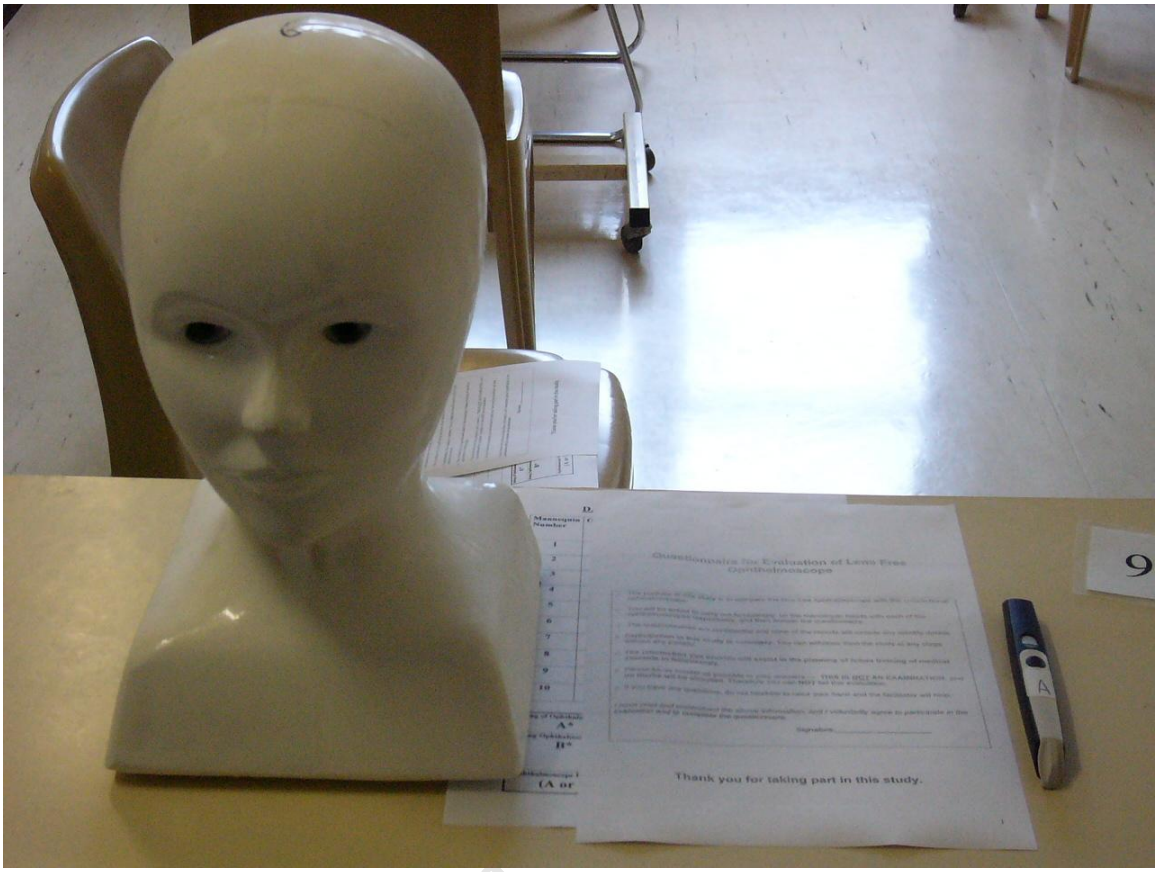


Figure 4: The mannequin head used for this study

The students were presented with five different optic disc/ macular diagnoses, similar to what might present to them in a primary care/ general practice setting. The diagnoses chosen were:

1) normal fundus (disc and macula)

2) optic atrophy

3) glaucomatous disc

4) disc swelling

5) diabetic maculopathy

Each of these diagnoses were represented by two similar, but non-identical photographic slides, to make up a total of ten slides. The slides were then inserted into a mannequin head, behind the right eye. The slides were placed in the groove that would result in a focused image in the case of an emmetropic examiner and emmetropic patient. The ten mannequin heads were then placed in random order, each on a separate desk. One of the Optyse™ or Welch Allyn ophthalmoscopes were then placed on each of these desks, ensuring that each diagnosis, represented by a pair of similar slides, would be accompanied by a Welch Allyn and an Optyse™ ophthalmoscope, respectively. Each desk was marked by a number one to ten, and a memorandum page was constructed, with the respective diagnosis written next to the desk number, to be able to mark the students' answers at a later stage.

For an examination room, we used one of the rooms in the eye ward in Groote Schuur Hospital. The ten desks (with chairs) were arranged in two rows. Because each group of students consisted of between fifteen to twenty persons, we decided to set up rest stations, consisting of a chair, interspaced in-between the desks with mannequin heads, so that each student would be seated on a chair during the examination, whether it be a rest station or a test station. A consent form (appendix 1) and data collection sheet (appendix 2) were then placed at each of the stations (figure 5).

Figure 5: The examination room set up

The question paper was constructed in such a way that each test station, represented by its corresponding number, had two questions:

- Can you see the fundus (yes/ no)
- What is the diagnosis?

Next to each number, they also had to fill in which ophthalmoscope was used, “A” or “B”, where “A” was the Optyse™, and “B” the Welch Allyn ophthalmoscope, respectively.

After all the test stations were covered, they had to answer two more questions:

- What is the rating, in terms of ease of use, of the two ophthalmoscopes, where a rating of one (1) is “very easy to use”, two (2) is “easy to use”, three (3) is “okay to use”, four (4) is “difficult to use”, and five (5) is “very difficult to use” ?
- Which ophthalmoscope is preferred, “A” or “B”?

Figure 6: Students taking part in the study

The students took part in the study on the same day they did their final written ophthalmology examination, at the end of their ophthalmology rotation. They were instructed that, under the heading of diagnosis, they could either fill in the diagnosis if they knew it, or alternatively, if they were not sure of the diagnosis, they could fill in the clinical signs identified (i.e. “dot haemmorrhages and exudates” would be awarded the same mark as “diabetic maculopathy”, or “blurred optic disc margin and flame haemmorrhages” would be awarded the same mark as “swollen disc”, etc.). The students were informed that the photographic slides represented common fundal pathologies that they should be able to recognize as primary care physicians, and that it might also include a normal fundus. It was emphasized that the examination did not count towards their final ophthalmology marks and that their answer sheets were anonymous. They were asked not to guess an answer if they did not recognize the pathology. Each student signed a consent form to participate in the study. They were allowed 1 ½ minutes per station, and were not allowed to talk during the examination.

Figure 7: A student taking part in the study

CHAPTER 3

RESULTS

1. Subjects recruited

173 fifth year M.B.,Ch.B students were recruited into the study in 2006 and in 2007. None of the students refused to participate in the study.

2. Ability to see the fundus photographs

Of a total of 826 fundus photographs viewed with each ophthalmoscope, 784 (95%) could be seen with the Optyse™ ophthalmoscope and 789 (95.5%) could be seen with the Welch Allyn ophthalmoscope. This difference was not statistically significant (p= 0.7).

Table one shows the ability of the students to see the fundus photographs with the two ophthalmoscopes.

Table 1: Ability of the students to see the fundus photographs with the ophthalmoscopes

	Optyse™ ophthalmoscope		Welch Allyn ophthalmoscope	
	Number	%	Number	%
All 5 photographs	120	69.4	113	65.3
4 photographs	34	19.7	47	27.2
3 photographs	16	9.2	12	6.9
2 photographs	2	1.1	1	0.6
1 photograph	0	0	0	0
0 photographs	1	0.6	0	0
Totals	173	100	173	100

3. Overall ability to make the correct diagnosis

Of a total of 826 fundus photographs viewed with each ophthalmoscope, the correct diagnosis was made in 483 (58.5%) examined with the Optyse™ ophthalmoscope and in 464 (56.2%) examined with the Welch Allyn ophthalmoscope. This difference was not statistically significant (p=0.2).

Table two shows the ability of the students to make the correct diagnosis with the two ophthalmoscopes.

Table 2: Ability of the students to make the correct diagnosis with the ophthalmoscopes

	Optyse™ ophthalmoscope		Welch Allyn ophthalmoscope	
	Number	%	Number	%
All 5 photographs	17	9.8	13	7.5
4 photographs	35	20.2	36	20.8
3 photographs	52	30.1	43	24.9
2 photographs	45	26.0	51	29.5
1 photograph	17	9.8	27	15.6
0 photographs	7	4.0	3	1.7
Totals	173	100	173	100

4. Ability to make specific diagnoses

Table three shows the ability of the students to correctly diagnose specific conditions with the two ophthalmoscopes.

Table 3: Ability of the students to diagnose specific conditions with the two ophthalmoscopes

Diagnosis	Both correct	Optyse™ only correct	Welch Allyn only correct	P value for comparison between ophthalmoscopes
Normal fundus	46	30	32	0.9
Optic atrophy	72	33	19	0.07
Swollen disc	62	45	22	0.01
Cupped disc	73	26	36	0.25
Diabetic retinopathy	117	17	33	0.03

5. Rating of "ease of use" of the ophthalmoscopes

Table 4 shows the rating given by the students for the "ease of use" of the two ophthalmoscopes, where a rating of 1 is "very easy to use" and 5 is "very difficult to use".

Table 4: Rating of "ease of use" of the ophthalmoscopes

	Rating = 1 (very easy to use) No (%)	Rating = 2 (easy to use) No (%)	Rating = 3 (okay to use) No (%)	Rating = 4 (difficult to use) No (%)	Rating = 5 (very difficult to use) No (%)	Mean rating
Optyse™ ophthalmoscope	26 (15.0)	53 (30.6)	69 (39.9)	19 (10.9)	6 (3.5)	2.6
Welch Allyn ophthalmoscope	52 (30.2)	84 (48.8)	31 (18.0)	4 (2.3)	1 (0.6)	1.9
P value						0.00

Some students added additional comments. One student found both ophthalmoscopes easy to use with dilated pupils, but found the Optyse™ ophthalmoscope more difficult if the pupils are undilated. Another comment was that, when faced with "an easy patient and an easy eye", both ophthalmoscopes are easy to use, whereas the Welch Allyn ophthalmoscope is "by far superior when faced with difficulty, be it the patient, the eye, or the inexperienced examiner". One student complained that the Optyse™ ophthalmoscope "strained" his eyes, and he was unable to get a clear view of the fundus with it.

4. Ophthalmoscope preference

The Welch Allyn ophthalmoscope was the preferred ophthalmoscope for 128 (74.0%) students, compared to 34 (19.7%) preference for the Optyse™ ophthalmoscope. This difference is significant ($p<0,001$). Eleven students (6.4%) had no preference.

Some informal remarks were added to "preference" by some students. One student preferred the Optyse™ ophthalmoscope for its portability. Another remarked that they preferred the Optyse™ ophthalmoscope because one "does not have to focus it first, and does not have to struggle with the on-off switch". One student remarked that the Optyse™ ophthalmoscope was "ridiculously overpriced for what one gets", and for this reason preferred the Welch Allyn ophthalmoscope. Another student preferred the Welch Allyn because of its wide variety of uses, and also because of its wider field of view. One student remarked that he preferred the Welch Allyn ophthalmoscope because he could adjust the ophthalmoscope's lenses to compensate for his ametropia.

CHAPTER 4

DISCUSSION

1. Ability to see the fundus photographs

The ability of the students to visualise the fundal slides were similar with the two ophthalmoscopes, with no significant difference. This differs from the findings in the study of Deacons et al, where the Optyse™ ophthalmoscope gave a poorer clarity of view compared to the conventional ophthalmoscope. Their study was performed on real patients, and the poorer clarity of view with the Optyse™ ophthalmoscope was associated with the presence of cataracts, but not with ametropia (5).

2. Ability to make a diagnosis

The ability of the students to make a diagnosis is a measure of their competence in ophthalmoscopy and in recognizing different pathologies. Overall, they were able to make the correct diagnosis in only 57.3% of cases. This suggests that the one week of time allocated for their practical training is inadequate.

The students were twice as likely to recognise *diabetic retinopathy* with the Welch Allyn than with the Optyse™ ophthalmoscope. In contrast, they were almost twice as likely to recognise *optic atrophy* and *disc swelling wi*th the Optyse™ ophthalmoscope. There was no difference in the diagnosis of *disc cupping* and *normal fundus*.

It is interesting to note that the Welch Allyn ophthalmoscope performed better at the slide with macular pathology, and the Optyse™ ophthalmoscope better at two of the slides with optic disc pathologies. The reason for this is not clear, and might even be coincidental, as both ophthalmoscopes performed equally with the remainder of the slides. However, one can attempt to make some postulations as to the reason for this. One theory might be explained by considering the difference in the optics of the two ophthalmoscopes. The Optyse™ ophthalmoscope yields an image of greater magnification than the Welch Allyn ophthalmoscope. The greater magnification might make it easier to evaluate disc pathology with the Optyse™, whereas the resultant limited field of view might make it more difficult to evaluate macular pathology. The Optyse™ ophthalmoscope also has a more dispersive light compared to the Welch Allyn ophthalmoscope, which might compromise the quality of view beyond the optic disc. This might even be more relevant when performing fundoscopy through an undilated pupil. In the study done by Deacons et al, some of the observers remarked on the difficulty of visualising the macula and periphery with the Optyse™ ophthalmoscope on real patients with undilated pupils (5).

3. Rating of "ease of use"

The majority of students rated the two ophthalmoscopes between "*very easy to use"* and "*okay to use"* (rating 1 to 3).Overall, the students found the Welch Allyn ophthalmoscope to be the easier instrument to use.

We can gain more insight into some of the reasons for this preference if we look at the additional remarks made by some of the students. A few students based their rating on the experience they had with the ophthalmoscopes during their practical sessions in the eye clinic, rather than during the study with the mannequin heads. It seems that for some, the variability factors that plays a part in a "real patient situation" made the Optyse™ ophthalmoscope the more difficult instrument to use, whether this is attributed to patient cooperation, media opacities, etc. The Optyse™ ophthalmoscope was also mentioned by some students to be more difficult to use on patients with undilated pupils.

This last observation correlates with the remarks of some of the examiners in the study of Deacons et al, who also found that a smaller pupil makes the use of the Optyse™ ophthalmoscope more difficult (5).

4. Ophthalmoscope preference

The Welch Allyn opththalmoscope was the preferred ophthalmoscope.

One student preferred the Welch Allyn ophthalmoscope for its greater variety of uses. Admittedly, many health care workers, when using the conventional direct ophthalmoscope, only use the diffuse illuminating light function. However, for those who are accustomed to the ophthalmoscope's other functions, i.e. smaller aperture illuminating lights for miosed pupils, the dimming light function, red free filter, cobalt blue light etc., the Optyse™ will be found to be inadequate.

One student preferred the Welch Allyn ophthalmoscope because of his own refractive error. The lens focusing system of the conventional direct ophthalmoscope is an important and useful function in the context of ametropia of the patient, the examiner, or both. Ametropia does not exclude the use of a fixed-focus ophthalmoscope. The problem of ametropia can be overcome by the use of the appropriate optical correction by the examiner and/ or patient involved (if this is available). In the study done by Deacons et al, some of the examiners remarked that the ease of use of the Optyse™ was still acceptable when the examiner had to wear spectacles, but difficult in the case where the patient had to wear spectacles (5).

Another preference was the wider field of view with the Welch Allyn ophthalmoscope, which enables the examiner to evaluate more of the fundus compared to the Optyse™ ophthalmoscope.

The cost of the Optyse™ was raised by one of the students, who stated that it was severely overpriced for the product that was offered. Table 5 compares the price of the Optyse™ lens free direct ophthalmoscope with some of the entry-level models of conventional direct ophthalmoscopes. The prices quoted are for November 2008, include a battery handle, and include value added tax, shipping fees, and student discounts where relevant.

Ophthalmoscope model	Marketing price and distributor	Student discount
OPTYSE™ LENS FREE OPHTHALMOSCOPE	**R 772.50** (£51.50) Ophthalmos (U.K. Distributor)	**R 640.50** (£ 42.70)
	R 966.72 Combined Medical Specialties (South African Distributor)	**R870**
WELCH ALLYN POCKET JUNIOR no focusing lenses, red free and cobalt blue filter, 4 aperture options	**R 1144** Myriad Medical	**R 1000**
HEINE MINI 2000 lens range +20 to -20D, 4 aperture options, incl. red free light, halogen bulb	**R1003.20** Genop Holdings	
WELCH ALLYN POCKET PROFESSIONAL lens range +40 to -25D, 6 aperture options, red free and cobalt blue filter, halogen bulb	**R 1379** Myriad Medical	**R 1206**
HEINE ALPHA POCKET lens range +20 to -30D, 4 aperture options, red free filter, halogen bulb	**R2052** Genop Holdings	
WELCH ALLYN with 3.5V COAXIAL HEAD (model used in study) lens range +40 to -25D, 6 aperture options, red free and cobalt blue filter, halogen bulb	**R 2233.40** Myriad Medical	**R 1786.72**
KEELER POCKET lens range +20 to -20D, 6 aperture options, red free filter, halogen bulb	**R 3152** Medical Distributors	

On the Optyse™ ophthalmoscope website, it is advertised as "affordable" and "a fraction of the cost of its traditional rivals"[6]. The inventor of the Optyse™ ophthalmoscope made this device at home for less than a pound. The marketed product consists of a plastic body, two AAA batteries, a light bulb, a reflecting prism and a pouch to store it in. With the pocket direct conventional ophthalmoscopes now available (with focusing lenses and adjustable apertures) for just a fractionally higher price than the Optyse™ ophthalmoscope, the distributors of the Optyse™ might find that they have priced themselves out of the market.

5. Student performance

The students had no difficulty in visualising the fundal photographs. 95% of slides were seen with the two ophthalmoscopes. This compares favourably with a study done by Lippa et al, who found that 72-82% of the students could visualise various parts of the fundus (21).

One can further evaluate the students' diagnostic competence by looking at their performance on each diagnosis. For *diabetic retinopathy*, the students made the correct diagnosis in 82% of slides, in 60% of *cupped disc* slides, in 56% of *optic atrophy* slides, in 55% of *swollen disc* slides and in 44% of *normal fundus* slides.

From the above we can see that the students were very competent in diagnosing/ identifying the clinical signs of *diabetic retinopathy*, and were fairly competent in identifying a *cupped disc*. Seeing that the students are the future primary care physicians, this result is enlightening. Glaucoma and diabetic retinopathy are number two and three, respectively, on the list of causes of blinding diseases in South Africa (7). Patients with these diseases can be prevented from progressing to blindness by proficient screening.

The students' ability to identify the other two disc pathologies, namely *optic atrophy* and *disc swelling*, fell below 60%. There is reason to be concerned about this result.

Both these optic disc pathologies can present to non-ophthalmologists as ocular manifestations of a systemic disease, i.e. intra-cranial tumours or increased intra-cranial pressure. To miss these signs can lead to disastrous consequences, and even death if, for instance, papilloedema is missed as a sign of increased intracranial pressure in a patient with meningitis, and a lumbar puncture is performed.

Ironically, the students performed worse on the slide with the normal fundus. Perhaps, this result could, at least partly, be explained by the students' expectation of being presented with pathological fundal pictures. However, this poor result illustrates an important point. A large percentage of the practical training of medical students in teaching facilities, is spent by teaching the students to diagnose pathological diseases. In the tertiary hospital clinics, most of the patients who attend have some form of pathology, with pathological signs. This certainly includes the ophthalmology out patients clinic at Groote Schuur Hospital, where the students involved in this study did their practical week in ophthalmology. Although it is important for the students to be competent in identifying the abnormal fundus, it might be just as important to know what a normal fundus, and the variation of normal, looks like. This might result in less unnecessary referrals to tertiary care. Also, to have a baseline knowledge of what "normal" looks like, it becomes easier to identify the "abnormal", even if a diagnosis cannot be made.

Ophthalmoscopy is an important skill for medical students to master, as it is needed in many of the disciplines other than ophthalmology. Although the students did well in the diagnosis of diabetic retinopathy, their competence in the diagnosis of other important fundal diagnoses ranged from fair to poor. Our view point is therefore that one week of practical ophthalmology training is not enough for the students to learn such an essential skill.

6. Short comings of this study

We decided to use mannequin heads with fundal photographs for this study. The reason for this was an attempt to eliminate study variables, i.e. patient cooperation and availability, media clarity and variability in clinical signs of a specific diagnosis. A mannequin head presents the examiner with the equivalent of the "easiest patient" with the "easiest eye". It is static, has widely dilated pupillary apertures and presents the examiner with a clear view of the fundal picture. On the questions of "*ease of use"* and "*preference"*, some of the students did remark that their experience with the two ophthalmoscopes were different when faced with a real patient. A study that evaluates the ophthalmoscopy skills of the students on real patients (with and without dilated pupils), might yield a different outcome of results.

One of the main differences between the Optyse™ and the conventional direct ophthalmoscope is the fact that the Optyse™ ophthalmoscope does not have a lens focusing system. A lens focusing system becomes relevant in the case of an ametropic patient or examiner. Although ametropia does not preclude the use of the Optyse™ in order to get a focused fundal view (by the use of appropriate optical correction by the patient or examiner), this clinical scenario has not been evaluated in our study. The issue of ametropia was raised as a reason for his preference of the Welch Allyn by one of the students. If we included a station where ametropia was similated in the mannequin head, it might have influenced the results.

The standard Welch Allyn direct ophthalmoscope with 3.5V coaxial halogen ophthalmoscope head was used to compare to the Optyse™ ophthalmoscope in this study. Keeler, Welch Allyn and Heine all have a smaller pocket direct ophthalmoscope available, which is more competitive in terms of price with the Optyse™ ophthalmoscope than the Welch Allyn model used in our study. A study comparing these pocket models to

the Optyse™ ophthalmoscope, might be further helpful to evaluate the Optyse™ in terms of cost-effectiveness.

We used the fifth year medical students as our subjects to evaluate the ophthalmoscopes in our study. However, there are other health care workers who might also be potential users of the Optyse™ lens free ophthalmoscope, i.e. general practitioners and nursing staff. Seeing that the Optyse™ might be a potentially cost-effective alternative ophthalmoscope to use in the primary health care setting, a valuable future study would be to include these staff members in a study evaluating the use of the Optyse™ ophthalmoscope.

We assessed the skills of the medical students in ophthalmoscopy immediately after their ophthalmology rotation. Lippa et al evaluated the retention of ophthalmoscopic skills in medical students, and found a worrisome erosion of skills over their three-year evaluation period (21). They also found an improvement in ophthalmoscopic skills of over 50% in these students after a brief refresher course. Ophthalmoscopy is an acquired skill, which, as with any other practical skill, improves and gets retained by continuous practice and reinforcement. Therefore, it would be a worthwhile study to test for the retention of the ophthalmoscopic skills of the students involved in our study after one (or more) years. Furthermore, if their skills were found to be decreased, one could evaluate the effect of a refresher course for the students.

CHAPTER 5

CONCLUSION

The purpose of this study was two-fold: firstly to evaluate the Optyse™ lens free ophthalmoscope, and secondly to evaluate the ophthalmoscopy skills of the fifth year medical students at the University of Cape Town, at the end of their ophthalmology rotation.

The performance of the students in ophthalmoscopy varied between the different outcome measures. We have demonstrated that they have mastered the basics of ophthalmoscopy by being able to visualise the fundus in 95% of cases. The students being future health care workers, it was also enlightening to find that they were competent in the identification of diabetic retinopathy and a glaucomatous optic disc. However, they did lack competence in the diagnosis of other important optic disc pathologies (disc swelling and optic atrophy), and also displayed poor performance in discerning a normal from an abnormal fundus. Ophthalmoscopy is an important skill to master for the use in all disciplines of medicine. The students should therefore perform better in this skill than their performance in this study. For this reason, we suggest a longer practical training period in ophthalmology, with a stronger emphasis on the practice of this skill.

The students preferred to use the Welch Allyn direct ophthalmoscope, and also found it to be the easier instrument to use. However, in terms of performance, the Optyse™ proved to be just as effective in providing a clear view of the fundus photographs, and in enabling the students to make fundal diagnoses, than the Welch Allyn ophthalmoscope. From the results of the specific diagnoses, there was even a suggestion that the Optyse™ ophthalmoscope might be the better instrument to use for optic disc evaluation.

Although proven to be an effective instrument, the cost of the Optyse™ ophthalmoscope is a concern. The Optyse™ seems to be overpriced for the product that is offered if compared to its rivals on the market. From a primary health care point of view, it will be a pity to loose out on a potentially cost-effective instrument like the Optyse™ ophthalmoscope because of an artificially inflated marketing price. To regain its market value, this issue needs to be addressed by the distributors.

South Africa's primary health care system functions under constant financial constraints. Instruments, like the currently available conventional direct ophthalmoscope models, are considered to be expensive. This can preclude their use in our health care system. The availability of cost-effective alternatives can help alleviate this problem. The Optyse™ lens free ophthalmoscope has the potential to be such an alternative, if the marketing price can be reduced.

APPENDIX 1

Questionnaire for Evaluation of Lens Free Ophthalmoscope

- The purpose of this study is to compare the lens free ophthalmoscope with the conventional ophthalmoscope.
- You will be asked to carry out fundoscopy on the mannequin heads with each of the two ophthalmoscopes, and then answer the questionnaire.
- The questionnaires are confidential and none of the reports will include any identity details.
- **Participation in this study is voluntary.** You can withdraw from the study at any stage without any penalty.
- **The information you provide will assist in the planning of future training of medical students in fundoscopy.**
- Please be as honest as possible in your answers — **THIS IS *NOT* AN EXAMINATION**, and **no marks** will be allocated. Therefore you can **NOT** fail this evaluation.
- If you have any questions, do not hesitate to raise your hand and the facilitator will help.

I have read and understood the above information, and I voluntarily agree to participate in the evaluation and to complete the questionnaire.

*Signature:*_____

Thank you for taking part in this study.

APPENDIX 2

DATA COLLECTION SHEET

Mannequin Number	Ophthalmoscope (A or B)	Able to see Fundus (Yes/ No)	Diagnosis / Clinical Findings
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Rating of Ophthalmoscope A*	
Rating Ophthalmoscope B*	
Ophthalmoscope Preference (A or B)	

*** Rating 1 → 5**
1 = very easy to use
2 = easy to use
3 = okay to use
4 = difficult to use
5 = very difficult to use

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