Anterior segment optical coherence tomography imaging in angle closure: advances in diagnosis and care

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Purpose of review
To highlight emerging applications of anterior segment optical coherence tomography (AS-OCT) in the diagnosis, risk stratification, and management of angle closure glaucoma, with particular emphasis on the integration of artificial intelligence.

Recent findings
AS-OCT enables objective and reproducible quantification of anterior chamber angle parameters, overcoming the subjective and qualitative nature of traditional gonioscopy. Recent studies also suggest that AS-OCT can better predict angle closure disease and treatment outcomes than gonioscopy. Furthermore, advances in artificial intelligence-based image analysis have achieved expert-level accuracy in detecting angle closure and related anatomical features, facilitating personalized risk stratification and treatment planning. Overall, these advancements show strong potential for broad adoption to enhance clinical care and workflows.

Summary
High-resolution AS-OCT imaging combined with artificial intelligence-driven analytics is transforming the evaluation and management of angle closure disease. This noninvasive, objective approach has the potential to augment traditional methods, paving the way for more precise, personalized, and evidence-based care. Broad clinical adoption requires further rigorous prospective validation across large and diverse patient populations.

Keywords
angle closure glaucoma, anterior segment optical coherence tomography, artificial intelligence, deep learning, risk stratification

INTRODUCTION

Primary angle-closure glaucoma (PACG) is a leading cause of irreversible blindness worldwide, affecting an estimated 25 million people [1,2]. The risk of blindness conferred by PACG is roughly twice that of primary open-angle glaucoma (POAG), indicating a significant public health concern [3▪▪,4▪]. Therefore, identifying and treating high-risk eyes on the spectrum of primary angle closure (sPAC) before the onset of PACG and PACG-related blindness is critical. Longitudinal monitoring of eyes at the primary angle closure suspect (PACS) stage [5▪▪] enables timely interventions that may mitigate irreversible optic nerve damage. However, large-scale studies such as the Zhongshan Angle Closure Prevention (ZAP) trial and the Singapore Asymptomatic Narrow Angles Laser Iridotomy Study (ANA-LIS) have raised doubts about routine prophylactic treatment of most PACS eyes, given the relatively low progression rate to primary angle closure (PAC) [5▪▪]. These findings underscore the need for a more individualized, evidence-based strategy, consistent with the principles of precision medicine.

Anterior segment optical coherence tomography (AS-OCT) offers a noninvasive, high-resolution imaging modality well suited for risk assessment in angle closure. In a prospective analysis of 643 untreated PACS eyes from the ZAP Trial, narrower

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KEY POINTS

- AS-OCT provides reproducible, non-contact measurements of anterior chamber angle anatomy, improving upon subjective gonioscopy.
- Modern SS-OCT enables comprehensive circumferential imaging, enhancing detection of sectoral angle variation and disease severity.
- AS-OCT enables mechanism-specific treatment planning and longitudinal monitoring of disease progression and intervention outcomes, supporting personalized care.
- Integration of artificial intelligence, including deep learning, enhances landmark detection, diagnostic accuracy, and scalability of AS-OCT analysis.
- Combining AS-OCT with artificial intelligence offers a precision-guided framework for early detection, monitoring, and tailored intervention in angle closure.

horizontal AOD500 and flatter iris curvature measured by AS-OCT were identified as independent risk factors for progression to PAC, whereas cumulative gonioscopy score showed no association [6]. These findings underscore the advantages of quantitative AS-OCT metrics over traditional qualitative gonioscopic assessment for early risk stratification. If biometric parameters derived from AS-OCT reliably predict long-term progression risk, clinicians could identify high-risk patients for targeted intervention [5▪▪,7▪].

In parallel, artificial intelligence has emerged as a scalable and reproducible tool for ophthalmic screening. For example, deep learning, a subfield of artificial intelligence, can be applied to fundus photographs to detect referable glaucoma at specialist-level performance [8▪], illustrating the potential of artificial intelligence to enhance the detection of other at-risk populations. Therefore, the integration of AS-OCT-derived risk modeling with artificial intelligence-driven analysis could enable earlier identification of high-risk patients, improve diagnostic precision, and guide targeted interventions to prevent blindness from PACG.

RECENT ADVANCES IN OPTICAL COHERENCE TOMOGRAPHY TECHNOLOGY FOR ANTERIOR SEGMENT IMAGING

Recent advancements in AS-OCT technology, exemplified by modern swept-source OCT (SS-OCT) systems such as the ANTERION (Heidelberg Engineering, Heidelberg, Germany) and CASIA2 (Tomey Corporation, Nagoya, Japan), have redefined quantitative anterior segment assessment. SS-OCT enables rapid, high-resolution imaging (~50 000 A-scans/s; ~10 μm axial resolution) of critical structures, including the scleral spur and ciliary body [9▪,10▪]. Compared with ultrasound biomicroscopy (UBM), AS-OCT is non-contact, faster, and generally better tolerated, while providing superior image quality [10▪,11].

Anterior segment OCT has evolved from early time-domain (TD-OCT) to modern spectral-domain (SD-OCT) and SS-OCT systems, with major gains in resolution, imaging depth, and reproducibility. Although pivotal in establishing the technique, TD-OCT was limited by relatively low resolution and shallow penetration, restricting consistent visualization of the scleral spur and reducing the reproducibility of biometric measurements [12]. Modern SD- and SS-OCT systems overcome these barriers, enabling highly reproducible detection of the scleral spur and measurement of biometric parameters such as angle opening distance (AOD), trabecular–iris space area (TISA), and lens vault [13,14]. Intra-device repeatability studies consistently report intraclass correlation coefficients above 0.90 for most biometric parameters across multiple commercial systems. Modern SS-OCT systems also demonstrate improved inter-device agreement, compared with earlier TD-OCT systems [14–16].

SS-OCT technology provides greater tissue penetration, especially when paired with image averaging, allowing more comprehensive and reproducible assessment of the lens and ciliary body, two structures central to the pathogenesis of primary angle closure disease (PACD) [16]. Notably, this includes improved visualization of the ciliary body and muscle, which play important roles in angle closure pathogenesis and accommodation, respectively [17,18]. However, the interpretation of AS-OCT images for mechanism classification has limitations [19–21]. For example, manual plateau iris detection using qualitative AS-OCT grading demonstrated only moderate sensitivity (56–78%) and specificity (49–64%) when benchmarked against UBM, with fair agreement between modalities ($\kappa = 0.31$–0.35) [22]. These findings highlight that while modern AS-OCT improves visualization of deeper structures, automated or artificial intelligence-assisted interpretation may be required to fully realize its diagnostic potential [23].

Due to their enhanced imaging speeds, modern SS-OCT systems can acquire over 100 cross-sectional images within seconds, a leap from earlier TD-OCT systems that typically captured only one or two meridional scans, limiting assessment to selected quadrants. SS-OCT systems provide nearly complete circumferential coverage, enabling detailed

characterization of anatomical variation across the entire angle [24,25]. This dense sampling allows precise quantification of the extent of angle closure and reveals sectoral differences in angle configuration, which are strongly associated with IOP and angle closure severity [26–31].

Together, these advances minimize variability associated with manual spur localization and provide researchers and clinicians with standardized access to comprehensive anterior segment biometrics. By enhancing image quality, reproducibility, and coverage, modern AS-OCT has transformed the ability to characterize angle-closure related anatomical structures and stratify PACG risk in both research and clinical care [9▪,10▪,32].

ANGLE CLOSURE: DEFINITIONS, EVALUATION, AND RISK-STRATIFICATION USING ANTERIOR SEGMENT-OPTICAL COHERENCE TOMOGRAPHY

Accurate evaluation of the anterior chamber angle (ACA) is central to identifying eyes at risk for PACG and enabling precise risk stratification. Traditionally, sPAC has been defined based on gonioscopic criteria: PACS is characterized by at least 180° of nonvisible pigmented trabecular meshwork without peripheral anterior synechiae (PAS), PAC is PACS with PAS and/or elevated intraocular pressure (IOP), and PACG is PACS/PAC with glaucomatous optic neuropathy. Although gonioscopy remains the clinical reference, it is inherently subjective and may alter angle anatomy during examination, which contributes to its underutilization in practice and highlights the value of complementary non-contact imaging modalities [10▪,33▪▪,34].

AS-OCT provides an objective, multidimensional alternative to gonioscopy. Iridotrabecular contact (ITC) on AS-OCT, defined as appositional contact between the peripheral iris and the trabecular meshwork anterior to the scleral spur, can be assessed qualitatively or quantitatively (Fig. 1). Greater ITC extent has functional significance, being associated with reduced Schlemm's canal dimensions, higher IOP, and more severe stages of PACD [26,31,35,36]. The ITC index, defined as the proportion of the angle circumference with ITC, enables objective risk assessment. Threshold analyses suggest values exceeding 50% may identify eyes at heightened risk [37,38], while full 360° mapping refines prediction by capturing circumferential burden [31].

Beyond ITC, AS-OCT quantifies angle width using standardized parameters such as AOD and TIS, measured at 500 μm (AOD500, TISA500) or

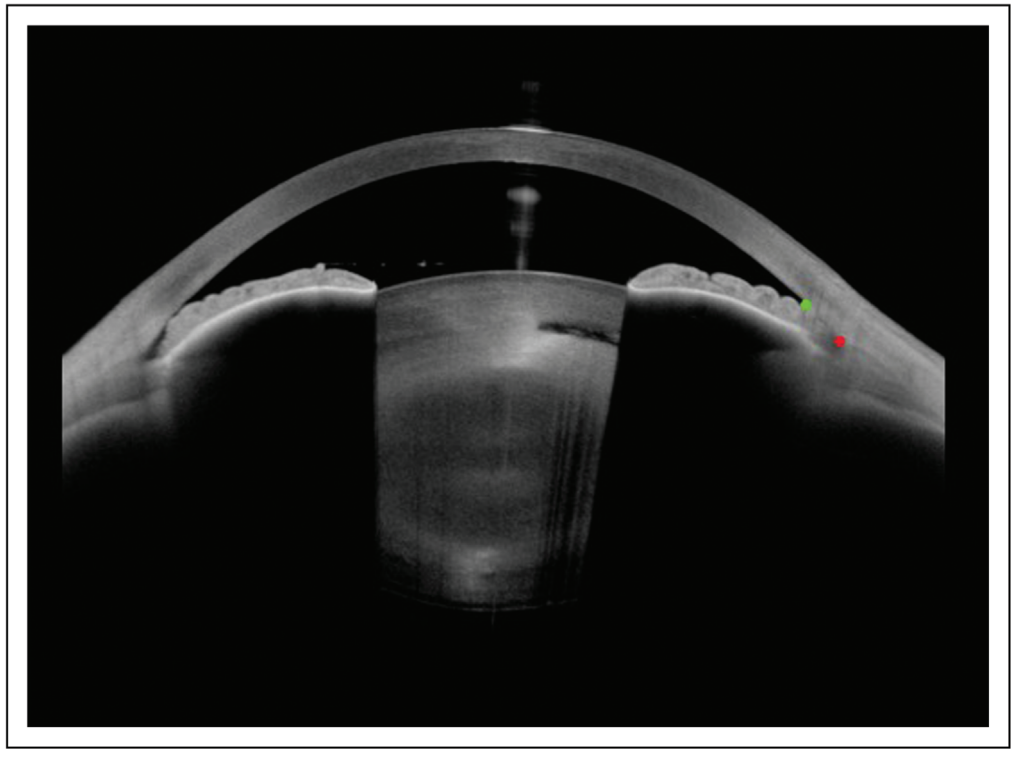

FIGURE 1. Cross-sectional anterior segment optical coherence tomography image of an eye with angle closure. The scleral spur (SS, red dot) and the iridotrabecular contact end point (EP, green dot) are marked, demonstrating iridotrabecular contact (ITC).

750 μm (AOD750, TISA750) from the scleral spur, distances that approximate the average trabecular meshwork height of approximately 840 μm [39]. In untreated and treated ZAP Trial eyes, a smaller horizontal AOD500 was significantly associated with progression to PAC, whereas gonioscopic grading was weakly or not predictive [6,40▪]. Other studies show that AOD750 offers the highest diagnostic accuracy for gonioscopic closure, while TISA750 correlates most strongly with IOP [41,42]. Together, these findings suggest that while AOD500 is the most robust predictor of progression, supplemental parameters, such as TISA500, AOD750, and TISA750, provide additional diagnostic and physiological insights.

AS-OCT also quantifies lens- and iris-derived metrics such as lens vault and iris curvature. Greater lens vault and IC are consistently associated with narrow angle width and higher risk of PAC and PACG [43]. Biometric patterns derived from the AS-OCT cluster according to known mechanisms of angle closure, including pupillary block, plateau iris configuration, and high lens vault. Cluster analyses of PACS, PAC, PACG, and APAC eyes have revealed subgroups characterized by exaggerated lens vault, increased iris curvature, or larger iris area, each corresponding to a recognized anatomical mechanism [20,44].

Comprehensive risk stratification also requires dynamic and longitudinal assessment. Dynamic imaging, such as light-to-dark testing, captures physiologic variability and highlights differences in angle behavior between normal and sPAC eyes. For example, sPAC eyes showed attenuated decreases in iris area and iris volume, changes that correlate with disease severity and progression risk [40▪,45–47]. In addition, static parameters measured in the light, particularly TISA500, may be equally or more predictive of progression than dark-only metrics [45]. The ZAP Trial showed that higher baseline IOP, shallower ACD, and narrower angles predict progression from PACS to PAC, although absolute risk increments per mmHg IOP were modest [5▪▪]. Longitudinal studies indicate that residual ITC often persists after interventions; for example, persistent ITC following laser peripheral iridotomy (LPI) correlated with a greater need for pharmacologic therapy [48]. ZAP Trial data also indicate that short-term anatomical changes may carry predictive value; an 18-month increase in lens vault and reduction in TISA750 predicted progression over years 3-–6 [49▪▪]. Age-related lens thickening and anterior displacement further contribute to angle narrowing, whereas relatively stable parameters such as lens vault retain value for selective long-term monitoring [50].

In summary, AS-OCT-derived ITC, AOD, TISA, and lens-iris metrics provide a reproducible framework for classification and risk stratification in sPAC. By integrating static, dynamic, and longitudinal data, AS-OCT offers a comprehensive complement to gonioscopy and may improve early identification of high-risk eyes. This data-driven approach has the potential to guide targeted interventions and reduce PACG-related visual morbidity, though further validation is needed.

REFINING ANGLE CLOSURE TREATMENT WITH LASER PERIPHERAL IRIDOTOMY AND LENS EXTRACTION

Timely treatment of PAC and PACG is essential for preserving visual function and preventing irreversible optic nerve damage. AS-OCT provides a powerful, high-resolution, non-contact adjunct to gonioscopy, allowing detailed visualization and quantitative assessment of anterior chamber structures. These measurements establish a reproducible framework for risk stratification and therapeutic planning, complementing gonioscopy by reducing observer variability and eliminating mechanical distortion of the angle. Importantly, the integration of these quantitative metrics enables mechanism-specific treatment planning, guiding interventions tailored to each eye's underlying anatomic profile [51].

LPI remains the intervention of choice for eyes with predominantly pupillary block. AS-OCT allows detailed characterization of iris curvature, ACD, and ITC, helping predict LPI efficacy [51,52▪]. In addition, AS-OCT can document the anatomical effects of LPI, including relief of pupillary block and flattening of iris curvature, changes that correspond with improved aqueous dynamics and reduced ITC [51,52▪]. Eyes with extensive ITC or markedly shallow ACD are recognized as higher risk for progression from PACS to PAC. Nonetheless, longitudinal studies, including the ZAP Trial, indicate that only a subset (~25%) of PACS eyes progress to PAC over 14 years, underscoring the need for selective, risk-based application rather than routine prophylaxis [45,53]. When combined with gonioscopic assessment and IOP evaluation, AS-OCT findings provide a robust, evidence-based foundation for targeted monitoring and timely intervention.

Lens extraction is a key intervention when lens-related crowding drives angle closure or when LPI fails to provide adequate opening [52▪]. AS-OCT enables quantitative assessment of its anatomical effects, including deepening of the anterior chamber, widening of the angle recess, and reduction of ITC, confirming the mechanism-specific benefits of surgery [54,55]. Beyond documenting these changes,

AS-OCT also quantifies parameters such as lens vault, ACD, and lens position which inform surgical planning and correlate with intraoperative considerations, including zonular stability [56,57].

Clinical studies consistently show that lens extraction achieves greater and more durable angle widening than LPI, particularly in eyes with exaggerated lens vault and anterior lens positioning [52▪,58]. Yet, postoperative response is heterogeneous. Eyes with flat iris curvature or plateau iris configuration tend to demonstrate limited widening, underscoring the contribution of non-lens mechanisms [54]. Conversely, eyes with large lens vault and shallow ACD typically derive the greatest benefit, though these gains may come with greater surgical complexity and heightened zonular risk [57].

Collectively, these findings underscore the dual role of AS-OCT: it provides objective quantification of the anatomical effects of LPI and lens extraction and helps identify predictors of poor or limited response. By incorporating these biometric insights into preoperative evaluation, clinicians can target surgery to eyes most likely to achieve durable anatomic relief and long-term IOP control.

POSTOPERATIVE ASSESSMENT AND LONGITUDINAL MONITORING

Postoperative AS-OCT provides objective and reproducible visualization of anatomic changes following intervention, including ACD, anterior chamber volume, angle width, and the ITC index. These parameters capture the mechanism-specific effects of procedures such as lens extraction, demonstrating angle widening and reduction of ITC, thereby supporting longitudinal assessment of surgical efficacy and individualized postoperative care.

In addition, AS-OCT provides important insights into glaucoma surgeries beyond lens extraction. SS-OCT has demonstrated expansion of Schlemm's canal after phaco-goniosynechialysis, correlating with improved IOP control [59]. In minimally invasive glaucoma surgery (MIGS), AS-OCT enables early detection of trabecular meshwork fibrosis, a predictor of suboptimal long-term outcomes [60]. Taken together, these applications highlight the broader potential of AS-OCT in postoperative monitoring, allowing clinicians to anticipate long-term treatment response across diverse surgical modalities.

ROLE OF ARTIFICIAL INTELLIGENCE IN OPTICAL COHERENCE TOMOGRAPHY BASED ANGLE CLOSURE CARE

AS-OCT generates rich, quantitative datasets that enable mechanism-specific risk stratification and longitudinal monitoring. The integration of artificial intelligence, particularly deep learning, into AS-OCT analysis addresses major limitations of manual interpretation by reducing grader dependence, improving reproducibility, and standardizing landmark detection. Artificial intelligence can also identify subtle anatomical features that are difficult for human observers to quantify, supporting earlier recognition of high-risk eyes and more consistent therapeutic planning.

Integration of artificial intelligence and deep learning into AS-OCT analysis substantially enhances diagnostic accuracy, workflow efficiency, and scalability [61▪▪,62]. Deep learning algorithms can automatically detect gonioscopic angle closure and ITC, demonstrating robust performance across diverse patient populations and clinical settings [34,63–65]. A recent meta-analysis reported a pooled sensitivity of 94% and specificity of 93.6% for OCT-based detection of angle closure, highlighting the potential of artificial intelligence-assisted AS-OCT for consistent, high-throughput assessment [66]. Artificial intelligence can also distinguish appositional from synechial closure by analyzing paired images obtained under varying physiologic conditions, providing anatomical insights that support individualized intervention strategies [51].

Automated detection of the scleral spur, the key anatomical structure for quantitative AS-OCT analysis, has enabled expert-level biometric measurements [67▪▪,68,69]. Deep learning models provide expert-level scleral spur detection across multiple SS-OCT systems, improving reproducibility and supporting efficient analysis in both clinical and research settings [62,67▪▪,70]. In addition, biometric measurements derived from these automatically detected scleral spur locations are highly reproducible, even across diverse populations. These algorithms are now integrated into commercially available AS-OCT systems, facilitating broader clinical adoption [67▪▪,68].

The combination of AS-OCT imaging and artificial intelligence-driven analysis provides a scalable, reproducible, and precision-guided platform with the potential to transform care for angle closure patients. Advanced deep learning architectures enable classification of underlying mechanisms of angle closure directly from volumetric AS-OCT data, bypassing manual localization and supporting mechanism-specific therapeutic planning [71,72]. Furthermore, as larger and more diverse datasets with long-term clinical outcomes become available, artificial intelligence may discover subtle anatomical patterns and novel imaging biomarkers that address the performance gap in current predictive models. However, clinical translation of artificial intelligence-assisted AS-OCT will

depend on large-scale validation, workflow integration, and improved interpretability, considerations that remain essential for its adoption in routine care [62].

FUTURE DIRECTIONS

Although significant advances have been made in the past decade, further work is needed to enable widespread adoption of AS-OCT imaging for angle closure diagnosis and care. While studies such as the ZAP Trial have hinted at the prognostic value of AS-OCT measurements, broader adoption will require consensus on OCT-based definitions and clinically meaningful thresholds to guide intervention [73▪▪]. Longitudinal studies must clarify how changes in biometric parameters correlate with disease progression and treatment response, and help establish evidence-based guidelines for incorporating AS-OCT into routine risk stratification and management. Furthermore, combining AS-OCT with complementary imaging modalities, such as ultrasound biomicroscopy, could enhance mechanistic insights and support multimodal risk modeling [74].

The integration of artificial intelligence into AS-OCT workflows represents a critical next step toward scalable precision care. Future artificial intelligence models should move beyond simple classification to provide clinically interpretable predictions of progression risk, treatment response, and long-term outcomes. Algorithms for automated landmark detection, 360° biometric quantification, and mechanism classification could improve reproducibility while reducing observer variability and clinician workload. To achieve real-world impact, these systems require rigorous validation across diverse cohorts and care settings. Ultimately, coupling artificial intelligence-driven AS-OCT analysis with patient-specific data – such as demographics, genetics, and systemic health factors – could enable comprehensive predictive models that inform individualized, mechanism-specific intervention strategies.

Despite these opportunities, important technological and implementation barriers remain. A lack of standardized imaging protocols and cross-platform calibration currently limits interoperability, hindering both clinical integration and the generalizability of study findings [73▪▪]. Device costs also pose a barrier, particularly in resource-limited regions where PACG prevalence is highest. Encouragingly, the incorporation of AS-OCT into modern optical biometers for cataract surgery suggests that broader access could be achievable through existing clinical infrastructure. Efforts to reduce costs, develop portable or simplified devices, and harmonize imaging protocols are essential to ensure equitable adoption across diverse healthcare systems. Addressing these challenges will be key to determining if AS-OCT and artificial intelligence can be fully realized as accessible, scalable tools for global PACG prevention and management.

CONCLUSION

AS-OCT has transformed the evaluation of angle closure by providing reproducible, quantitative imaging that surpasses traditional gonioscopy in risk stratification and mechanism-specific assessment. The integration of artificial intelligence enhances its scalability, accuracy, and clinical utility, offering the potential for automated, high-throughput, and personalized management. Together, AS-OCT and artificial intelligence represent a paradigm shift toward precision, data-driven care with the potential to significantly reduce the global burden of PACG-related blindness.

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Conflicts of interest

B.Y.X. receives research support from Heidelberg Engineering. All other authors declare no competing interests.

REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:

- ▪ of special interest
- ▪▪ of outstanding interest

1. Tham YC, Li X, Wong TY, *et al.* Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. Ophthalmology 2014; 121:2081–2090.
2. George R, Panda S, Vijaya L. Blindness in glaucoma: primary open-angle glaucoma versus primary angle-closure glaucoma-a meta-analysis. Eye (Lond) 2022; 36:2099–2105.
3. ▪▪ Shah SN, Zhou S, Sanvicente C, *et al.* Prevalence and risk factors of blindness among primary angle closure glaucoma patients in the United States: an IRIS Registry Analysis. Am J Ophthalmol 2024; 259:131–140.

This large-scale IRIS Registry analysis identifies real-world risk factors for blindness in PACG patients in the United States, providing critical epidemiologic insight.

4. ▪ Tan SS, Tun TA, Aung T, Nongpiur ME. Comparison of intraocular pressure and anterior segment parameters in subjects with asymmetrical primary angle closure disease. Clin Exp Ophthalmol 2024; 52:724–731.

This study provides comparative biometric profiles in asymmetrical PAC, informing heterogeneity in disease progression.
5. Yuan Y, Xiong R, Wang W, *et al.* Long-term risk and prediction of progression in ■■ primary angle closure suspect. JAMA Ophthalmol 2024; 142:216–223.
This prospective study establishes predictive models for PACS progression, directly informing risk-stratified care.
6. Xu BY, Friedman DS, Foster PJ, *et al.* Ocular biometric risk factors for progression of primary angle closure disease. Ophthalmology 2022; 129: 267–275.
7. Schipper P, Weber C, Lu K, *et al.* Anterior segment OCT for imaging PAUL® ■ glaucoma implant patch grafts: a useful method for follow-up and risk management. Graefes Arch Clin Exp Ophthalmol 2024; 263:1071–1079.
This study demonstrates innovative clinical use of AS-OCT in monitoring glaucoma implants, broadening its utility beyond angle imaging.
8. Nguyen V, Iyengar S, Rasheed H, *et al.* Comparison of deep learning and ■ clinician performance for detecting referable glaucoma from fundus photographs in a safety net population. Ophthalmol Sci 2025; 5:100751.
This study validates artificial intelligence performance against clinicians, illustrating the growing role of deep learning in glaucoma screening.
9. Chansangpetch S, Phinyo P, Patumanond J, *et al.* Diagnostic abilities of three- ■ dimensional anterior segment optical coherence tomography in detecting angle closure. J Glaucoma 2024; 33:801–807.
This article shows the enhanced accuracy of 3D AS-OCT in detecting angle closure, reinforcing its clinical value.
10. Zhao R, Du Q, Wu Y, *et al.* Analysis of indicators for assessing the risk of ■ progression from PACS to APAC and the degree of intraocular pressure elevation in APAC using AS-OCT. J Ophthalmol 2024; 2024:8368315.
This study highlights novel AS-OCT-based indicators to predict progression risk, aligning directly with risk-stratification themes.
11. Li F, Zhang X, Yang K, *et al.* Deep learning-based anterior segment identification and parameter assessment of primary angle closure disease in ultrasound biomicroscopy images. BMJ Open Ophthalmol 2025; 10:e001600.
12. Sakata LM. Assessment of the scleral spur in anterior segment optical coherence tomography images. Arch Ophthalmol 2008; 126:181–185.
13. Cumba RJ, Radhakrishnan S, Bell NP, *et al.* Reproducibility of scleral spur identification and angle measurements using Fourier domain anterior segment optical coherence tomography. J Ophthalmol 2012; 2012:487309.
14. Xu BY, Mai DD, Penteado RC, *et al.* Reproducibility and agreement of anterior segment parameter measurements obtained using the CASIA2 and spectralis OCT2 optical coherence tomography devices. J Glaucoma 2017; 26:974–979.
15. Chansangpetch S, Nguyen A, Mora M, *et al.* Agreement of anterior segment parameters obtained from swept-source Fourier-domain and time-domain anterior segment optical coherence tomography. Investig Ophthalmol Vis Sci 2018; 59:1554–1561.
16. Pardeshi AA, Song AE, Lazkani N, *et al.* et al. Intradevice repeatability and interdevice agreement of ocular biometric measurements: a comparison of two swept-source anterior segment OCT devices. Transl Vis Sci Technol 2020; 9:14.
17. Xie X, Sultan W, Corradetti G, *et al.* Assessing accommodative presbyopic biometric changes of the entire anterior segment using single swept-source OCT image acquisitions. Eye 2022; 36:119–128.
18. Xie X, Corradetti G, Song A, *et al.* Age- and refraction-related changes in anterior segment anatomical structures measured by swept-source anterior segment OCT. Bhattacharya S, editor. PLoS One 2020; 15:e0240110.
19. Cho A, Lewinger JP, Pardeshi AA,, *et al.* et al. Classification of angle closure severity by hierarchical cluster analysis of ocular biometrics in the dark and light. Transl Vis Sci Technol 2023; 12:4.
20. Moghimi S, Torkashvand A, Mohammadi M, *et al.* Classification of primary angle closure spectrum with hierarchical cluster analysis. Bhattacharya S, editor. PLoS One 2018; 13:e0199157.
21. Nongpiur ME, Atalay E, Gong T, *et al.* et al. Anterior segment imaging-based subdivision of subjects with primary angle-closure glaucoma. Eye 2017; 31: 572–577.
22. Wanichwecharungruang B, Pattanapongpaiboon W, Kongsomboon K, *et al.* et al. Diagnostic performance of anterior segment optical coherence tomography in detecting plateau iris. BMJ Open Ophthalmol 2022; 7:e000931.
23. Wanichwecharungruang B, Kaothanthong N, Pattanapongpaiboon W, *et al.* Deep learning for anterior segment optical coherence tomography to predict the presence of plateau iris. Transl Vis Sci Technol 2021; 10:7.
24. Blieden LS, Chuang AZ, Baker LA, *et al.* Optimal number of angle images for calculating anterior angle volume and iris volume measurements. Investig Ophthalmol Vis Sci 2015; 56:2842–2847.
25. Shan J, Pardeshi A, Jiang X, *et al.* Optimal number and orientation of anterior segment OCT images to measure ocular biometric parameters in angle closure eyes: the Chinese American Eye Study. Br J Ophthalmol 2023; 107:795–801.
26. Porporato N, Chong R, Xu BY, *et al.* Angle closure extent, anterior segment dimensions and intraocular pressure. Br J Ophthalmol 2023; 107:927–934.
27. Porporato N, Baskaran M, Perera S, *et al.* Evaluation of meridional scans for angle closure assessment with anterior segment swept-source optical coherence tomography. Br J Ophthalmol 2021; 105:131–134.
28. Xu BY, Pardeshi AA, Shan J, *et al.* Effect of angle narrowing on sectoral variation of anterior chamber angle width: the Chinese American Eye Study. Ophthalmol Glaucoma 2020; 3:130–138.
29. Xu BY, Burkemper B, Lewinger JP, *et al.* Correlation between intraocular pressure and angle configuration measured by OCT. Ophthalmol Glaucoma 2018; 1:158–166.
30. Xu BY, Israelsen P, Pan BX, *et al.* Benefit of measuring anterior segment structures using an increased number of optical coherence tomography images: the Chinese American Eye Study. Investig Ophthalmol Vis Sci 2016; 57:6313–6319.
31. Zhang X, Guo PY, Lin C, *et al.* Assessment of iris trabecular contact in eyes with gonioscopic angle-closure. Ophthalmology 2023; 130:111–119.
32. Gedde SJ, Chen PP, Muir KW, *et al.* et al. Primary angle-closure disease preferred practice pattern®. Ophthalmology 2021; 128:30–70.
33. Lee JH, Yoo K, Lung K, *et al.* Patterns and disparities in recorded gonioscopy ■■ during initial glaucoma evaluations in the United States. Am J Ophthalmol 2024; 264:90–98.
This article highlights disparities in gonioscopy documentation during initial glaucoma evaluations in the United States, reinforcing the need for objective, standardized imaging approaches such as AS-OCT.
34. Randhawa J, Chiang M, Porporato N, *et al.* Generalisability and performance of an OCT-based deep learning classifier for community-based and hospital-based detection of gonioscopic angle closure. Br J Ophthalmol 2023; 107: 511–517.
35. Ding X, Huang L, Peng C, *et al.* Evaluation of Schlemm's canal with swept-source optical coherence tomography in primary angle-closure disease. BMC Ophthalmol 2023; 23:256.
36. Murgoitio-Esandi J, Xu BY, Song BJ, *et al.* A mechanistic model of aqueous humor flow to study effects of angle closure on intraocular pressure. Transl Vis Sci Technol 2023; 12:16.
37. Yaisiri P, Panarojwongse N, Treesit I, *et al.* Comparison of swept-source anterior segment ocular coherence tomography and gonioscopy in detecting anterior chamber angle closure. Clin Ophthalmol 2025; 19:699–711.
38. Tun TA, Nongpiur ME, Xu BY, *et al.* Investigating the determinants of iridolenticular contact area: a novel parameter for angle closure. Br J Ophthalmol 2024; 108:940–945.
39. Chen RI, Barbosa DT, Hsu CH, *et al.* Ethnic differences in trabecular meshwork height by optical coherence tomography. JAMA Ophthalmol 2015; 133: 437–441.
40. Bao YK, Xu BY, Friedman DS, *et al.* Biometric risk factors for angle closure ■ progression after laser peripheral iridotomy. JAMA Ophthalmol 2023; 141: 516–524.
This study identifies key biometric predictors of post-LPI progression, reinforcing personalized management strategies.
41. Guo PY, Zhang X, Li F, *et al.* Diagnostic criteria of anterior segment swept-source optical coherence tomography to detect gonioscopic angle closure. Br J Ophthalmol 2024; 108:1130–1136.
42. Pradhan S, Sah RK, Bhandari G, *et al.* Anterior segment OCT for detection of narrow angles: a community-based diagnostic accuracy study. Ophthalmol Glaucoma 2024; 7:148–156.
43. Xu BY, Lifton J, Burkemper B, *et al.* Ocular biometric determinants of anterior chamber angle width in Chinese Americans: the Chinese American Eye Study. Am J Ophthalmol 2020; 220:19–26.
44. Nongpiur ME, Gong T, Lee HK, *et al.* Subgrouping of primary angle-closure suspects based on anterior segment optical coherence tomography parameters. Ophthalmology 2013; 120:2525–2531.
45. Cho A, Xu BY, Friedman DS, *et al.* Role of static and dynamic ocular biometrics measured in the dark and light as risk factors for angle closure progression. Am J Ophthalmol 2023; 256:27–34.
46. Liao C, Quigley H, Jiang Y, *et al.* Iris volume change with physiologic mydriasis to identify development of angle closure: the Zhongshan Angle Closure Prevention Trial. Br J Ophthalmol 2024; 108:366–371.
47. Quigley HA, Silver DM, Friedman DS, *et al.* Iris cross-sectional area decreases with pupil dilation and its dynamic behavior is a risk factor in angle closure. J Glaucoma 2009; 18:173–179.
48. Gupta B, Angmo D, Yadav S, *et al.* Quantification of iridotrabecular contact in primary angle-closure disease. J Glaucoma 2020; 29:681–688.
49. Hong KL, Xu BY, Wang W, *et al.* Short-term ocular biometric changes as ■■ predictors of long-term angle closure progression. JAMA Ophthalmol 2025; 143:543–551.
This study establishes dynamic short-term biometric changes as predictors of long-term PACG progression, enhancing individualized risk assessment.
50. Tang Y, Gao Y, Yu X, *et al.* Novel diagnostic indicators for acute angle closure secondary to lens subluxation based on anterior segment and lens parameters. Heliyon 2024; 10:e25460.
51. Zhang Y, Zhang X, Zhang Q, *et al.* Automated classification of angle-closure mechanisms based on anterior segment optical coherence tomography images via deep learning. Heliyon 2024; 10:e35236.
52. Rifada M, Ramdhani RF, Nadifa I, *et al.* Evaluating the effectiveness of laser ■ peripheral iridotomy on angle-closure diseases: the role of Spectral Domain Anterior Segment Optical Coherence Tomography (SD AS-OCT) in Indonesia Tertiary Eye Hospital. Open Ophthalmol J 2025; 19:e18743641337429.
This study highlights the clinical role of SD AS-OCT in evaluating LPI outcomes in angle-closure disease.
53. Kwak J, Shon K, Lee Y, Sung KR. Progressive changes in the anterior segment and their impact on the anterior chamber angle in primary angle closure disease. Am J Ophthalmol 2024; 257:57–65.

54. Xu BY, Friedman DS, Foster PJ, *et al.* Anatomic changes and predictors of angle widening after laser peripheral iridotomy. Ophthalmology 2021; 128: 1161–1168.

55. Zebardast N, Kavitha S, Krishnamurthy P, *et al.* Changes in anterior segment morphology and predictors of angle widening after laser iridotomy in South Indian eyes. Ophthalmology 2016; 123:2519–2526.

56. Bahadur M, Amrutkar JR, Satpute K, Malviya A. Study of association between lens vault, anterior chamber angle, and change in intraocular pressure after cataract surgery in glaucoma patients. Delhi J Ophthalmol 2024; 34:110–113.

57. Pei XT, Wang SH, Qing GP, *et al.* Zonular instability-associated morphologic features in eyes with primary angle closure disease using the swept-source anterior segment–optical coherence tomography system. BMC Ophthalmol 2024; 24:203.

58. Song WK, Sung KR, Kim KE. Anterior chamber angle and intraocular pressure control after phacoemulsification in primary angle closure with different mechanisms. J Glaucoma 2024; 33:748–757.

59. Huang H, Gao F, Sun X, Chen Y. Swept-source optical coherence tomography assessment of Schlemm's canal after phacoemulsification with goniosynechialysis in Chinese patients with primary angle-closure glaucoma. Quant Imaging Med Surg 2024; 14:8119–8130.

60. Rao A, Mukherjee S. Healing responses at the angle after micro-invasive glaucoma surgery-an AS-OCT study. PLoS One 2024; 19:e0305740.

61. ■■ Bolo K, Xu BY. Applications of deep learning in the analysis of optical coherence tomography images for glaucoma-related diagnostics. Taiwan J Ophthalmol 2025; 15:354–363.

This article reviews recent applications of AI in OCT, emphasizing clinical translation for glaucoma diagnostics.

62. Soh ZD, Tan M, Nongpiur ME, *et al.* Assessment of angle closure disease in the age of artificial intelligence: a review. Prog Retin Eye Res 2024; 98:101227.

63. Fu H, Baskaran M, Xu Y, *et al.* A deep learning system for automated angle-closure detection in anterior segment optical coherence tomography images. Am J Ophthalmol 2019; 203:37–45.

64. Li F, Yang Y, Sun X, *et al.* Digital gonioscopy based on three-dimensional anterior-segment OCT. Ophthalmology 2022; 129:45–53.

65. Xu BY, Chiang M, Chaudhary S, *et al.* Deep learning classifiers for automated detection of gonioscopic angle closure based on anterior segment OCT images. Am J Ophthalmol 2019; 208:273–280.

66. Olyntho MAC, Jorge CAC, Castanha EB, *et al.* Artificial intelligence in anterior chamber evaluation: a systematic review and meta-analysis. J Glaucoma 2024; 33:658–664.

67. ■■ Bolo K, Apolo Aroca G, Pardeshi AA, *et al.* Automated expert-level scleral spur detection and quantitative biometric analysis on the ANTERION anterior segment OCT system. Br J Ophthalmol 2024; 108:702–709.

This article demonstrates expert-level artificial intelligence for scleral spur detection, enabling reproducible quantitative biometrics in AS-OCT.

68. Liu P, Higashita R, Guo PY, *et al.* Reproducibility of deep learning based scleral spur localisation and anterior chamber angle measurements from anterior segment optical coherence tomography images. Br J Ophthalmol 2023; 107:802–808.

69. Xu BY, Chiang M, Pardeshi AA, *et al.* Deep neural network for scleral spur detection in anterior segment OCT images: the Chinese American Eye Study. Transl Vis Sci Technol 2020; 9:18.

70. Shen A, Chiang M, Pardeshi AA, *et al.* Anterior segment biometric measurements explain misclassifications by a deep learning classifier for detecting gonioscopic angle closure. Br J Ophthalmol 2023; 107:349–354.

71. Eslami Y, Mousavi Kouzahkanan Z, Farzinvash Z, *et al.* Deep learning-based classification of subtypes of primary angle-closure disease with anterior segment optical coherence tomography. J Glaucoma 2023; 32:540–547.

72. Zhou R, Chuang AZ, Feldman RM, Giancardo L. MVGL-Net: a generalizable multiview convolutional network for anterior segment OCT. Biomed Signal Process Control 2023; 85:104778.

73. ■■ Fraser AS, Ang M, Bellchambers A, *et al.* Proposed nomenclature for landmarks in anterior-segment OCT: the APOSTEL-AS Panel Consensus. JAMA Ophthalmol 2025; 143:749–757.

This article provides standardized OCT landmark nomenclature, expected to unify reporting across research and clinical practice.

74. Kwon J, Sung KR, Han S, *et al.* Subclassification of primary angle closure using anterior segment optical coherence tomography and ultrasound biomicroscopic parameters. Ophthalmology 2017; 124:1039–1047.