Anterior Segment Scanning
Computerized Ophthalmic Diagnostic Imaging

Number: 0749

Policy

*Please see amendment for Pennsylvania Medicaid at the end of this CPB.

Aetna considers anterior segment optical coherence tomography (OCT) experimental and investigational for all indications including the following (not an all-inclusive list) because its clinical value has not been established:

- Assessment of Haab striae
- Detection of glaucoma
- Evaluation of anterior segment morphology of hyperopia
- Evaluation of blebs after filtering surgery
- Identification of fungal infections with endophthalmitis after cataract surgery
- Imaging of extra-ocular rectus muscle insertions for pre-operative planning

Aetna considers anterior segment imaging (ciliary body, cornea, iris and lens) using the following techniques experimental and investigational because of insufficient evidence of its effectiveness:

Policy History

Last Review 08/25/2016
Effective: 03/21/2008
Next Review: 08/24/2017

Definitions

Additional Information

Clinical Policy Bulletin Notes
effectiveness:

- Pentacam
- Scanning laser ophthalmoscopy (SLO), also called confocal laser scanning ophthalmoscopy
- Scanning laser polarimetry (SLP), also called confocal scanning laser polarimetry

Note: Aetna members may not be eligible under the Plan for anterior segment (ciliary body, cornea, iris and lens) imaging using the Pentacam for any indication relating to refractive eye surgeries (eg, LASIK, laser eye surgery, etc.). Refractive eye surgeries are generally excluded by contract; therefore, any imaging done in conjunction with this type of procedure would not be covered if the surgery itself is not a covered benefit.

See also CPB 0344 - Optic Nerve and Retinal Imaging Methods (../300_399/0344.html).

Background

Scanning computerized ophthalmic diagnostic imaging (SCODI) may be used as a diagnostic measure for eye conditions and includes the following technologies:

Optical coherence tomography (OCT) is a noninvasive, transpupillary, retinal imaging technology, which uses near-infrared light to produce high-resolution cross-sectional images. It is suggested for diagnostic use as an alternative to standard excisional biopsy and to guide interventional procedures.

Scanning laser ophthalmoscopy (SLO), also called confocal laser scanning ophthalmoscopy, is a method of examining the eye using confocal laser scanning microscopy (stereoscopic videographic digitized imaging) to make quantitative topographic measurements of the optic nerve head and surrounding retina. This may be done with either reflection or fluorescence. Targeted tissues can be viewed in 3-dimensional (3D) high-resolution planes running parallel to the line of sight.
Scanning laser polarimetry, also called confocal scanning laser polarimetry, measures change in the linear polarization (retardation) of light. It uses both a scanning laser ophthalmoscope and a polarimeter (an optical device to measure linear polarization change) to measure the thickness of the nerve fiber layer of the retina. The confocal scanning laser polarimeter is essentially a confocal scanning laser ophthalmoscope with an additional polarization modulator, a cornea polarization compensator and a polarization detection unit.

The Oculus Pentacam system is a multifunctional tool that images the cornea and anterior segment using a rotating Scheimpflug camera and a monochromatic light source (blue LED at 475 nm) that rotate together around the optical axis of the eye. There are five evaluation modes: Scheimpflug tomography, pachymetry (including adjustment for intraocular pressure), 3D anterior chamber analysis (chamber depth, angle and volume, including a manual measuring function for any location in the anterior chamber), densitometry of the lens and corneal topography (including anterior and posterior corneal surface as well as keratometry).

In optical coherence tomography (OCT), low coherence near-infrared light is split into a probe and a reference beam. The probe beam is directed at the tissues while the reference beam is sent to a moving reference mirror. The probe light beam is reflected from tissues according to their distance, thickness, and refractive index, and is then combined with the beam reflected from the moving reference mirror. When the path lengths of the two light beams coincide (known as constructive interference), this provides a measure of the depth and reflectivity of the tissue that is analogous to an ultrasound A scan at a single point. A computer then corrects for axial eye movement artifacts and constructs a 2-dimensional B mode image from successive longitudinal scans in the transverse direction. A map of the tissue is then generated based on the different reflective properties of its components, resulting in a real-time cross-sectional histological view of the tissue (AHFMR,
Optical coherence tomography (OCT) of the posterior segment of the eye has been used for screening, diagnosis, and management of glaucoma and other retinal diseases (AHFMR, 2003; NHSC, 2002).

Optical coherence tomography is also being studied as a method of evaluating the anterior segment of the eye (e.g., the cornea, iris, anterior chamber and the central portion of the lens). Primary angle closure glaucoma is a common cause of visual loss. Currently, gonioscopy is the standard method for evaluating the anatomy of the anterior segment of the eye. Anterior segment OCT (AS-OCT), with its rapid, non-contact, and high-resolution image acquisition, appears to be a promising tool for the assessment of the anterior chamber angle (ACA) configuration, including changes induced by illumination and laser peripheral iridotomy. It has the potential for use as a rapid screening tool for detection of occludable angles.

The Visante OCT (Carl Zeiss Meditec, Dublin, CA) is a non-contact, high-resolution tomographic and biomicroscopic device that received marketing clearance through the U.S. Food and Drug Administration (FDA) 510(k) process in 2005, listing the Stratus OCT and Orbscan II as predicate devices. It is indicated for the in vivo imaging and measurement of ocular structures in the anterior segment such as corneal and laser in situ keratomileusis (LASIK) flap thickness (FDA, 2005). Since Visante OCT is a non-invasive procedure that can be conducted by a technician, it has been proposed that this device may provide a rapid diagnostic and screening tool for the detection of angle closure in glaucoma. Also being investigated is the possibility that the 0.8 micron wavelength Stratus OCT may provide sufficient detail for routine clinical assessment of the ACA in glaucoma patients. Radhakrishnan et al (2005) stated that ongoing clinical trials should aid to evaluate the effectiveness of AS-OCT especially in the setting of detection of occludable angles.
In a prospective observational case series, Nolan and colleagues (2007) evaluated AS-OCT as a qualitative method for imaging the ACA and ascertained its ability to detect primary angle closure when compared with gonioscopy in Asians. A total of 203 subjects with diagnoses of primary angle closure, primary open-angle glaucoma, ocular hypertension, or cataract were recruited. Both eyes (if eligible) of each patient were included in the study. Exclusion criteria were pseudophakia or previous glaucoma surgery. Images of the nasal, temporal, and inferior angles were obtained with AS-OCT in dark and then light conditions. Gonioscopic angle width was graded using the Spaeth classification for each quadrant in low lighting conditions. Angle closure was defined by AS-OCT as contact between the peripheral iris and angle wall anterior to the scleral spur and by gonioscopy as a Spaeth grade of 0 degree (posterior trabecular meshwork not visible). Comparison of the two methods in detecting angle closure was done by eye and by individual. Sensitivities and specificities of AS-OCT were calculated using gonioscopy as the reference standard. Complete data were available for 342 eyes of 200 patients. Of the patients, 70.9 % had a clinical diagnosis of treated or untreated primary angle closure. Angle closure in greater than or equal to 1 quadrants was detected by AS-OCT in 142 (71 %) patients (228 [66.7 %] eyes) and by gonioscopy in 99 (49.5 %) patients (152 [44.4 %] eyes). The inferior angle was closed more frequently than the nasal or temporal quadrants using both AS-OCT and gonioscopy. When performed under dark conditions, AS-OCT identified 98 % of those subjects found to have angle closure on gonioscopy (95 % confidence interval [CI]: 92.2 to 99.6) and led to the characterization of 44.6 % of those found to have open angles on gonioscopy to have angle closure as well. With gonioscopy as the reference standard, specificity of AS-OCT in the dark was 55.4 % (95 % CI: 45.2 to 65.2) for detecting individuals with angle closure. The authors concluded that AS-OCT is a rapid non-contact method for imaging angle structures. It is highly sensitive in detecting angle closure when compared with gonioscopy.

It should be noted that evaluation of the diagnostic
performance of the Visante OCT should depend on
demonstration of an improvement in clinical outcomes.
Although the resolution of the images and the ease of use
might be considered advantageous, available evidence is
insufficient to ascertain if the use of OCT can improve detection
and management of patients at risk of developing primary
angle closure glaucoma.

In a prospective observational study, Kalev-Landoy and
colleagues (2007) assessed the ability of OCT to visualize the
ACA in patients with different angle configurations. The
anterior segments of 26 eyes of 26 patients were imaged using
the Zeiss Stratus OCT, model 3000. Imaging of the anterior
segment was achieved by adjusting the focusing control on the
Stratus OCT. A total of 16 patients had abnormal angle
configurations including narrow or closed angles and plateau
irides, and 10 had normal angle configurations as determined
by prior full ophthalmic examination, including slit-lamp
biomicroscopy and gonioscopy. In all cases, OCT provided
high-resolution information regarding iris configuration. The
ACA itself was clearly visualized in patients with narrow or
closed angles, but not in patients with open angles. The
authors concluded that the Stratus OCT offers a non-contact,
convenient and rapid method for assessing the configuration of
the anterior chamber. Despite its limitations, it may be of help
during the routine clinical assessment and treatment of
patients with glaucoma, particularly when gonioscopy is not
possible or difficult to interpret.

In a population-based, cross-sectional study, Zhao and
associates (2007) compared the measurement of the central
corneal thickness (CCT) by Visante OCT with ultrasound
pachymetry (USP). Subjects were part of a study of 3,280
Malay subjects aged 40 to 80 years. Ultrasound pachymetry of
CCT was performed on all participants and approximately 10 %
underwent further evaluation with AS-OCT. A total of 285
subjects were included, with a mean age of 57.9 (+/- 10.8)
years. Central corneal thickness as measured by USP was highly
correlated with the equivalent AS-OCT reading (the Pearson
correlation coefficient = 0.93, p < 0.001). However, Bland-Altman analysis showed that CCT as measured by USP was significantly higher by 16.5 +/− 11.7 microm (limits of agreement -6.1 to 39.1, p < 0.001). The authors concluded that CCT measured by Visante AS-OCT was highly correlated with that from USP. However, CCT readings by Visante OCT were consistently less than that of USP.

Konstantopoulos and co-workers (2007) stated that anterior segment imaging is a rapidly advancing field of ophthalmology. New imaging devices such as rotating Scheimpflug imaging (Pentacam-Scheimpflug) and AS-OCT (Visante OCT and Slit-Lamp OCT) have recently become commercially available. These new devices supplement the more established imaging tools of Orbscan scanning slit topography and ultrasound biomicroscopy. All devices promise quantitative information and qualitative imaging of the cornea and anterior chamber. They provide a quantitative angle estimation by calculating the angle between the iris surface and the posterior corneal surface. Direct angle visualization is feasible with the OCT devices and biomicroscopy; they provide images of the scleral spur, ciliary body, ciliary sulcus and even canal of Schlemm in some eyes. Pentacam-Scheimpflug can measure net corneal power, a feature especially useful for cataract patients having undergone previous corneal surgery. Anterior segment OCT can measure corneal flap depth following LASIK and anterior chamber width prior to phakic intra-ocular lens implantation. The authors noted that the advent of new imaging devices may herald the dawn of a new era for ophthalmic diagnosis.

In an observational, cross-sectional study (n = 70), Li and co-workers (2007) evaluated the agreement of CCT and para-central corneal thickness (PCCT) measurements between USP, Orbscan II, and Visante AS-OCT. Each subject underwent Orbscan II (using an acoustic equivalent correction factor of 0.89), AS-OCT, and USP examination. Bland-Altman plots were used to evaluate agreement between instruments. Main outcome measures were CCT and PCCT measurements by the 3
methods and agreement, as evaluated by 95% limits of agreement (LOA). The mean measurements of average CCT by USP, Orbscan II, and AS-OCT were 553.5 +/- 30.26 microm, 553.22 +/- 25.47 microm, and 538.79 +/- 26.22 microm, respectively. There was high correlation between instruments: USP with AS-OCT (r = 0.936, p < 0.001), USP with Orbscan II (r = 0.900, p < 0.001) for CCT measurements, and Orbscan II with AS-OCT for average para-central 2- to 5-mm measurements (r = 0.947, p < 0.001). The mean differences (and upper/lower LOA) for CCT measurements were 0.31 +/- 13.34 microm (26.44/-25.83) between USP and Orbscan II, 14.74 +/- 10.84 microm (36.0/-6.51) between USP and AS-OCT, and 14.44 +/- 9.14 microm (32.36/-3.48) between Orbscan II and AS-OCT. The average mean difference (and upper/lower LOA) between Orbscan II and AS-OCT for PCCT 2- to 5-mm corneal thickness measurements was 10.35 +/- 8.67 microm (27.35/-6.65). The authors concluded that AS-OCT under-estimated corneal thickness compared with that measured with USP. Anterior segment-OCT had better agreement with the gold standard USP, as compared with Orbscan II. However, important discrepancies among instruments exist. These researchers stated that clinicians should be aware that measurements of CCT are influenced by the method of measurement and that, although highly correlated, these instruments should not be used interchangeably for the assessment of corneal thickness.

Ho et al (2007) compared corneal thickness assessment using 4 measurement methods in eyes after LASIK for myopia. A total of 52 consecutive patients (103 eyes) who had LASIK for the correction of myopia had Orbscan II, Visante, Pentacam, and USP 6 months after surgery. Data were analyzed using the paired sample t test, Bland-Altman plots, and linear regression. The mean post-operative corneal thickness measurements by USP, Orbscan (0.89 acoustic factor), Pentacam, and Visante were 438.2 microm +/- 41.18, 435.17 +/- 49.63 microm, 430.66 +/- 40.23 microm, and 426.56 +/- 41.6 microm, respectively. Compared with the USP, Pentacam and Visante measurements significantly under-estimated corneal thickness by a mean of
7.54 +/- 15.06 microm (p < 0.01) and 11.64 +/- 12.87 microm (p < 0.01), respectively. There was no statistically significant difference between USP and Orbscan measurements. The authors concluded that Pentacam and Visante measurements of corneal thickness 6 months after LASIK were significantly less than those obtained using Orbscan and USP, although all 4 measurement methods showed a high correlation with each other.

Radhakrishnan et al (2007) evaluated the reproducibility of ACA measurements obtained using AS-OCT. Patients with suspected glaucoma and those with glaucoma, ocular hypertension, or anatomically narrow angles were recruited for this study. All subjects underwent imaging of the nasal, temporal, and inferior ACA with an AS-OCT prototype under standardized dark and light conditions. For short-term reproducibility analysis, a single observer acquired 2 sets of images followed by a 3rd set of images acquired by a 2nd observer. The interval between sessions was 10 minutes. For long-term reproducibility analysis, a single observer acquired two sets of images at least 24 hours apart. Images were measured using custom software to determine the anterior chamber depth (ACD), angle opening distance at 500 microm (AOD(500)), angle recess area at 500 microm (ARA(500)), and trabecular-iris space area at 500 microm (TISA(500)). The intra-class correlation coefficient (ICC) was calculated as a measure of intra-observer and inter-observer reproducibility. Twenty eyes of 20 patients were analyzed for short-term reproducibility, and 23 eyes of 23 patients were analyzed for long-term reproducibility. Anterior chamber depth measurement demonstrated excellent reproducibility (ICC 0.93 to 1.00) in both dark and light conditions. For the nasal and temporal quadrants, all ACA parameters demonstrated good to excellent short-term (ICC 0.67 to 0.90) and long-term (ICC 0.56 to 0.93) reproducibility in both dark and light conditions. In the inferior quadrant, reproducibility was lower in all categories of analysis and varied from poor to good (ICC 0.31 to 0.73). The authors concluded that AS-OCT allows quantitative assessment of the ACA. The reproducibility of ACA measurements was good to excellent for
the nasal and temporal quadrants. The lower reproducibility of measurements in the inferior quadrant may be unique to this prototype due to difficulty in acquiring high-quality images of the inferior angle. These researchers noted that further assessment of the commercially available AS-OCT is needed to clarify this finding.

The American Optometric Association's guideline on care of the patient with open angle glaucoma (2002) recommended biomicroscopy for the evaluation of anterior and posterior segment ocular structures. Furthermore, the American Academy of Ophthalmology's guidelines on primary open-angle glaucoma as well as primary open angle glaucoma suspect (2005a, 2005b) did not discuss the use of AS-OCT, especially in the physical examination of the anterior segment as well as measurement of CCT.

Anterior segment OCT is also being investigated for other indications such as imaging of trabeculectomy blebs (Singh et al, 2007), diagnosis and management of capsular block syndrome (Lau et al, 2007), diagnosis of residual Descemet's membrane after Descemet's stripping endothelial keratoplasty (Kymionis et al, 2007), as well as visualization of aqueous shunt position and patency (Sarodia et al, 2007). However, there is currently insufficient evidence to support its use for these indications.

Nolan (2008) described the 2 main anterior segment imaging modalities and summarized their applications, strengths and weaknesses. Ultrasound biomicroscopy and more recently AS-OCT are imaging modalities that can be used to obtain 2-D images of the angle and surrounding structures. Ultrasound biomicroscopy has the advantage of being able to illustrate the ciliary body and therefore give clinicians information on non-pupil block mechanisms of primary angle closure and also diagnose other abnormalities such as cyclodialysis clefts. Moreover, AS-OCT is a non-contact and rapid method of imaging the angle and anterior segment that has great potential in the diagnosis and follow-up of patients with angle closure.
The author concluded that rapid advances in anterior segment imaging are enlightening clinicians and researchers to the importance in making the diagnosis of primary angle closure, trying to establish underlying causal mechanisms, and evaluating treatments. Although they do not replace conventional angle and anterior segment examination, they hold great potential for the future.

Pekmezci and colleagues (2009) noted that AS-OCT is an alternative method for the assessment of angle width. These investigators evaluated the accuracy of AS-OCT for detecting occludable angles and compared the results of high- and low-resolution images with gonioscopy. Visante AS-OCT (Carl Zeiss Meditec, Dublin, CA) images of 303 eyes (155 patients) presenting between February 1 and July 15, 2007, were retrospectively analyzed. Angle recess area (ARA) and angle opening distances (AOD) at 250, 500, and 750 micron were measured and correlated with the corresponding gonioscopic measurements. Anterior segment OCT parameters showed a non-linear relationship with gonioscopy, ARA having the highest correlation. Correlations between high- and low-resolution images were modest. Cut-off values were 0.180 mm² (70.3 % sensitivity, 87.4 % specificity) for ARA and 0.264 mm (71.8 % sensitivity, 84.8 % specificity) for AOD at 500 micron. The authors concluded that AS-OCT appears to be a promising screening tool for narrow angles.

In a prospective, observational case series study, Pavlin and colleagues (2009) assessed the utility of AS-OCT in the imaging of anterior segment tumors and compared the images to ultrasound biomicroscopy (UBM). A total of 18 eyes (18 patients) with anterior segment tumors were evaluated at Princess Margaret Hospital. The evaluation included clinical examination, clinical photography, AS-OCT, and UBM. Comparison of images obtained by both methods was done. Anterior segment-OCT imaged small hypo-pigmented tumors with complete penetration. Cysts were incompletely imaged behind the iris pigment epithelium. Highly pigmented tumors, large tumors, and ciliary body tumors were incompletely
penetrated. Even without complete penetration, it was possible to differentiate cystic lesions from solid lesions. Ultrasound biomicroscopy penetrated all tumors completely. The authors concluded that AS-OCT can penetrate small hypopigmented tumors and supply some information on internal characteristics of other tumors. However, UBM is preferable for clinical anterior tumor assessment and follow-up because of its superior ability to penetrate large tumors, highly pigmented tumors, and ciliary body tumors.

In a cross-sectional study, Mansouri and colleagues (2010) compared the accuracy in measurement of the anterior chamber (AC) angle by AS-OCT and UBM in European patients with suspected primary angle closure (PACS), primary angle closure (PAC), or primary angle-closure glaucoma (PACG). In all, 55 eyes of 33 consecutive patients presenting with PACS, PAC, or PACG were examined with AS-OCT, followed by UBM. The trabecular-iris angle (TIA) was measured in all 4 quadrants. The AOD was measured at 500 mum from the scleral spur. The Bland-Altman method was used for assessing agreement between the 2 methods. The mean (+/- SD) superior TIA was 19.3 +/- 15.8 degrees in AS-OCT and 15.7 +/- 15.0 degrees in UBM (p = 0.50) and inferior TIA was 17.9 +/- 12.9 degrees (AS-OCT) and 16.7 +/- 14.1 degrees (UBM) (p = 0.71). The superior AOD(500) was 0.17 +/- 0.16 mm in UBM and 0.21 +/- 0.16 mm in AS-OCT (p = 0.06). Bland-Altman analysis showed a mean SD of +/- 9.4 degrees for superior and inferior TIA and a mean SD of +/- 0.10 mm for superior and inferior AOD(500). This comparative study showed that AS-OCT measurements are significantly correlated with UBM measurements but show poor agreement with each other. The authors do not believe that AS-OCT can replace UBM for the quantitative assessment of the AC angle.

The American Academy of Ophthalmology's preferred practice patterns of primary angle closure (AAO, 2010) stated that there is good evidence showing general agreement between findings on gonioscopy and anterior segment imaging, including UBM and AS-OCT. The AAO noted that these technologies may prove
useful in evaluating for secondary causes of angle closure and to elucidate plateau iris.

In a population-based, cross-sectional study, Foo and colleagues (2012) investigated determinants of angle width and derive mathematic models to best predict angle width. A total of 1,067 Chinese subjects aged greater than or equal to 40 years were included in this study. Participants underwent gonioscopy, A-scan biometry, and imaging by AS-OCT (Carl Zeiss Meditec, Dublin, CA). Customized software (Zhongshan Angle Assessment Program, Guangzhou, China) was used to measure AS-OCT parameters. Linear regression modeling was performed with trabecular-iris space area at 750 μm (TISA750) and angle opening distance at 750 μm (AOD750) from the scleral spur as the 2 dependent angle width variables. By using a combination of AS-OCT and biometric parameters, an optimal model that was predictive of angle width was determined by a forward selection regression algorithm. Validation of the results was performed in a separate set of community-based clinic study of 1,293 persons aged greater than or equal to 50 years. Main outcome measures were angle width and biometric parameters. The mean age (standard deviation) of the population-based subjects was 56.9 (8.5) years; and 50.2 % were male. For TISA750, the strongest determinants among AS-OCT and A-scan independent variables were anterior chamber volume (ACV, R(2) = 0.51), followed by anterior chamber area (ACA, R(2) = 0.49) and lens vault (LV, R(2) = 0.47); for AOD750, these were LV (R(2) = 0.56), ACA (R(2) = 0.55), and ACV (R(2) = 0.54). The R(2) values for anterior chamber depth and axial length were 0.39 and 0.27 for TISA750, respectively, and 0.46 and 0.30 for AOD750, respectively. An optimal model consisting of 6 variables (ACV, ACA, LV, anterior chamber width [ACW], iris thickness at 750 μm, and iris area) explained 81.4 % of the variability in TISA750 and 85.5 % of the variability in AOD750. The results of the population-based study were validated in the community-based clinic study, where the strongest determinants of angle width (ACA, ACV, and LV) and the optimal model with 6 variables were similar. The authors concluded that angle width is largely dependent on variations
in ACA, ACV, and LV. They stated that a predictive model comprising 6 quantitative AS-OCT parameters explained more than 80% of the variability of angle width and may have implications for screening for angle closure.

Nguyen and Chopra (2013) stated that the rapid emergence and widespread adoption of OCT has spurred the development of many ophthalmic applications. Spectral domain OCT provides high-resolution in-vivo images of both anterior and posterior segments of the eye. Innovations in AS-OCT aim to improve refractive accuracy and reduce surgical risks. These investigators reviewed the utility of AS-OCT in cataract surgery for pre-operative assessment, intra-operative assistance, and post-operative management to improve surgical outcomes. Recent advances in AS-OCT for pre-operative planning include characterization of dry eye and ocular surface conditions, calculation of intra-ocular lens (IOL) power, delineation of anterior chamber structures, and assessment of risk factors for post-operative complications. Successful intra-operative use of AS-OCT has been described for in-vivo assessment of clear cornea wound architecture and OCT-guided femtosecond laser-assisted cataract surgery. The essential roles of OCT in managing post-operative complications include characterization of maculopathy or corneal wound integrity, assessment of IOL stability or optical changes, and evaluation of laser-assisted in situ keratomileusis flaps after cataract surgery. The authors concluded that in its rapidly evolving state, the utility of OCT in cataract surgery continues to broaden with applications from pre-operative planning, intra-operative image-based treatments, and post-operative care. They advocate the judicious use of OCT, wherever clinically indicated, because routine use may not be clinically necessary or economically feasible for each stage of cataract evaluation and management.

In a cross-sectional study, Nongpiur et al (2013) identified subgroups of PACS based on AS-OCT and biometric parameters. These investigators evaluated 243 PACS subjects in the primary group and 165 subjects in the validation group. Participants underwent gonioscopy and AS-OCT. Customized software was
used to measure AS-OCT parameters. An agglomerative hierarchical clustering method was first used to determine the optimum number of parameters to be included in the determination of subgroups. The best number of subgroups was then determined using Akaike Information Criterion (AIC) and Gaussian Mixture Model (GMM) methods. Main outcome measures were subgroups of PACS. The mean age of the subjects was 64.8 years, and 65.02% were female. After hierarchical clustering, 1 or 2 parameters from each cluster were chosen to ensure representativeness of the parameters and yet keep a minimum of redundancy. The parameters included were iris area, anterior chamber depth (ACD), ACW, and LV. With the use of GMM, the optimal number of subgroups as given by AIC was 3. Subgroup 1 was characterized by a large iris area, subgroup 2 was characterized by a large LV and a shallow ACD, and subgroup 3 was characterized by elements of both subgroups 1 and 2. The results were replicated in a second independent group of 165 PACS subjects. The authors concluded that clustering analysis identified 3 distinct subgroups of PACS subjects based on AS-OCT and biometric parameters. These findings may be relevant for understanding angle-closure pathogenesis and management.

Benitez-Herreros et al (2014) compared AS-OCT, direct visualization, and ultrasound biomicroscopy (UBM) for detecting conjunctival blebs in sutureless sclerotomies after vitrectomy. Conjunctival blebs are formed by sclerotomy leakage due to incompetent closure. Experimental, randomized, and observer-masked study in which 23-gauge vitrectomies were performed in cadaveric pig eyes were used in this analysis. Post-operative conjunctival blebs were assessed by UBM, AS-OCT, and direct visualization. No conjunctival blebs were classified as Grade 0 (G0), thin blebs (less than or equal to 50 % of scleral thickness) as Grade 1 (G1) and thick blebs (greater than 50 % of scleral thickness) as Grade 2 (G2). A total of 50 pig eyes were included in this study. Conjunctival blebs were found in 13.3 % (8 % G1, 5.3 % G2) of the incisions analyzed by UBM, in 20 % (14.7 % G1, 5.3 % G2) of the sclerotomies studied by AS-OCT, and in 7.3 % (2 % G1, 5.3 % G2)
of the wounds evaluated by direct visualization. Anterior segment-OCT was the most sensitive method for identifying conjunctival blebs when compared with UBM and direct visualization (p < 0.001). In turn, UBM was better than direct visualization for observing sclerotomy blebs (p = 0.004). The authors concluded that AS-OCT is the most sensitive technique for detecting subclinical blebs (G1) and thus, it may be useful in research for studying the influence that surgical factors and maneuvers may exert on sclerotomy closure capacity after vitrectomy. Moreover, they stated that direct visualization, that is used in routine clinical practice to determine which sclerotomies should be sutured, is useful only to identify thick blebs (G2) after vitrectomy.

Chen and colleagues (2013) compared the differences in the ACD measured by AS-OCT and UBM. All studies pertaining to ACD measured by AS-OCT and UBM were collected from online databases. The assessment of methodological quality and data extraction from the included studies were performed independently by 2 reviewers for meta-analysis. A total of 8 studies involving 710 eyes were included in the analysis. The difference of ACD measurements between AS-OCT and UBM was not statistically significant in the overall patients included for analysis (SMD = 0.19, 95% CI: 0.00 to 0.39) or in the patients with primary angle-closed glaucoma (SMD = 0.02, 95% CI: -0.04 to 0.19). The authors concluded that the ACD measurements do not differ significantly between AS-OCT and UBM. Moreover, they stated that due to the relatively small number of the included studies and the patients involved, this conclusion needs further confirmation by high-quality studies involving larger sample sizes.

On behalf of the AAO, Smith et al (2013) evaluated the published literature pertaining to the association between anterior segment imaging and gonioscopy and determined if such imaging aids in the diagnosis of PAC. Literature searches of the PubMed and Cochrane Library databases were last conducted on July 6, 2011. The searches yielded 371 unique citations. Members of the Ophthalmic Technology Assessment
Committee Glaucoma Panel reviewed the titles and abstracts of these articles and selected 134 of possible clinical significance for further review. The panel reviewed the full text of these articles and identified 79 studies meeting the inclusion criteria, for which the panel methodologist assigned a level of evidence based on a standardized grading scheme adopted by the AAO -- 3, 70, and 6 studies were rated as providing level I, II, and III evidence, respectively. Quantitative and qualitative parameters defined from UBM, AS-OCT, Scheimpflug photography, and the scanning peripheral anterior chamber depth analyzer (SPAC) demonstrated a strong association with the results of gonioscopy. There was substantial variability in the type of information obtained from each imaging method. Imaging of structures posterior to the iris is possible only with UBM. Direct imaging of the ACA was possible using UBM and OCT. The ability to acquire OCT images in a completely dark environment allowed greater sensitivity in detecting eyes with appositional angle closure. Non-contact imaging using OCT, Scheimpflug photography, or SPAC made these methods more attractive for large-scale PAC screening than contact imaging using UBM. The authors concluded that although there is evidence suggesting that anterior segment imaging provides useful information in the evaluation of PAC, none of these imaging methods provides sufficient information about the ACA anatomy to be considered a substitute for gonioscopy. Moreover, they stated that longitudinal studies are needed to validate the diagnostic significance of the parameters measured by these instruments for prospectively identifying individuals at risk for PAC.

Piotrowiak and colleagues (2014) evaluated anterior segment spectral OCT (AS-SOCT) for assessing the lens-to-cornea fit of rigid gas-permeable (RGP) lenses. The results were verified with the fluorescein pattern method, considered the criterion standard for RGP lens alignment evaluations. A total of 26 eyes of 14 patients were enrolled in the study. Initial base curve radius (BCR) of each RGP lens was determined on the basis of keratometry readings. The fluorescein pattern and AS-SOCT tomograms were evaluated, starting with an alignment fit, and subsequently, with BCR reductions in increments of 0.1 mm, up
to 3 consecutive changes; AS-SOCT examination was performed with the use of RTVue (Optovue, CA). The average BCR for alignment fits, defined according to the fluorescein pattern, was 7.8 mm (SD = 0.26). Repeatability of the measurements was 18.2%. Base curve radius reductions of 0.1, 0.2, and 0.3 mm resulted in average apical clearances detected with AS-SOCT of 12.38 (SD = 9.91, p < 0.05), 28.79 (SD = 15.39, p < 0.05), and 33.25 (SD = 10.60, p > 0.05), respectively. The authors concluded that BCR steepening of 0.1 mm or more led to measurable changes in lens-to-cornea fits. Although AS-SOCT represents a new method of assessing lens-to-cornea fit, apical clearance detection with current commercial technology showed lower sensitivity than the fluorescein pattern assessment.

Maram et al (2015) evaluated the reproducibility of ACA measurements obtained by the Zeiss Visante AS-OCT. A total of 20 eyes from 20 normal subjects with open ACAs were studied. The ACA was imaged using the Visante AS-OCT. The angle-opening distance (AOD 500, AOD 750), trabecular iris space area (TISA 500, TISA 750) and scleral spur angle (SS angle) at the inferior angle location were measured. All the subjects underwent imaging in a darkened room (1 foot candles measured at the eye). Images were graded in a masked fashion by certified Doheny Image Reading Center graders. For intra-grader reproducibility assessments, images were re-graded by the same grader 1 week later after random sorting of images. For inter-grader assessments, a 2nd masked grader independently reviewed the images. Intraclass correlation coefficients (ICC) were used to assess reproducibility. Inferior angle measurements of AOD (500, 750), TISA (500, 750) and SS angle for 20 normal eyes were calculated. The intra-observer ICC calculations showed excellent reproducibility for all measurements (AOD 500 = 0.95, AOD 750 = 0.97, TISA 500 = 0.93, TISA 750 = 0.94, SS = 0.96; p < 0.001 for all). The inter-observer ICC calculations showed lower reproducibility for all measurements (AOD 500 = 0.71, p < 0.001; AOD 750 = 0.82, p < 0.001; TISA 500 = 0.49, p = 0.08; TISA 750 = 0.61, p = 0.02; SS = 0.75). The authors concluded that determination of ACA
measurements was possible with the time-domain AS-OCT, but only modest inter-observer reproducibility was found even among experienced graders.

In a single-center, prospective clinical study, Yamazaki et al (2014) investigated in-vivo corneal changes of radial keratoneuritis in early-stage acanthamoeba keratitis (AK) using AS-OCT. A total of 4 eyes (4 patients with a mean age of 28.5 years) with early-stage AK showing radial keratoneuritis were included in this study. Definitive diagnosis was made by confirmation of AK cysts using in-vivo confocal microscopy and culture. Anterior-segment OCT examination was performed on the initial visit and at follow-up visits paying special attention to radial keratoneuritis. Selected AS-OCT images of the cornea were evaluated qualitatively for the shape and degree of light reflection of abnormal neurons. With the use of AS-OCT, these researchers successfully obtained high-resolution images of putative radial keratoneuritis in all patients as highly reflective bands or lines in the corneal stroma. The depth and width of the highly reflective bands/lines varied from case to case (anterior stroma to mid-stroma, from 20 to 200 μm). Some lines ran obliquely from the deep peripheral stroma toward the anterior stroma, and some were located at different depths (subepithelial and mid-stroma) and ran relatively parallel to the corneal layers. After appropriate treatment, radial keratoneuritis was resolved by both slit-lamp biomicroscopy and AS-OCT in all patients. The authors concluded that high-resolution Fourier-domain AS-OCT provides novel and detailed visual information of radial keratoneuritis in patients with early-stage AK. They stated that visualization of radial keratoneuritis by AS-OCT may be a useful adjunct to the diagnosis and follow-up of early-stage AK.

In a prospective, single-center, consecutive case-series study, Ehlers et al (2014) evaluated the feasibility, safety, and utility of intra-operative OCT for use during ophthalmic surgery. Intra-operative scanning was performed with a microscope-mounted spectral-domain OCT system. Disease-specific or procedure-specific imaging protocols (e.g., scan type, pattern, size,
orientation, density) were used for anterior and posterior segment applications. A surgeon feedback form was recorded as part of the study protocol to answer specific questions regarding intra-operative OCT utility immediately after the surgical procedure was completed. During the first 24 months of the PIONEER study, 531 eyes were enrolled (275 anterior segment cases and 256 posterior segment surgical cases). Intra-operative OCT imaging was obtained in 518 of 531 eyes (98 %). Surgeon feedback indicated that intra-operative OCT informed surgical decision-making and altered surgeon understanding of underlying tissue configurations in 69 of 144 lamellar keratoplasty cases (48 %) and 63 of 146 membrane peeling procedures (43 %). The most common anterior segment surgical procedure was Descemet stripping automated endothelial keratoplasty (DSAEK, n = 135). Vitrectomy with membrane peeling was the most common procedure for posterior segment surgery (n = 154). The median time that surgery was paused to perform intra-operative OCT was 4.9 minutes per scan session. No adverse events were specifically attributed to intra-operative OCT scanning during the procedure. The authors concluded that intra-operative OCT is feasible for numerous anterior and posterior segment ophthalmic surgical procedures. A microscope-mounted intra-operative OCT system provided efficient imaging during operative procedures. The information gained from intra-operative OCT may impact surgical decision-making in a high frequency of both anterior and posterior segment cases. The clinical value of intra-operative OCT for both anterior and posterior segment ophthalmic surgical procedures has yet to be determined.

Li and associates (2015) performed AS-OCT imaging of eyelids, tear meniscus, cornea and conjunctiva in subsequent sessions on a patient who has ocular graft versus-host disease (GVHD) after allogeneic related donor stem cell transplant. The OCT results were presented together with those from a normal subject. Optical coherence tomography imaging is promising in visualizing several ocular GVHD manifestations, such as abnormal meibomian gland orifice (MGO), conjunctival
keratinization, conjunctival hyperemia and chemosis, corneal epithelium opacification, thinning and sloughing. The authors concluded that this case study demonstrated the capability of AS-OCT in the imaging and monitoring of ocular GVHD, which may be useful in the development of current ocular GVHD staging system and the clinical management for GVHD treatment.

In a cross-sectional, observational study, Ang and colleagues (2015) evaluated the application of an OCT angiography (OCTA) system adapted for the assessment of anterior segment vasculature. Consecutive subjects with normal eyes on slit-lamp clinical examination and patients with abnormal corneal neovascularization were included in this study. All scans were performed using a commercially available AngioVue OCTA system (Optovue, Inc., Fremont, CA) using an anterior segment lens adapter and the split-spectrum amplitude decorrelation angiography algorithm. Each subject underwent scans from 4 quadrants (superior, inferior, nasal, and temporal) in each eye by 2 trained, independent operators. Analysis of signal strength, image quality, and reproducibility of corneal vascular measurements were performed. In this study of 20 normal subjects (10 men, 10 women; mean age of 25.3 ± 7.8 years), these researchers found good repeatability (κ coefficient, 0.76) for image quality score and good inter-observer agreement for vasculature measurements (intra-class coefficient, 0.94). After optimization of the angiography scan protocol, vascular measurements within the regions of interest were compared in the superior versus inferior quadrants (mean vascular loops of 3.34 ± 1.16 versus 3.12 ± 0.90 [p = 0.768]; segment-to-loop ratio of 4.18 ± 0.71 versus 4.32 ± 0.87 [p = 0.129]; fractal dimension [Df] value of 1.78 ± 0.06 versus 1.78 ± 0.06 [p = 0.94]; vascular loop area, 25.9 ± 14.5 versus 25.9 ± 10.7 × 10^{-3} mm^2 [p = 0.21]) and nasal versus temporal quadrant (mean vascular loops of 2.89 ± 0.98 versus 3.57 ± 0.99 [p < 0.001]; segment-to-loop ratio of 3.94 ± 0.69 versus 4.55 ± 0.78 [p = 0.897]; Df value of 1.78 ± 0.06 versus 1.77 ± 0.06 [p = 0.14]; vascular loop area of 29.7 ± 15.7 versus 22.1 ± 7.1 × 10^{-3} mm^2 [p = 0.38]. These investigators then used the established OCTA
scanning protocol to visualize abnormal vasculature successfully in 5 patients with various corneal pathologic features, including graft associated neovascularization, post-herpetic keratitis scarring, lipid keratopathy, and limbal stem cell deficiency. The authors concluded that this preliminary study described a method for acquiring OCTA images of the cornea and limbal vasculature with substantial consistency. They stated that this technique may be useful for the objective evaluation of corneal neovascularization in the future.

In a prospective, observational study, Kojima et al (2015) evaluated time-dependent post-trabeculectomy changes in filtering bleb parameters using 3-D AS-OCT. Patients with open-angle glaucoma who underwent uncombined fornix-based trabeculectomy between January 1, 2012, and October 31, 2012, were included. A total of 29 eyes were enrolled, 23 of which were followed-up for 1 year without additional glaucoma surgical procedures; 3 required additional glaucoma surgery. The primary end-points were changes in bleb parameters including the position and width of the filtration openings on the scleral flap, the total bleb height, fluid-filled cavity height, bleb wall thickness, and bleb wall intensity, which were measured using 3-D AS-OCT. The secondary end-points were post-surgical intra-ocular pressure (IOP) measured 0.5, 3, 6, and 12 months after trabeculectomy, and the effects of aqueous cytokine levels on the bleb parameters. These researchers observed increased total bleb height (0.82 to 1.25 mm; difference: 95 % CI: 0.10 to 0.75; p = 0.01), bleb wall thickness (0.46 to 0.61 mm; difference: 95 % CI: 0.02 to 0.28; p = 0.03), and distance from the top of the scleral flap to the filtration opening (1.69 to 2.16 mm; difference: 95 % CI: 0.28 to 0.70; p < 0.001), as well as decreased width of the filtration opening (2.08 to 1.12 mm; difference: 95 % CI: -1.75 to -0.49; p = 0.002) between 0.5 and 12 months post-trabeculectomy. The filtration openings tended to close from the fornix side of the scleral flap during the wound healing process. Moreover, the width of the filtration opening at 0.5 months post-trabeculectomy correlated with the IOP at 12 months (p = 0.02). The aqueous humor level of monocyte chemo-attractant
protein-1 was correlated with the width of the filtration opening at 3 and 6 months post-trabeculectomy. The authors concluded that the width of the filtration opening at 0.5 months post-trabeculectomy correlated with the IOP at 12 months. The width of the filtration opening at the early stage may be a prognostic factor for long-term IOP control. They stated that large-scale studies with longer follow-up periods are needed.

An UpToDate review on “Angle-closure glaucoma” (Weizer, 2015) states that “Gonioscopy is the gold-standard method of diagnosing angle-closure .... High definition anterior segment optical coherence tomography is being used as a modality to image the drainage angle and detect eyes at risk for angle-closure. Findings suggest that eyes prone to developing angle-closure do not merely differ anatomically from normal eyes, but may also respond differently to light stimuli”.

Ehlers et al (2015a) assessed the feasibility and effect on surgical decision making of a microscope-integrated intraoperative OCT (iOCT) system. This report highlighted the 1-year results (March 2014 to February 2015) of the RESCAN 700 portion of the DISCOVER (Determination of Feasibility of Intraoperative Spectral Domain Microscope Combined/Integrated OCT Visualization During En Face Retinal and Ophthalmic Surgery) study, a regarding this investigational device. Participants included patients undergoing ophthalmic surgery. Data on clinical characteristics were collected, and iOCT was performed during surgical milestones, as directed by the operating surgeon. A surgeon questionnaire was issued to each surgeon and was completed after each case to evaluate the role of iOCT during surgery and its particular role in select surgical procedures. Main outcome measures included percentage of cases with successful acquisition of iOCT (i.e., feasibility) and percentage of cases in which iOCT altered surgical decision making (i.e., utility). During year 1 of the DISCOVER study, a total of 227 eyes (91 anterior segment cases and 136 posterior segment cases) underwent imaging with the RESCAN 700 system. Successful imaging (e.g., the ability to acquire an OCT
image of the tissue of interest) was obtained for 224 of 227 eyes (99% [95% CI: 98% to 100%]). During lamellar keratoplasty, the iOCT data provided information that altered the surgeon's decision making in 38% of the cases (e.g., complete graft apposition when the surgeon believed there was interface fluid). In membrane peeling procedures, iOCT information was discordant with the surgeon's impression of membrane peel completeness in 19% of cases (e.g., lack of residual membrane or presence of occult membrane), thus affecting additional surgical maneuvers. The authors concluded that the DISCOVER study demonstrated the feasibility of real-time iOCT with a microscope-integrated iOCT system for ophthalmic surgery. The information gained from iOCT appeared to allow surgeons to assess subtle details in a unique perspective from standard en face visualization, which can affect surgical decision making some of the time, although the effect of these changes in decision-making on outcomes remains unknown. They stated that a prospective randomized masked trial is needed to confirm these results.

Ehlers et al (2015b) evaluated the feasibility and utility of iOCT during pars plana vitrectomy surgery for dense vitreous hemorrhage. The Prospective Assessment of Intraoperative and Perioperative OCT for Ophthalmic Surgery study examined the utility of iOCT in ophthalmic surgery. Intra-operative scanning was performed with a microscope-mounted spectral domain OCT system. This report was a case-series study of those eyes undergoing pars plana vitrectomy for dense central vitreous hemorrhage that precluded pre-operative OCT assessment. Intra-operative OCT images were qualitatively evaluated for retinal abnormalities that might impact intra-operative or perioperative management. Clinical variables were collected and assessed. Surgeon assessment of iOCT utility was also evaluated. A total of 23 eyes were identified and included. The etiology for the vitreous hemorrhage was proliferative diabetic retinopathy (19 eyes, 82.6%), horseshoe retinal tear (1 eye, 4.3%), retinal vein occlusion with neovascularization (1 eye, 4.3%), presumed polypoid choroidal vasculopathy (1 eye, 4.3%), and presumed retinal arterial macro-aneurysm (1 eye, 4.3%). Intra-
operative OCT revealed epi-retinal membrane (14 eyes, 60.9 %), macular edema (14 eyes, 60.9 %), posterior hyaloid traction (1 eye, 4.3 %), and retinal detachment (1 eye, 4.3 %). Surgeon feedback suggested that iOCT impacted surgical decision-making in eyes where membrane peeling was performed. The authors concluded that iOCT during pars plana vitrectomy for vitreous hemorrhage may provide physicians with clinically relevant information that may impact surgical management, peri-operative management, and patient outcomes. The clinical value of intra-operative OCT during pars plana vitrectomy has to be ascertained in well-designed studies.

Assessment of Haab Striae:

Spierer et al (2015) presented a case series demonstrating the AS-OCT findings of Haab striae in 3 patients with congenital glaucoma. The authors stated that the use of AS-OCT in the assessment of Haab striae in pediatric glaucoma is novel, previously undescribed, and possibly allows differentiation between acute and chronic corneal changes. These preliminary findings need to be further evaluated in well-designed studies.

Detection of Glaucoma:

In a prospective case-series study, Qian and colleagues (2015) evaluated the role of AS-OCT as a standardized method of imaging Boston type I keratoprosthesis (KPro) after surgery, particularly in the visualization of iris and angle structures. A total of 20 patients who underwent KPro implantation in 1 eye were included in this study. Patients underwent AS-OCT imaging before surgery. After KPro implantation, patients were imaged using the AS single, dual, and quad scans to obtain transverse images of the eye every 15° over 360°. High-resolution, corneal quad, and anterior chamber scans were also obtained. This imaging protocol allowed juxtaposition and comparison of the same imaging coordinates obtained before surgery and 3, 6, and 12 months after surgery. Main outcome measures included post-operative visual acuity (VA), glaucoma progression on clinical examination and formal
visual field testing, and anatomic angle changes on AS-OCT defined by angle closure, peripheral anterior synechiae (PAS), iris-KPro backplate touch, and graft host interface changes over time. Mean follow-up was 18.8 ± 3.2 months. The average pre-operative VA was 1.9 ± 0.5 logarithm of the minimum angle of resolution. After surgery, VA improved to 1.0 ± 0.9 at last follow-up (p = 0.002); 14 of 20 patients had glaucoma before surgery. After surgery, 5 of these patients deteriorated clinically and 1 de-novo diagnosis of glaucoma was made. On OCT, the average total degrees of angle closure for all patients increased from 158.5 ± 158.9° before surgery to 205.4 ± 154.0° after surgery (p = 0.04). The number of eyes with 360° of PAS increased from 6 of 20 before surgery to 9 of 20 after surgery. Iris-backplate touch was demonstrated in 5 of 20 patients, with an average area of involvement of 24.2 ± 36.2°. Overall, of the 12 of 20 patients with clear signs of anatomic angle narrowing and synechiae progression on imaging, 3 had glaucoma deterioration detected by clinical examination. In the other 9 patients, angle changes on OCT were not accompanied by any detectable clinical signs of glaucomatous deterioration. The authors concluded that AS-OCT can be used to observe anatomic changes after KPro implantation that cannot be detected otherwise. However, they were unable to demonstrate a correlation between anatomic features and clinical progression. The major drawbacks of this study were its small sample size and technical limitations.

**Evaluation of Anterior Segment Parameters of Hyperopia:**

Wang et al (2015) examined the feasibility of AS-OCT in evaluating the anterior segment morphology of hyperopia in school-aged children. A total of 320 eyes of 160 school-aged children aged 6 to 12 years were examined with AS-OCT and were divided into 4 groups according to the cycloplegic spherical equivalence of refractive error. The mentioned 4 groups were: (i) emmetropia group, (ii) low hyperopia group, (iii) moderate hyperopia group, and (iv) high hyperopia group. The measurements of central corneal thickness, anterior chamber depth, angle opening distance, trabecular iris space
area and scleral angle were compared in pairs among objects in the 4 groups. The results showed that high hyperopia and moderate hyperopia had shallower anterior chamber depth and narrower anterior chamber angle compared to those in emmetropia group. The authors concluded that the findings of this study showed that AS-OCT is a non-contact technology that could become a new technology for accessing the anterior segment morphology of hyperopia in school-aged children.

Evaluation of Blebs After Filtering Surgery:

In a pilot study, Meziani et al (2016) compared characteristics of functioning blebs (FBs) and non-functioning blebs (NFBs) with en-face spectral-domain OCT. These researchers evaluated 41 blebs of 38 patients after a first-time trabeculectomy. Eyes were classified into 2 groups: (i) FBs (22 eyes) and (ii) NFBs (19 eyes). En-face OCT images were analyzed semi-quantitatively for the density of intra-epithelial microcysts (0 to 3), internal fluid-filled cavity (0 to 3), and bleb vascularization (0 to 2). Presence of conjunctival fibrosis and visualization of the scleral flap were also analyzed. Functioning blebs showed significantly more intra-epithelial microcysts than did NFBs: the mean grading of microcyst density was 1.86 for FBs and 0.11 for NFBs (p < 0.0001). None of the FBs was rated 0 and none of the NFBs was rated 2 or 3 for the density of intra-epithelial microcysts. Non-functioning blebs presented more conjunctival fibrosis than FBs (63 % versus 32 %, p < 0.05). There was no significant difference between FBs and NFBs for bleb vascularization, visualization of the scleral flap, and presence of sub-epithelial fluid-filled cavities. There was a direct correlation between post-operative intra-ocular pressure (IOP) and intra-epithelial microcyst density (r = -0.7655, p < 0.0001). The long-term administration of preserved eye-drops before surgery was associated with fewer intra-epithelial microcysts (r = -0.5436; p = 0.0006). The authors concluded that FBs were associated with a higher number of intra-epithelial microcysts evaluated with en-face OCT. A higher density of microcysts was associated with a lower IOP and a shorter duration of preserved topical treatment before surgery. They stated that en-face OCT
provided a simple, non-invasive, and reproducible method to analyze blebs after filtering surgery. The findings of this pilot study need to be validated by well-designed studies.

Identification of Fungal Infections with Endophthalmitis after Cataract Surgery:

In a case-reports study, Kitahata and associates (2016) reported the use of AS-OCT for characterization of late-onset tunnel fungal infections with endophthalmitis after cataract surgery. A 77-year old female (case 1) and a 76-year old male (case 2) who received cataract surgery 15 and 1 year before their initial visits, respectively, were treated with topical steroids based on a diagnosis of uveitis, because they showed growing white lesions on the upper iris and beneath the cataract scleral wound. Irrigation of the anterior chambers and removal of the white lesions were performed in each case, and microbiological tests were positive for fungi (case 1, a positive culture of Fusarium sp.; case 2, a filamentous fungus present in a direct smear) in the white lesions. Both cases were diagnosed as late-onset fungal endophthalmitis after cataract surgery and were treated with topical and systemic anti-fungal agents. However, the white lesions re-appeared, and the inflammation in the anterior chambers worsened. Anterior segment optical coherence tomography showed the spread of the white lesions into the scleral incisions from cataract surgery. De-roofing of the tunnel and sclera-corneal patch grafts were performed in both cases to treat the fungal tunnel infections. After these treatments, inflammation of both corneas and anterior chambers subsided. The authors concluded that AS-OCT can be used to identify late-onset fungal tunnel infections with endophthalmitis after cataract surgery. These preliminary findings need to be validated by well-designed studies.

Imaging of Extra-Ocular Rectus Muscle Insertions for Pre-Operative Planning:

Pihlblad and co-workers (2016) evaluated the possibility of determining the insertion distance from the limbus of
horizontal and vertical extra-ocular rectus muscles with AS-OCT. The right eyes of 46 patients underwent AS-OCT. The horizontal and vertical extra-ocular rectus muscle insertion distances from the limbus were measured in a masked fashion by 2 pediatric ophthalmologists. A total of 42 lateral rectus, 43 medial rectus, 35 inferior rectus, and 40 superior rectus muscles of the right eyes of 46 patients were included. Insertion to limbus measurements (mean ± SD) were as follows: lateral rectus = mean 6.8 ± 0.7 mm, range = 4.8 to 8.4 mm; medial rectus = mean 5.7 ± 0.8 mm, range = 4.3 to 7.8 mm; inferior rectus = mean 6.0 ± 0.6 mm, range = 4.8 to 7.0 mm; superior rectus = mean 6.8 ± 0.6 mm, range = 5.5 to 8.1 mm. The intra-observer and inter-observer correlation coefficients for the insertion to limbus measurements of all 4 rectus muscles exceeded 0.75 (excellent correlation). The authors concluded that the findings of this study showed that AS-OCT is capable of imaging all 4 of the rectus muscle insertions and measuring the insertion to limbus distance, and this study was the second AS-OCT study to image the superior and inferior rectus muscle insertions. They stated that the insertion to limbus measurements between examiners and on repeat measurements were consistent and reproducible; and the ability to accurately image extra-ocular rectus muscle insertions may have future implications for the pre-operative procedure planning in patients who have had previous surgery.

In summary, available evidence for AS-OCT is primarily comparison studies between this imaging tool and established methods for measuring anterior segment ocular structures. Currently, there are no data that demonstrate improved outcomes using this technology. Thus, AS-OCT is a promising technology; but its clinical value remains to be ascertained by well-designed studies that show improved outcomes.
ICD-10 codes will become effective as of October 1, 2015:

CPT codes not covered for indications listed in the CPB:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>92132</td>
<td>Scanning computerized ophthalmic diagnostic imaging, anterior segment, with interpretation and report, unilateral or bilateral</td>
</tr>
</tbody>
</table>

The above policy is based on the following references:


17. Kymionis GD, Suh LH, Dubovy SR, Yoo SH. Diagnosis of


26. Mansouri K, Sommerhalder J, Shaarawy T. Prospective comparison of ultrasound biomicroscopy and anterior segment optical coherence tomography for evaluation of anterior chamber dimensions in European eyes with


44. Weizer JS. Angle-closure glaucoma. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed July 2015.


Copyright Aetna Inc. All rights reserved. Clinical Policy Bulletins are developed by Aetna to assist in administering plan benefits and constitute neither offers of coverage nor medical advice. This Clinical Policy Bulletin contains only a partial, general description of plan or program benefits and does not constitute a contract. Aetna does not provide health care services and, therefore, cannot guarantee any results or outcomes. Participating providers are independent contractors in private practice and are neither employees nor agents of Aetna or its affiliates. Treating providers are solely responsible for medical advice and treatment of members. This Clinical Policy Bulletin may be updated and therefore is subject to change.
Amendment to
Aetna Clinical Policy Bulletin Number: 0749
Anterior Segment Scanning Computerized Ophthalmic Diagnostic Imaging

There are no amendments for Medicaid.