OPS 2006 Annual Education Meeting Scientific Session Abstracts

50 Years of Eye Pathology Images: The CPMC Eye Pathology Digital Database Project

Denice A. Barsness, CRA, COMT, ROUB, FOPS
California Pacific Medical Center
Department of Ophthalmology
San Francisco, CA 94115 USA

Purpose: To design and produce a user friendly database from 50 years worth of CPMC Department of Ophthalmology Eye Pathology images. Many of these images were the private collection of the esteemed William H. Spencer, MD, noted author of the textbook Atlas of Ophthalmic Pathology, a standard reference volume in most ophthalmic teaching institutions. Case studies from various Eye Pathology organizational meetings (Western Pathology Club, Verhoeff Society, Hogan Society to name a few) going back to 1954 were part of this collection.

Our goal was to incorporate various image media (16mm tape, VHS tape, glass lantern slides, color positive slides, 35mm negatives, 4x4 slides, paper records and PowerPoint presentations) into a cohesive collection for the purposes of providing a comprehensive, keyword searchable educational database for the use by the ophthalmology Residents, Departmental Eye Pathologists and the ophthalmic community at large.

This presentation will discuss one teaching hospital's experience with the process of developing a comprehensive web-based browsing system from a priceless collection of historical but disparate images.

Methods: California Pacific Medical Center Department of Ophthalmology evaluated the body of the collection, created a plan, wrote a grant for funding, and implemented stages I, II and III of the project. Stages IV and V are still in process. All stages of this project will be presented.

Results: A user friendly, image friendly system was designed to incorporate all modalities of pathology media into one easy to use software package. Criteria for a user friendly template, search efficacy, physician satisfaction and economic viability were met. To date, over 15,000 images are incorporated into this collection. To our knowledge, only two such similar collections currently exist in the USA.

Conclusions: Mis-steps and triumphs along the way will be presented. Insights into potential landmines will be reviewed. Budgetary considerations will be discussed. The process involved in converting a disparate media collection into a cohesive web-based database system will be addressed.

Koch Eye/Joslin Vision Network System - One Year Study

Harry A. Kachadoorian, CRA
Koch Eye Center
Worcester, MA 01609 USA

Purpose: To image patients with diabetes and evaluate the level of diabetic retinopathy and risk factors through telemedicine.

Materials: Topcon TRC-nonmydriatic retinal camera NW6S. Joslin Diabetic Center proprietary software.

Method: 564 patients with the diagnosis of diabetes were imaged with non-mydriatic camera, low light and no pupil dilation utilizing the Joslin Vision Network system. This is the only system using 45 degrees retinal fields with stereo capability; validated as clinically accurate for retinopathy and macula edema assessment, as compared to the gold standard EDTRS.

Results: 564 diabetic patients imaged 200 (36%) patients triaged to Ophthalmology. 364 (64%) patients with no, or mild, diabetic retinopathy were to be followed up by JVN in six months to one year. (35%) patients did not show for scheduled imaging.

Conclusion: Our Joslin affiliation allows us to service a population of 100,000 people in Rhode Island with diabetes. The images taken are non-dilated and pain free. Evaluation of these images are interpreted and a report is sent. This enables the primary care and the eye care provider valuable information to help strengthen their position to manage the patient's diabetic condition and prevent blindness.

Integration of Ophthalmic Imaging Into a Radiology PACS Environment for Large-Scale Storage and Distribution of Images in a Large Medical Center

James D. Strong, CRA, Timothy J. Bennett, CRA, FOPS, Angus Khan
Penn State Department of Ophthalmology
Hershey, PA 17033 USA

Purpose: To evaluate the feasibility of integrating ophthalmic imaging services within a radiology-based Picture Archiving and Communications System (PACS) for large-scale image storage and distribution within a large university-based medical system.

Materials and Methods: Commercially available digital angiography systems often support the Digital Imaging and Communications in Medicine (DICOM) Standard; a set of comprehensive standards for handling, storing, printing, and transmitting diagnostic images. Conformance to these standards greatly simplifies the integration of imaging devices from various manufacturers with PACS and other hospital information systems.

The Radiology Department at the Penn State University Milton S. Hershey Medical Center (PSHMC) is in the process of integrating imaging services and digital image management for a variety of medical specialties into an institution-wide web-based PACS system (IDX Imagecast). Included in this project, using a stepped approach, a variety of third-party ophthalmic instruments are being interfaced and brought online using the IDX Imagecast PACS solution.

Results: Image capture, primary storage, and local image distribution within the ophthalmology clinic is accomplished using Topcon ImageNet. Additionally, color fundus photography, fluorescein angiography, fundus autofluorescence, slit-lamp and external photography are being exported into IDX Imagecast as a secondary, dual redundant image storage and distribution system. Via IDX, physicians are able to use a single browser-based interface to review images from a variety of diagnostic tests; unfortunately image enhancement and measurement tools specific to ophthalmology are not available in IDX at this time. Advantages and disadvantages of integration into a system designed for radiology will be presented.

Conclusions: There are many advantages to a single point of integration for all diagnostic imaging modalities in a large medical center. The infrastructure and financial support for PACS systems are already in place in many medical centers. Integrating ophthalmic imaging into PACS is a cost-effective solution to large-scale image distribution within a hospital or large medical center.

Clinical Detection of Diabetic Macular Edema Using the Automated Retinal Imaging System

Debra M Brown, COT, CRA, Antonio Ciardella, MD, Rebecca Doherty, MD, Jeremy Eulbergh, BS, Michael Buendia, BS
Denver Health Medical Eye Clinic
Denver, CO 80204 USA

Purpose: To compare stereo fundus photographs produced by the Automated Retinal Imaging System (ARIS) and retinal image maps created by Optical Coherence Tomography (OCT) to determine the effectiveness of the ARIS for screening for diabetic macular edema.

Materials: Single center, institutional. Forty five patients (90 eyes) with diabetes who presented to the Denver Health Eye Clinic in Denver, Colorado between November 2004 and February 2005 were evaluated. Only patients diagnosed with diabetes mellitus (type I or II) who had undergone OCT and ARIS imaging were included in the study. The ARIS photos were evaluated by a masked retinal specialist who viewed stereo pairs of field 2 photographs to determine the presence of diabetic macular edema. Macular edema was defined as central macular thickness greater than 250 microns, as measured by OCT.

Methods: A retrospective chart review.

Results: Results were obtained from 72 eyes. The ARIS sensitivity was 97% and specificity 44% when compared to OCT for detecting diabetic macular edema.

Conclusions: In preliminary results, the ARIS appears to be an effective screening tool for early diagnosis of macular edema. It is a new technology that requires little operator experience to create high quality stereo photographs that provide a vast array of information. Additional study is required to further assess the clinical usefulness of the ARIS.

High Resolution, Automatic Real Time, Wide Angle Photography Of the Retina With a Scanning Laser Ophthalmoscope

Denise Krolnik, John Peterson, CRA, Gene Knutson
University of Wisconsin
Madison, WI 53705 USA

Purpose: This presentation will demonstrate the advantage of Ultra wide-field fluorescein and ICG angiography with the Heidelberg Engineering HRA2 for documenting peripheral pathology.

Materials and Methods: An HRA2 with a 55 degree lens is used with HEYEX software version 1.5.7.0 in the Automatic Real Time (ART) mode. Images were compared between the HRA2 manual composite feature in which images were sequentially acquired and assembled as a composite, and the new ART mode. In the ART mode, the software calculates the composite in real time, as if painting it on the screen.

Results: Ultra-wide composite images by most cameras have normally been software-generated by assembling sequentially acquired images, after acquiring the images. They may also be taken with a hand held lens placed in front of the fundus camera lens, which is much more difficult for the operator and uncomfortable to the patient. The ART software enables you to see the results of the composite in real time, allowing for correction of mistakes on the fly. Finally, images are acquired in their native resolution and size, so when viewed full-frame detail is not minimized, as happens with other ultra wide-field images.

Conclusions: With the 55 degree field lens attached, it is possible to acquire images with a 110 degree field of view. The updated software allows for a smooth transition to different parts of the retina. This range allows for a greater amount of data to be given to the doctor.

Adaptive Optics – An Emerging Field for Ophthalmic Imaging

Richard E. Hackel, CRA, FOPS
Kellogg Eye Center
Ann Arbor, MI 48105 USA

Purpose: To explain the concept of adaptive optics, its historical beginnings in astronomy, and its current relevance to ophthalmic imaging.

Materials and Methods: Whether it is a cloud in the sky or a cataract in the lens, the fields of Astronomy and Ophthalmology share a similar problem. Land-based telescopes must deal with aberrations in the atmosphere that affect image accuracy, and ophthalmic imaging must deal with artifacts in the optical path to the retina.

While methods to deal with atmospheric aberrations have been developed since the 1950s, real advances have progressed rapidly with improvements in computers and micro machine technology. Much of this same technology may have applications in ophthalmic imaging.

Results: While there are some technologies in ophthalmology using adaptive optics, there is potential for a lot more development in this field.

Conclusions: As dinosaurs were a large-scale mock-up of what was to follow in evolution, the field of astronomy with its large telescopes and long distance viewing has provided ophthalmic imaging with a paradigm that can be transposed to the much smaller scale of the eye.

Identification of Optimal Imaging Methodology for Accurate Photogrammetric Colorimetry of the Iris

Jon R. Miles
Miles Research
Escondido, CA 92025 USA

Purpose: Identification of optimal imaging methodology for accurate photogrammetric colorimetry of the iris.

Materials and Methods: The human iris is becoming recognized as a reliable source of biometric data for personal identification and yet it is one of the least studied elements of the eye. Changes in iris color and texture are associated with Fuch's Heterochromic Iridocyclitis and other disorders of iris tissue. Iris color is also measured for analysis in genetic heritability studies. Iris color is dependent on both the spectral characteristics of the source illumination as well as the reflectance properties of the iris tissue itself. Photogrammetric colorimetry is also dependent on the operating characteristics of the imaging system, including the sensor specifications, color model used in image representation, and limitations in file formats. Iris coloration is based on both stromal pigmentation as well as the accumulation of pigment granules in the anterior border layer. Since iris coloration typically has regional variations and is not uniform, the iris images are sampled in four sectors that include the pupillary zone as well as the ciliary zone. In this study, multiple images of the same iris from each of a wide variety of cameras, including photo-slitlamps and macro cameras, were measured to assess the variability within and between camera types. Red-Green-Blue image components are converted to a standard CIE color space representation.

Results: Film and video cameras show the greatest variability in image color. Current-generation digital SLR cameras offer the greatest reliability for consistent imaging results. Optimal color measurement requires multiple sampling regions and uniform coaxial illumination.

Conclusions: Images for iris color measurement purposes can be most reliably obtained using digital SLR cameras using raw image format and precise mapping from the RGB color space into a standard CIE color space. Further studies of baseline iris color are needed.

Autofluorescence Imaging in Eyes with Geographic Atrophy Due to AMD

Pamela Vargo, CRA
University of Wisconsin
Madison, WI 53711 USA

Purpose: This presentation demonstrates that atrophic areas of the retina due to AMD can be characterized by Fundus Autofluorescent (FAF) imaging using a confocal scanning laser ophthalmoscope (cSLO).

Materials and Methods: Images were obtained using a Heidelberg Engineering HRA and HRA2. A FAF mean image was computed with a 30-degree field lens. Images were also taken in infrared, red-free, and in Fluorescein Angiography to see the differences in hypofluorescent, hyperfluorescent and autofluorescent patterns.

Results: Geographic atrophy is characterized by the presence, extension, and progressive coalescence of small areas of RPE atrophy and the overlying photoreceptors. These areas have a low FAF signal due to lack of autofluorescent material at the level of the RPE, which allows for precise delineation of atrophic patches and their enlargement over time. The pattern of abnormal FAF in the junctional zone has an impact on disease progression.

Conclusions: Atrophic areas due to AMD are surrounded by various patterns of abnormal FAF. Increased FAF precedes enlargement of pre-existing atrophy and development of new areas of geographic atrophy. Atrophic AMD has a very poor prognosis due to the absence of effective treatment at present, despite the promising results of a recent study (AREDS, the Age Related Eye Disease Study) that used antioxidant and vitamin A, C, and E supplements and ongoing studies on micronutrition and DHA.

Fundus Autofluorescence Imaging for Non-Invasive Imaging and Diagnosis of Retinal Diseases

Ethan R. Priel, FOPS
MOR Institute
Bnei Brak, Israel

Purpose: To describe the technique and results associated with fundus autofluorescence (FAF) imaging a non-invasive photographic method of documenting pathological findings and processes in the retina. Hyper- or hypofluorescent patterns generated by different areas and conditions in the retinal pigment epithelium (RPE) were evaluated.

Materials and Methods: As the amount of fluorescent light (at approx. 500 nm) emitted by the RPE is extremely low, an SLO (HRA 2) was used with both exciter illumination and barrier filters in place. Patients were dilated prior to photography. For correlation purposes, color photos, and an OCT exam were performed as well, prior to the fluorescein angiography (FA). A built-in option of the software was used in order to average multiple images, which were compared to the single images, as well as to the FA, OCT and color images. Pathologies imaged included AMD in all stages, BDR, CSR, CME and atrophic entities.

Results: Using the FAF technique, distinct patterns of RPE changes were noted, depending on the amount of light emitted by the lipofuscin accumulated in the RPE, adding important information to findings seen in the other imaging modalities. It was possible to obtain informative images from a variety of patients/diagnoses without the need for angiography.

Conclusions: FAF poses to be a promising ophthalmic imaging modality, complementing others already in use. It is especially helpful in outlining changes to the RPE before they become evident clinically or even angiographically, potentially opening the way for a follow-up modality for patients at risk of developing AMD.

Consistent Color Calibration for Digital Ophthalmic Photography Capture Systems: Principal and Application

Robert E. Curtin, CRA, FOPS
The Digital Angiography Reading Center
New York, NY 10022 USA

Purpose: The CCD chip revolutionized the digital imaging process. However, color reproduction in ophthalmic digital color photography capture and display systems can vary greatly. This paper will identify variables affecting color calibration in digital color capture systems and simple steps the Ophthalmic Photographer can take to minimize their impact. A case will be made for the need for standardization of color assessment and reproduction, and for manufacturers of ophthalmic digital imaging systems to provide hardware and software setup tools for consistent digital color capture.

Materials and Methods: Zeiss FF450 fundus cameras with the JVC KY-F70U, ZK-5, and the Phillips H5 sensors were used to generate digital color fundus images. A setup procedure for the H5 sensor using a Kodak 18% Gray Card with Zeiss Capture One software was developed in an to attempt to provide neutral system color balance. A monitor calibration device was used in an attempt to minimize the effect of display monitors at the Digital Angiography Reading Center.

Results: In comparison of images from different chips using the same type of fundus camera and imaging software, better color reproduction in digital ophthalmic photographic systems correlates strongly with increased chip resolution. The use of a user-accessible software-based setup program proved to be an effective tool for increasing system consistency. The use of the standard color reference Kodak 18% Gray Card proved to be effective in bringing system performance into repeatable near-neutrality. The monitor calibration device has limited usefulness in an environment where the color balance of images from different systems lacks standardization.

Conclusions: Most sensor chips have imbedded ICC color profiles built into them, which should enable the system to neutralize the color balance of the sensor. However, in practice, this is not the case. Manufactures of ophthalmic digital photographic imaging systems need to employ these profiles within their imaging software to minimize the variability of the sensors. Software setup solutions are useful when used in conjunction with standard color references common to photography, and should be provided with all levels of resolution. Calibration of display monitors is useful in critical applications, but requires standardized calibration throughout the capture system. Critical applications of digital color ophthalmic photography should require color test images, such as the 18% Gray Card or Pantone or Macbeth color samples.

Measuring Image Sharpness, Does Higher Spatial Resolution Provide Greater Image Sharpness?

Joseph W. Warnicki, FOPS
J-WAR Systems, Inc.
Pittsburgh, PA 15238 USA

Purpose: Higher mega-pixel cameras have produced better quality, sharper images than lower resolution retinal cameras. However, there is no established objective standard to actually prove this increase. I evaluated a public domain image sharpness grading program to obtain an objective numerical index of sharpness to determine its applicability to ophthalmic photography and if it could be used to help determine an answer.

Method: A digital camera on a tripod was aligned and pointed at a static subject. The subject had sharp irregular lines similar to what would be expected from retinal images. Multiple images were photographed of the subject varying focus and lighting conditions. A second set of images were then taken with the camera's resolution setting reduced to 25% of the original image set. Images were then digitally analyzed and the results compared to the parameters recorded during the photo session.

Results: Image sharpness measurements in the experiment ranged from nearly zero with poorly focused images to 20 which was obtained with very sharply focused images that showed well defined edges.

Preliminary analysis of the resulting high mega-pixel images ranged from an average sharpness of 16.3, for the images that were in focus, or 0 diopters of error to 0.4 measured from images that were 5 diopters out of focus. Plotting image sharpness to Diopters out of focus revealed a tangential curve increasing quickly the closer an image approached 0 diopters or sharp focus. The lower mega-pixel data plotted very closely to the high mega-pixel data when evaluating images that were greater than 2 diopters out of focus. When evaluating images within 1 diopter of correction the plotted curves separated. The higher resolution images had a higher value on the sharpness index.

Conclusions: Initial test results illustrate that higher resolution cameras have the potential of recording sharper images with greater information. However, subjects with poor quality media or cameras not properly focused can easily lose this advantage. Secondarily, the computer algorithm used for evaluating sharpness can be a useful tool to objectively evaluate images. Further testing is recommended to determine the precision of grading that can be obtained and what ophthalmic factors may cause measurement errors. I am continuing investigation and hope to report additional results at our annual meeting.
Commercial interest: None

Optimization and Standardization of Digital Color Fundus Photographs and Fluorescein Angiograms: Observations From a Central Reading Center

Larry D. Hubbard, Michael Neider, Dennis Thayer, Hugh Wabers, Pamela Vargo, CRA, Ericka Lambert
University of Wisconsin - Madison
Madison, WI 53711 USA

Purpose: Our central reading centers (RC) receives digital color fundus photographs (CP) and fluorescein angiograms (FA) from multiple clinics in studies of various eye diseases. We observe a wide range of practice in photographer management of various parameters, particularly illumination and color balance. Practices in some clinics allow RC staff to optimize/standardize these images for disease evaluation (as the clinic ophthalmologist might do), while other practices limit this option, resulting in less reliable or missing data.

Methods and Materials: Several eye diseases were analyzed in regard to the retinal appearances that are critical to the assessment of disease status. Within this context, digital CP and FA from a variety of publicly-funded studies were evaluated for image quality, particularly illumination and color balance – both subjectively (by conventional criteria) and objectively (by histogram analysis) – to determine the range of current practice across clinics. We explored various approaches (using digital fundus camera software and Adobe Photoshop) to allow RC staff to further optimize/standardize the images for disease assessment.

Results: While only 1-2% of the CP and FA that the RC receives from clinics in studies cannot be evaluated for primary disease variables, a much larger proportion are problematic for image optimization/standardization by RC staff. Common problems are under-illumination (both CP and FA) so that adequate contrast enhancement creates artifacts, over-illumination (CP) so that some retinal detail is over-saturated, and suboptimal color balance (CP) so that crucial green channel detail is overwhelmed by red channel content. Examples of optimum and problematic images will be presented and analyzed. Tentative guidelines for clinic practice in RC studies were formulated for discussion with the ophthalmic photography community.

Conclusions: Both RCs and clinics would benefit from the formulation of mutually acceptable guidelines for the parameters of digital CP and FA submitted in multi-center studies of ocular diseases.