Diagnosing Cytomegalovirus Retinitis through Teleophthalmology

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Citation

Abstract
Cytomegalovirus (CMV) retinitis is the most prevalent opportunistic ocular infection in acquired immune deficiency syndrome (AIDS). CMV retinitis occurred in forty percent of AIDS patients before the introduction of highly active antiretroviral agents. Without treatment, the necrotic retinitis progresses relentlessly to involve the entire retina. Irreversible loss of visual function in the affected retina and loss of vision results within several months.

The University of Texas Medical Branch (UTMB) is the managed care provider for the Texas Department of Criminal Justice (TDCJ). It is also the only tertiary care hospital for inmates with AIDS in Texas. Like most states, Texas faces a growing incidence of AIDS in its incarcerated population (fig 1). In 1995, almost 2% of Texas inmates were either HIV positive or had AIDS. Since testing of HIV is not required however, the actual number of currently infected inmates is unknown.

Figure 1
Figure 1

A large percentage of inmate eye examinations are initiated and performed by optometrists in satellite clinics throughout the state. Inmates with ophthalmic pathology travel long distances to UTMB for consultation with ophthalmology subspecialists (fig 2). Teleophthalmology diagnosis of CMV retinitis can increase inmate access to subspecialists, decrease delays in diagnosis and treatment, and reduce the number of inmates with vision disabilities.

Teleophthalmology combines an increased scope of services with local continuity of care. Economic savings through transportation and security personnel cost savings are also possible. We decided to investigate the feasibility of diagnosing CMV retinitis through teleophthalmology in 1995.

Figure 2

PURPOSE
We evaluated viewing and acquiring digital retina images using three modalities: slit lamp, binocular indirect ophthalmoscope and retinal camera. We also compared assessing CMV retinitis using digital images to traditional face-to-face examinations using slit lamp and binocular...
indirect ophthalmoscope.

METHODS
Thirty eyes of patients from the HIV Retina Clinic with established diagnosis of CMV retinitis were divided into three groups of ten. Each group had digital images of retinitis acquired by one method. Images were acquired either by video camera attached to a slit lamp (fig. 3), video camera attached to binocular indirect ophthalmoscope (fig. 4) or video camera attached to a retinal camera (fig. 5). Slit lamp and the binocular indirect ophthalmoscope images were taken by a second year ophthalmology resident. A staff ophthalmic photographer acquired retinal camera images. A retinal physician conducted examinations of CMV retinitis through still digital images before examining the same eye face-to-face.

The following equipment was used:

Slit lamp
- Haag-Striet 900BQ slit lamp
- Panasonic 3-chip color video camera
- Volk Superfield lens
- Medical Video Concepts MVC-400 digital video imaging system

Indirect Ophthalmoscope
- Keeler video binocular indirect ophthalmoscope
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- Single-chip color video camera
- Volk 20D lens
- Medical Video Concepts MVC-400 digital video imaging system

Retinal Camera

- Topcon TRC-50X camera, 50 degree field
- Sony 3-chip color video camera
- Ophthalmic Imaging Systems WinStation 1024

Digital images acquired using the three methods were evaluated for ease of use from the points of view of the acquiring examiner and reviewing examiner. Easy meant convenience and little time required to capture or review digital images. Digital image diagnostic accuracy of CMV retinitis was assessed based on whether images were of sufficient quality and adequate quantity to allow accurate diagnosis (figs. 6 & 7).

**Figure 6**

Figure 6

We measured experiences by scoring four questions from one to five:

- Was mechanical operation of acquiring images simple?
- Was the mechanical operation of reviewing images simple?
- Was image resolution satisfactory in terms of focus, color & magnification?
- Was funduscopic data sufficient in terms of size of the field and orientation of image?

Results 19,20,21,22

**Figure 8**

Results 19
The higher the score, the higher the acceptance of the teleophthalmology application. Correspondingly, lower scores were interpreted as perceived disadvantages. Scoring was intended to evaluate the feasibility of a particular method to diagnose CMV retinitis, not to compare methods.

The indirect ophthalmoscope method proved very difficult for image acquisition (figs. 14 & 15). The slit lamp required less operator skill than an indirect ophthalmoscope, but still required significant time and effort (fig. 18). The retinal camera proved easiest to use. Flash intensity for digital fundus photography is less than that required for traditional color slides. The illumination intensity for digital retinal camera photography is less than slit lamp or binocular indirect ophthalmoscope. Patients tolerated the retinal camera’s low-illumination better than the other two methods.
Digital image quality improved with experience. Instant digital imagery provided immediate feedback, allowing one to improve skills faster than traditional film-based photography. We found retinal camera skills easy to acquire by non-professional photographers.

All methods displayed adequate image resolution of active retinitis, pigmented retina and normal retina. Slit lamp and retinal cameras provided better resolution and allowed more magnification options (fig. 8) than the indirect ophthalmoscope. The retinal camera displayed the fewest number of artifacts (figs. 9, 19, 20).

For reviewing funduscopic data, the indirect
ophthalmoscope and retinal camera provided wider fields of view than the slit lamp (figs. 11, 12, 13, 16).

The retinal camera showed a direct image and relative constant magnification compared to slit lamp or indirect ophthalmoscope imagery. Indirect ophthalmoscope and retinal cameras provided useful mid-peripheral retinal views (figs. 10, 17). None of the methods displayed the peripheral retina.
Medical Video Concepts and Ophthalmic Imaging Systems software were equally user-friendly for image capture and image review. We found digital fundus photographs easier to review than digital slit lamp or indirect ophthalmoscope images.

**CONCLUSIONS**

Digital imagery for teleophthalmology is a viable diagnostic tool for CMV retinitis. The digital retinal camera has the greatest potential for diagnosis of the condition. Its direct image, wide field and constant image magnification allows diagnosis and quantitative measurements to potentially detect progression of the lesions (fig. 21, 22, 23, 24, 25). New examination skills are required for all three methods. Our experience gained in assessing CMV retinitis through electronic imagery may not be applicable to other ophthalmic diseases.
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