Optometry in Practice (Online) ISSN 2517-5696 Volume 24 Issue 1

Optometry in Practice

THE COLLEGE OF OPTOMETRISTS

Clinical case

# Evolution of patient care: three glaucoma case studies from within an ophthalmic diagnostic and treatment centre

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C-105948
1 CPD point for UK optometrists

Optometrists CPD PROVIDER General Optical Council

CLINICAL PRACTICE

COMMUNICATION

SPECIALTY: OPTOMETRIST AS/SP/IP

Date of acceptance: 21 February 2023
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## Abstract

In this article three interesting glaucoma cases are discussed alongside the evidence-based approach underpinning management decisions. All cases presented at the Cardiff University Ophthalmic Diagnostic and Treatment Centre (ODTC) which ran between July 2020 and August 2021 within the Cardiff University School of Optometry and Vision Sciences. The ODTC represented a collaborative partnership between Cardiff University and Cardiff and Vale University Health Board. The article highlights the benefits that result from collaborative working between primary care optometry and secondary care ophthalmology. The importance of developments such as the ODTC and the key advantages of this service in supporting the delivery of eye care and providing high-quality supervised clinical experience for optometrists are considered.


## Introduction

In this article three interesting glaucoma cases are discussed alongside the evidence-based approach underpinning management decisions. All cases presented at the Cardiff University Ophthalmic Diagnostic and Treatment Centre (ODTC) which ran between July 2020 and August 2021 within the Cardiff University School of Optometry and Vision Sciences. During the COVID-19 pandemic the ODTC functioned to improve access to eye care and support the recovery of National Health Service (NHS) services to pre-pandemic levels. Over the 13-month period that the ODTC was operational 283 hospital patients were seen by the three resident optometrists who were accredited with the College of Optometrists Professional Certificate in Glaucoma. All patients had previously attended the glaucoma clinic at the University Hospital of Wales. They were under ophthalmologist care and awaiting a follow-up appointment which was delayed before the COVID-19 pandemic, and had become further delayed during the pandemic. The NHS set up the community ODTCs to run as data capture clinics with secondary care virtual review. Following each consultation with the optometrists at Cardiff University, the digital patient record, fundus images, optical coherence tomography (OCT) scans and visual field plots were virtually reviewed by a consultant ophthalmologist or an appropriately qualified optometrist, for example one accredited with the College of Optometrists Professional Diploma in Glaucoma and Independent Prescriber status.

In September 2021, the ODTC virtual clinic stopped, and an entirely new optometrist-led NHS glaucoma clinic was set up at Cardiff University under a new university/NHS collaboration. The clinic was renamed the Ophthalmic Diagnostic Treatment and Teaching Centre and was developed to provide glaucoma clinical placement experience for seven postgraduate optometry students who were studying towards the College of Optometrists Higher Certificate in Glaucoma. The service was extended in July 2022 and integrated into the newly established University NHS Eye Care Centre, which also incorporates on-site NHS optometrist-led medical retina clinics and consultant-led oculoplastic clinics. Having evolved significantly since the ODTC virtual clinic first opened its doors, the current aim of the service is for patients with glaucoma to be independently managed by optometrists with the Diploma in Glaucoma and Independent Prescribing rights at a community location outside the hospital, whilst providing training opportunities to maximise the Higher Certificate optometrists' exposure to a more complex case mix. Presently a local consultant ophthalmologist is invited to use the university clinic facilities for one session per month. The consultant clinic runs alongside the optometrist-led clinic and allows the Higher Certificate student optometrists to see pre- and post-surgical glaucoma patients.

Developments such as the University NHS Eye Care Centre highlight the benefits that result from collaborative working between primary care optometry and secondary care ophthalmology. The key advantage is increased clinic capacity to support the management of the growing number of patients requiring eye care, alongside providing high-quality supervised clinical experience for optometrists committed to upskilling. Evolution of the profession in this manner validates the importance of optometrist upskilling which provides the potential for a longer-term solution to capacity issues.

## Case 1

A 43-year-old Caucasian man presented at the ODTC for a follow-up review having been diagnosed as right ocular hypertension and left primary open-angle glaucoma (POAG) suspect within the hospital eye service (HES) 9 months previously. His baseline intraocular pressure (IOP) upon diagnosis was 23 mmHg both eyes (BE) as measured using Goldmann applanation tonometry (GAT). He was treated with uncomplicated bilateral selective laser trabeculoplasty (SLT). IOP using GAT 6 weeks post-SLT was 17/18 mmHg (right/left) and a 6-month follow-up review was scheduled. Unfortunately this review was further delayed by 3 months by the time he was seen at the ODTC.

Upon initial questioning he was asymptomatic, had no general health issues and was not taking any ophthalmic or systemic medication.

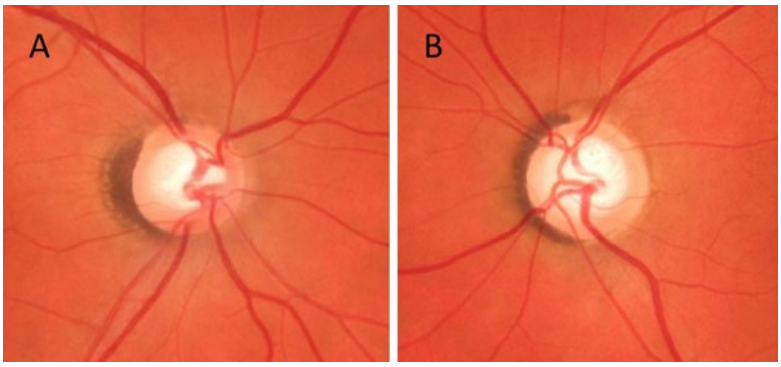


**Figure 1 Case 1:** colour photographs of the right (A) and left (B) optic nerve.

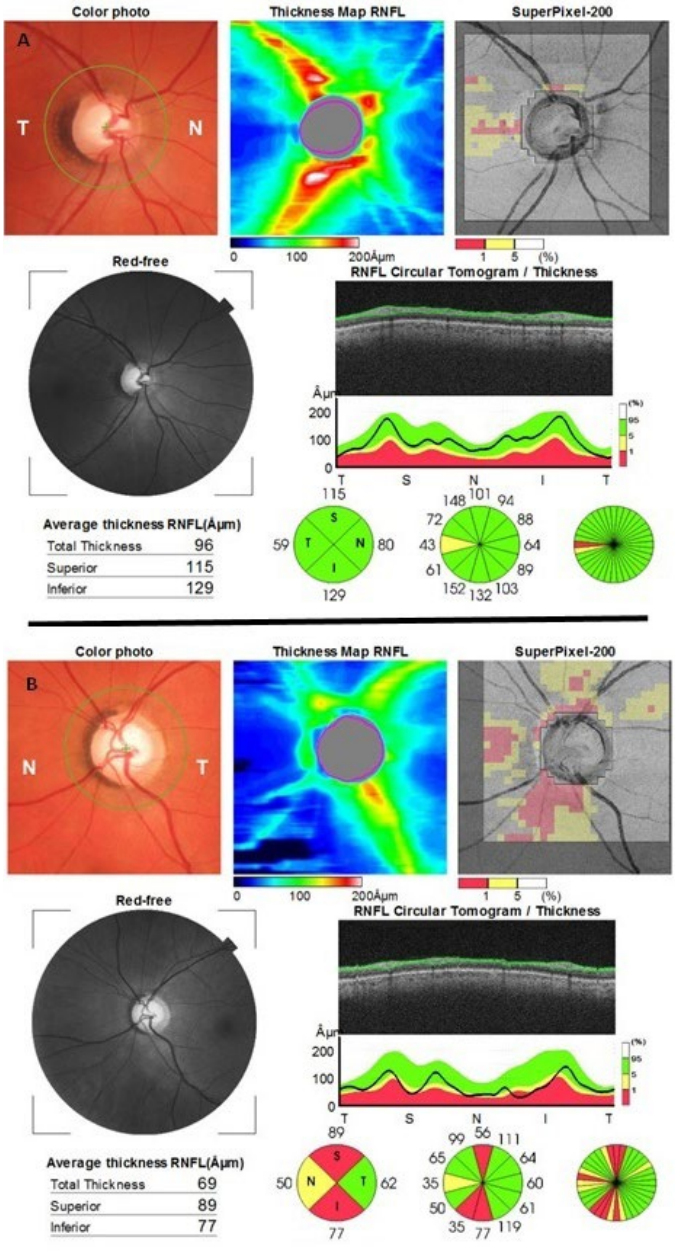


**Figure 2 Case 1:** Topcon Triton OCT disc report for the right (A) and left (B) eye showing a colour photograph of the optic nerve, retinal nerve fibre layer (RNFL) temperature thickness plot, temporal, superior, nasal, inferior, temporal (TSNIT) graph and RNFL radial analyses.

He stated that he smoked 7–8 cigarettes daily and had done so for 20 years. He was unsure of his family history and was a driver working in the retail sector. He did not wear spectacles and a Snellen visual acuity of 6/5 BE was recorded. Ocular adnexae and pupil reactions were normal. His anterior chamber was deep (grade 4 modified Shaffer grading in all quadrants) with a central corneal thickness of 592/587 microns (right/left) as measured using ultrasound pachymetry. His IOP was 24 mmHg BE (GAT). The optic nerve appearance is shown in Figure 1. Vertical disc diameter was 1.9/2.0 mm (right/left) as recorded with 66-D slit-lamp binocular indirect ophthalmoscopy (BIO). The right optic nerve head (ONH) showed an even neuroretinal rim (NRR) with no convincing defect. Right ONH vasculature appeared normal and a cup:disc (C:D) ratio estimate of 0.70 was recorded. The left ONH had an emerging NRR notch at 12–1 o'clock. Other clinical features synonymous with glaucoma included early inferior baring of the circumlinear vessel and a large C:D ratio (0.80).

Figure 2 shows the OCT 3D disc report (Topcon Triton; Topcon Healthcare, Tokyo). The retinal nerve fibre layer (RNFL) temperature thickness plot, temporal–superior–nasal–inferior–temporal graph and radial analysis parameters were all normal for the right eye. Conversely, left-eye analysis suggested possible reduced RNFL thickness (inferior > superior) when compared to an age-matched normal individual. SITA standard 24-2 visual field assessment was performed and repeated on the day. The right eye was normal and the left eye showed a repeatable superior nasal step defect that was less established at initial diagnosis 9 months previously. In accordance with the stable, healthy ONH appearance and full visual fields there was no indication of right-eye conversion to POAG. In contrast, due to the suspicious ONH appearance, emergent visual field defect and abnormal OCT-based RNFL analysis, a change of diagnosis for the left eye from POAG suspect to POAG was suggested pending ophthalmologist virtual review.

The patient had already undergone one session of SLT, but its effect on the IOP had subsided. The tentative left POAG diagnosis, suboptimal IOP and continued risk of right-eye conversion/left-eye progression were discussed. An overview of possible management options pending virtual review was also given; these included monitoring only, repeat SLT or starting topical drug treatment. The patient indicated a preference for topical hypotensive treatment and pre-emptive discussions were conducted to establish willingness to use drug therapy long-term and effective eye drop administration

technique. Since this patient was seen under the original ODTC data capture clinic, all clinical data and information relating to discussions was uploaded to the HES via an electronic patient record. A virtual review was conducted within 2 days of the patient episode. The tentative diagnosis of left POAG was upheld, a target IOP of 18 mmHg or less was set and a recommendation was made for the patient to start using generic latanoprost 0.005% BE nightly. A letter was sent to the patient and his general practitioner (GP) to outline the diagnosis and management plan. The patient was also sent a prescription form (NHS FP10SS) to enable him to acquire the drug from his local pharmacy, pending repeat prescription by the GP. A 12-week ODTC follow-up appointment was scheduled with the intention to monitor IOP reduction, eye drop tolerance and adherence to the treatment regimen. The patient was advised to contact the HES glaucoma clinic if any issues arose in the meantime.

## Discussion

In 2007 a meta-analysis was conducted to review the effectiveness of treatment for those with ocular hypertension.[1] Amongst the 10 clinical trials included within the review were two seminal publications; the European Glaucoma Prevention Study[2] and the Ocular Hypertension Treatment Study.[3] The review concluded that lowering the IOP for those with ocular hypertension was an effective strategy to reduce the risk of developing chronic open-angle glaucoma (COAG). At 5 years those treated were found to have 40% less incidence of glaucomatous visual defects than controls. Although this evidence strongly supports treating those with ocular hypertension, it is also pertinent to remember than only a minority (10%) of those with ocular hypertension develop COAG over 5 years.[3] In addition, not all those who develop COAG are at risk of visual impairment in their lifetime. The treatment strategy outlined in the National Institute for Health and Care Excellence (NICE) Guideline NG81[4] stratifies the groups most at risk of developing COAG and as such most likely to benefit from treatment. In accordance with this, treatment for the right eye was offered in the present case as the patient's IOP was 24 mmHg or more and he was at risk of visual impairment within his lifetime. Visual impairment risk (as defined as a severe reduction in vision, which cannot be corrected with standard glasses or contact lenses and reduces a person's ability to function in a visual environment) was determined using risk factors, including level of IOP, central corneal thickness, family history and life expectancy.

A diagnosis of POAG was made for the left eye and treatment offered. The impact of lowering IOP on COAG progression was evidenced by the Early Manifest Glaucoma Trial,[5] which compared the effect of immediately lowering IOP versus no treatment or later treatment on the progression of newly detected open-angle glaucoma. After a median follow-up period of 6 years, glaucoma progression, as defined by visual field loss and ONH biomarkers, occurred for 45% of those treated ($n$ = 129; average IOP reduction 25% from baseline) versus 62% of controls ($n$ = 126). This finding was supported by the Collaborative Initial Glaucoma Treatment Study, which reported no average visual field loss over a 7-year period when an IOP reduction of 30% was maintained for mild open-angle glaucoma cases.[6] In accordance with this it is sensible to conclude that a 25–30% reduction in IOP from baseline in the present case would be a viable target.

At the time of the patient's presentation in the clinic, both the NICE NG81 guideline[4] and the European Glaucoma Society guidelines[7] recommended monotherapy as first-line treatment. This has since changed in alignment with the results of the LiGHT study[8] and SLT is now considered to be the first-line treatment for newly diagnosed ocular hypertension and COAG. As the patient had no contraindications or adverse reaction profile to a prostaglandin analogue, g.latanoprost nocte BE was offered. Prostaglandin analogues are the most potent drug class of glaucoma medication (25–33% efficacy) with the most efficient treatment regimen (once daily) and minimal side effects.[9,10] Having an average IOP reduction of 25–35% when used as a monotherapy, latanoprost was a sensible choice to achieve the target IOP.[11] A review of four clinical trials that assessed the efficacy of bimatoprost versus latanoprost was conducted by Simmons et al.[11] It was reported that the mean IOP reduction between patients was 0–1.5 mmHg more in those using bimatoprost than in those using latanoprost. The greater efficacy of bimatoprost to lower IOP may be clinically significant given that a 1-mmHg change has been reported to reduce risk of progression in those with glaucoma.[5] Despite this, bimatoprost was not selected as a treatment option primarily due to the increased risk of transient, mild conjunctival hyperaemia compared to latanoprost.[11]

If monotherapy was well tolerated and effective but did not lower IOP to the target pressure an additional drug of a different class could be added. As multiple topical treatments may reduce adherence and increase exposure to preservatives, then a once-daily fixed-combination eye drop such as g.latanoprost and timolol mane would be most prudent.[11] Prior to changing the drug choice or contemplating other treatment strategies due to suboptimal IOP reduction the patient would be questioned as to his adherence to the treatment regimen. The importance of this management step should not be underestimated and has been highlighted via the #KnowYourDrops campaign.[12] The campaign suggested that support for correct eye drop technique and compliance aids was often overlooked outside specialist ophthalmic units compared with other specialist medicines.[12] The campaign emphasised that a key factor behind poor compliance was that glaucoma treatment does not always improve sight, and this would be a motivator to use drops correctly.

## Summary

Confirmation of tentative diagnosis and management plan was received via HES virtual review within 2 days of the patient episode. Upon review 3 months after starting g.latanoprost nocte BE, IOPs were within target at 16/17 mmHg (right/left) and no adverse reaction to treatment was reported. The patient was advised to continue the current treatment strategy and a 9-month follow-up at the ODTC was planned.

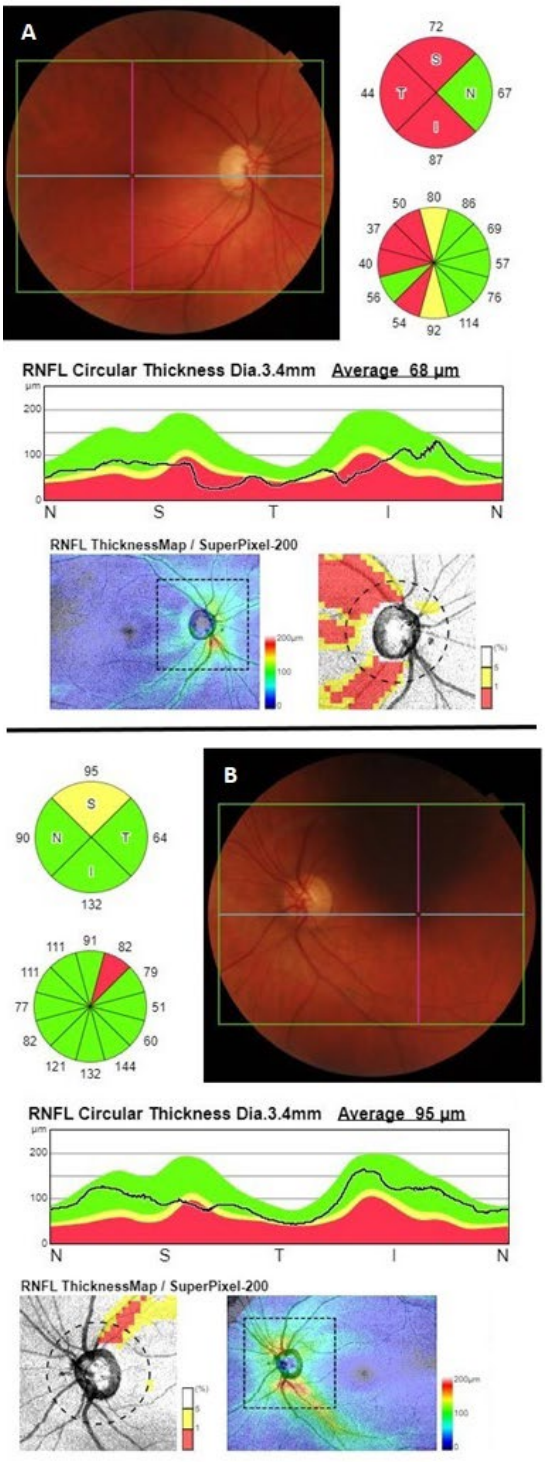


**Figure 3 Case 2:** Topcon Triton optical coherence tomography (OCT) retinal nerve fibre layer (RNFL) analysis data for the right (A) and left (B) eye showing a colour photograph of the optic nerve, RNFL radial analyses, temporal, superior, nasal, inferior, temporal (TSNIT) graph and RNFL temperature thickness plots.

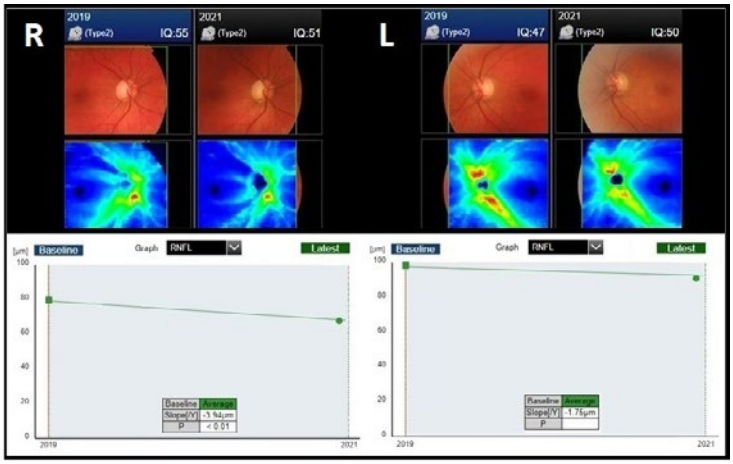


**Figure 4 Case 2:** Topcon Triton optical coherence tomography (OCT) retinal nerve fibre layer (RNFL) trend analysis for the right (R) and left (L) eye.

## Case 2

A 55-year-old Caucasian woman presented having been diagnosed as right normal-tension glaucoma (NTG) and left NTG suspect within the HES almost 2 years previously. Her baseline IOP upon diagnosis was 17 mmHg BE when measured using GAT. Treatment was initiated for the right eye only (g.latanoprost nocte). A 4-month review was originally scheduled that she was unable to attend as her husband's general health had deteriorated. The subsequent COVID-19 pandemic further delayed her review. Upon initial questioning at the ODTC she reported no ocular symptoms; alongside her topical hypotensive she had also been using hypromellose PRN BE for long-standing dry eye. She was a driver who reported no general health issues and was working as a civil servant. She had a history of migraine with aura since youth which she self-medicated with systemic analgesics PRN. In his 70s her father was diagnosed with glaucoma which was treated with a topical hypotensive.

Her unaided Snellen distance visual acuity was 6/5 and 6/6 (right and left). Near vision with a +1.50-DS add was n5 BE. Ocular adnexae and pupil reactions were normal. Her anterior chamber was deep (grade 3 modified Shaffer grading in all quadrants) with a central corneal thickness of 500/512 microns (right/left) as measured using ultrasound pachymetry (DGH 55 Pachmate II). Her IOP was 13/17 mmHg (right/left) when measured using GAT. Slit-lamp BIO revealed disc height measurements (and C:D ratio estimates) of 1.4 mm (0.85) and 1.5 mm (0.75) right and left, respectively. Marked NRR loss from 7 to 12 o'clock was evident in the right eye, accompanied by notable vascular nasalisation and bayonetting at 7 o'clock. Less damage was evident when reviewing the left eye, although there was possible superior NRR thinning visible through an emerging notch at 12–1 o'clock and vascular baring. OCT disc analysis is shown in Figure 3. RNFL thickness loss correlated with visible NRR loss, as seen directly with BIO. Longitudinal RNFL thickness analysis showed progressive RNFL loss BE since initial presentation (Figure 4). SITA standard 24-2 visual field analysis for the right eye showed enlargement of her inferior arcuate scotoma and the onset of an early superior arcuate defect over the past 22 months (mean deviation change from −5.10 dB to −6.30 dB). Visual field loss was less conclusive using the same testing paradigm for the left eye.

Despite the use of g.latanoprost nocte, evidence to suggest right glaucomatous progression was strong. Conversely, although left disc assessment showed a possible NRR notch developing at 12–1

o'clock, there was no corresponding visual field loss. The presence of a visibly emerging NRR defect was however supported via OCT-based RNFL thickness analysis. In accordance with these findings a case of right NTG progression and left suspect NTG was presented virtually to the supervising specialist optometrist. Possible treatment options communicated to the patient included monitor only, SLT or changing the ocular hypotensive regimen. The patient had indicated that she would prefer to continue with eye drops as opposed to SLT. The virtual review was conducted within 5 days of the patient episode. To reduce the risk of further right progression and left conversion, a new target of at least 25–30% IOP reduction from baseline was set for both eyes. An amendment to the treatment strategy was made by adding g.brinzolamide BD for the right eye and initiating g.latanoprost mane for the left eye. The diagnosis and management plan were communicated to the patient and her GP via a letter. The patient was also sent a prescription form (NHS FP10SS) to enable her to acquire the drug from her local pharmacy, pending repeat prescription by the GP. A follow-up review within the ODTC was scheduled for 3 months to assess IOP and adherence to treatment.

## Discussion

Studies have shown that the proportion of NTG in COAG varies significantly in different ethnic groups: approximately 40%, 60% and 70% in Caucasian, African and Asian populations, respectively.[13] Furthermore, in East Asian populations it accounts for 83–95% of COAG cases.[13] However, the prevalence of NTG in glaucoma clinics tends to be much lower, suggesting that a large majority of such patients remain undiagnosed. Epidemiologic and genetic studies report that those with NTG have a different set of predisposing factors compared to those with POAG. Those with NTG tend to be older than those with POAG.[14] NTG is also more prevalent in females[14] and individuals with a thinner mean central corneal thickness.[15] Higher incidences in those with vascular dysregulation from systemic disease or vasospastic disorder have also been found.[16] Myopia has been identified as an important risk factor.[17] This finding, alongside morphometric differences associated with the structure of the ONH, retina and cornea, may explain the high prevalence of NTG in Asians when compared to other populations.[18, 19]

Management of NTG follows the same principles as treatment for other COAG subtypes, i.e. to reduce IOP by the minimum amount needed to lower the risk of visual impairment during a lifetime. The treatment strategy used in the present case was based on the findings of two landmark clinical trials, the Early Manifest Glaucoma Trial[5] and the Collaborative Normal-Tension Glaucoma Study.[20] The Early Manifest Glaucoma Trial randomised 255 participants aged 50–80 years with newly diagnosed COAG to receive laser trabeculoplasty plus topical betaxolol hydrochloride ($n$ = 129) or no initial treatment ($n$ = 126). Half of those enrolled in the trial had a baseline IOP of <21 mmHg on diagnosis. The reported outcome was that after 5 years 45% of the intervention group (mean IOP reduction 25%) and 62% of the control group showed glaucomatous progression as based on visual field and optic disc outcomes. This difference remained even when results were stratified according to baseline IOP level.[5] The Collaborative Normal-Tension Glaucoma Study randomised 140 participants with COAG and a maximum IOP <25 mmHg to receive an IOP reduction of 30% or no treatment. After a 4-year follow-up period it was reported that 35% of controls and 12% of intervention participants had shown glaucomatous progression based on visual field loss. Filtration surgery was the most effective method of lowering IOP; however, it also caused cataract to develop more readily than topical hypotensive or laser trabeculoplasty.[20] Although the level of IOP had influenced the course of NTG, the authors remarked that the rate of progression was highly variable, sufficiently so that half of the controls showed no progression over the duration of the trial. It was recommended that treatment should be individualised according to risk factors, the stage of disease and rate of progression.[20] When considering the present case the risk factors outlined by the Collaborative Normal-Tension Glaucoma Study as useful predictors of progression were female gender, migraine and family history, all of which were identified as leading to a higher risk of faster progression.[20]

Although the pathophysiology of NTG is not completely understood it has been suggested that poor circulation to the eye is a contributing factor. Intraocular venous pressure, as measured using ophthalmodynamometry, is typically equal to or slightly above IOP in healthy individuals.[21] Conversely it is often markedly increased in those with open-angle glaucoma.[22,23] An increase in intraocular venous pressure may decrease perfusion to the ONH[24] which has been associated with optic disc excavation[25,26] and visual field loss in NTG.[27–29] Due to a positive influence on ocular haemodynamics, interventional studies have suggested a potential role for phosphodiesterase 5 inhibitors in the treatment of those with open-angle glaucoma.[30,31] However, further investigation is warranted before a definitive conclusion can be made.[32]

In the present case the decision to add a medicine from another therapeutic class to treat the right eye was primarily underpinned by NICE guidance.[4] Brinzolamide was chosen as the use of beta-blockers for NTG treatment is not well supported[33] and brimonidine has a high rate of discontinuance (30%) secondary to drug-related adverse events.[33,34] Studies have suggested that patients only use their drops about 50% as often as prescribed or that even when using their drops they fail to instil them effectively into the eye.[12] The use of multiple drops contributes to this issue and increases the amount of preservative entering the tear film. The latter has been established as a cause of non-tolerance to topical glaucoma medication, particularly when benzalkonium chloride is used with pre-existing ocular surface disease, as in the present case.[35] To combat this, the patient was counselled carefully about the possible change in treatment strategy beforehand. If in subsequent reviews there is poor IOP control or continued progression, further intervention will need to be considered for this 55-year-old patient.

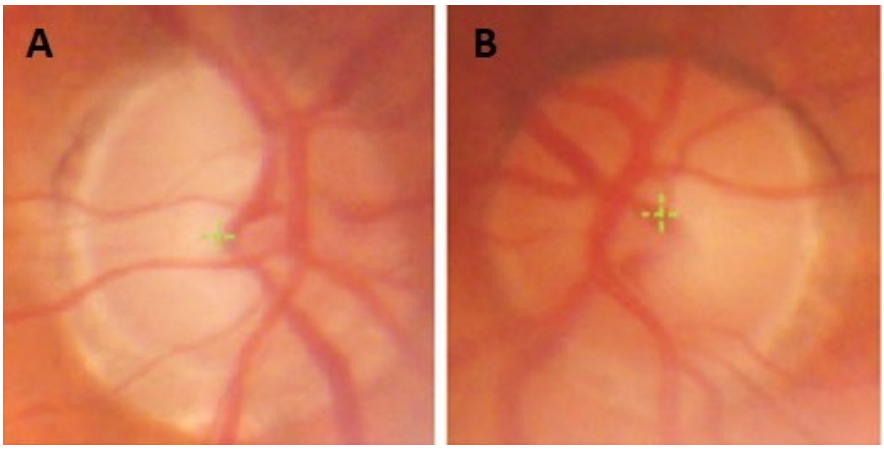


**Figure 5 Case 3:** colour photographs of the right (A) and left (B) optic nerve.

**Summary**

In the present case, a young, healthy patient treated for right NTG presented for a significantly delayed follow-up within the ODTC. Following assessment, right NTG progression and left suspect NTG were found. Following virtual review by a specialist optometrist a management plan was formulated consisting of increased augmentation of topical hypotensive for the right eye of a different drug class and initiating drop therapy for the left eye. A follow-up review within the ODTC was scheduled for 3 months to assess IOP and adherence to treatment.

## Case 3

An 89-year-old Caucasian male presented having been diagnosed with right POAG 10 years previously (baseline IOP 24 mmHg using GAT). He had been monitored within the HES regularly since then and this was his first visit to the ODTC. The reason for unilateral disease was unclear but it was presumed that trauma may have been implicated from his previous career as a boxer. He was originally prescribed g.bimatoprost nocte to treat; however suboptimal IOP control and disease progression over the past decade resulted in fixed-combination g.brimonidine and timolol BD being added to his treatment plan. Since diagnosis his IOP had ranged from 13 to 25 mmHg when measured using GAT. He reported no issues with administering his eye drops and demonstrated an adequate technique.

Upon presentation the patient reported no ocular or visual issues. He had no HES history outside of glaucoma and his left eye was found to be unremarkable. He was fit and well, a non-smoker and non-driver. Systemic medication was taken for long-standing hypertension and gout. He had a low hyperopic prescription and wore bifocal glasses. His best-corrected Snellen visual acuity was 6/9 and 6/6 (right and left). Pupil reactions were normal, as was the appearance of the anterior eye. No anterior-chamber activity or evidence of pseudoexfoliation syndrome was evident. Van Herick estimates of the right temporal and nasal iridocorneal angle depth were narrow (grade 1). Comparatively the iridocorneal angle was estimated as wide open (grade 4) for the left eye. Gonioscopy was performed with a non-indentation (Goldmann-type) lens. Right gonioscopy was recorded as grade 1 all quadrants with peripheral anterior synechiae covering the entire temporal quadrant. Left gonioscopy was grade 3 in all quadrants. There was moderate nuclear sclerotic cataract (right > left). His IOP was measured as 29/14 mmHg (right/left) using GAT.

The ONH appearance of each eye is shown in Figure 5. Both ONHs were measured as 1.7 mm vertical diameter; C:D ratio estimates were 0.70/0.50 (right/left). A right NRR notch at 12 o'clock was noted, alongside shallow, sloping NRR at 6 o'clock. Nasal cupping with associated nasalisation and bayonetting of ONH vasculature was also recorded. The left ONH appearance was stable and deemed not suspicious. SITA standard 24-2 visual field analysis of the right eye showed a stable inferior centre-involving arcuate defect and early superior nasal step (mean deviation −7.13 dB). The left visual field was normal when tested using the same paradigm. The degree of right ONH damage and associated visual field loss exhibited was consistent with that recorded 1/12 previously at his most recent HES review. At that time the right IOP was 21 mmHg (GAT). Therefore the current level of raised IOP was deemed not to have caused progression of the pre-established glaucoma.

When considering the existing optic neuropathy, history of trauma and angle configuration, a tentative diagnosis of right secondary angle closure glaucoma was made. The findings and associated implications were explained to the patient. Warnings of acute angle closure signs/symptoms were also given. The case was marked for urgent virtual review by the supervising consultant ophthalmologist who responded within 24 hours. The suggested management was to list for right phacoemulsification surgery and lower the IOP in the meantime by adding another agent to the patient's treatment plan, i.e. starting fixed-combination g.brimonidine and brinzolamide BD and fixed-combination g.bimatoprost and timolol mane. This recommendation was discussed with the patient via a telephone conversation. The patient consented and was posted a prescription form (NHS FP10SS) to enable him to acquire the necessary topical eye drops from his local pharmacy, pending repeat prescription by the GP. A follow-up review within the ODTC was scheduled for 4 weeks to assess IOP and adherence to treatment.

**Discussion**

Primary angle closure is not associated with any other cause, while secondary angle closure is associated with an identifiable contributory factor, e.g. history of trauma. Angle closure is characterised by the presence of iridotrabecular contact, which can lead to secondary elevation of IOP. In the present case the patient was originally

considered to have POAG; however, there is diagnostic uncertainty both at the original time of diagnosis and presently since no further information was available about the justification for the POAG diagnosis. Based on the current angle configuration and patient history a new tentative diagnosis of secondary angle closure precipitated by trauma and associated inflammation (resulting in peripheral anterior synechiae) was suggested. Conversely, a mixed mechanism, e.g. previous traumatic optic neuropathy with angle closure glaucoma, could not be excluded.

As POAG and angle closure glaucoma are profoundly different, consideration must be given when investigating their presentation and when devising a management strategy. Treatment for POAG aims to lower the IOP by modifying aqueous production and outflow characteristics. In contrast, treatment of angle closure aims to open barriers to circulation of aqueous flow inside the eye via decompartmentalisation. To achieve this is particularly important as although angle closure glaucoma is less prevalent than POAG, it has a greater tendency to cause significant loss of vision over a shorter timeframe.[36]

Over the past 40 years laser peripheral iridotomy has been commonly used as a preventive strategy to reduce this risk of angle closure glaucoma and acute angle closure in those with primary angle closure. Recent figures reported by the Royal College of Ophthalmologists suggest that in 2021 it was current practice for three-quarters of all ophthalmology consultants based in the UK to offer a prophylactic laser peripheral iridotomy to those with narrow or occludable angles.[36] Despite this, no firm evidence base exists to support the use of laser peripheral iridotomy for those with asymptomatic primary angle closure without elevated IOP. Having documented 13,844 laser peripheral iridotomy patient episodes across England in 2018–2019, the NHS has cited this procedure as a significant burden on capacity and called for the benefit of this treatment to be scrutinised to determine necessity. A recent trial of prophylactic laser peripheral iridotomy in those diagnosed as primary angle closure suspect (PACS) was conducted by He et al.[37] The study, commonly referred to as the ZAP trial, was based in the People's Republic of China. A total of 889 participants with PACS were recruited and randomised to receive laser peripheral iridotomy in one eye only. The outcome was the risk of incident angle closure disease of the treated versus untreated eye. After a 6-year follow-up period the study reported the following key figures relating to the untreated eyes:

- 4% of eyes had incident angle closure disease
- 3% of eyes had peripheral anterior synechiae
- <1% of eyes had acute angle closure

The rate of new angle closure disease was halved by laser peripheral iridotomy. However, this was negated by the more clinically relevant finding that, in the highest-risk PACS population on earth, progression of angle closure disease is uncommon. Consequently, the risk of profound vision loss if left untreated is small over a 6-year period. However, the results are not directly transferable to the UK population as the risk of angle closure disease in Asians is greater than any other ethnic group. Therefore, we should be cautious when interpreting the data assuming that the UK population are at a similar risk as those included in the study. Based on the results, informing PACS patients that the risk of acute angle closure is approximately 1/1000 per year is acceptable, despite the true risk being 3–4 times lower than this for Caucasians.

The results of the ZAP study have been further supported by the results of its sister study, ANALIS,[38] which reported a conversion rate of 5% (laser peripheral iridotomy) and 9% (untreated) from PACS to primary angle closure, primary angle closure glaucoma (PACG) or acute angle closure over a 5-year period. Based on the data presented, it is logical to conclude that recommending prophylactic treatment for all PACS patients is unnecessary. In alignment with this, the Royal College of Ophthalmologists advises that presumed occluded angles should only be referred to the HES based on glaucoma, elevated IOP or a risk factor that designates the patient as 'PACS plus' as opposed to 'PACS minus'.[36] PACS plus criteria are defined as either a limbal chamber depth grade <¼ (when measured using the van Herick technique) or an anterior-segment OCT showing iridotrabecular contact plus one of the following criteria:

- People with only one 'good eye' in which deterioration of vision may threaten independent living or livelihood
- Vulnerable adults who may not report ocular or vision symptoms
- Family history of significant angle closure disease
- High hypermetropia (> +6.00 D)
- Diabetes or another condition necessitating regular pupil dilation
- Those using antidepressants or medication with an anticholinergic action
- People either living in remote locations (such as foreign aid workers, armed forces stationed overseas or oil rig workers) where rapid access to emergency ophthalmic care is not possible

Conversely, PACS minus is defined as an individual who has the specified angle characteristics but none of the 'plus' criteria, and does not meet NICE glaucoma referral guidelines. It is recommended that a PACS minus patient should be advised to seek an annual sight test.[36]

Following publication of the EAGLE study, the management of those with primary angle closure and PACG has also been scrutinised.[39] The study, conducted in 30 HES over five countries, enrolled 419 participants aged 50 or over with primary angle closure and IOP ≥30 mmHg, or with PACG and IOP ≥21 mmHg. Participants were randomised to receive either laser peripheral iridotomy or clear lens extraction. The trial showed that clear lens extraction was better than laser peripheral iridotomy for disease control, patient-reported outcomes and economic measures. It was also reported that after 3 years, IOP control was 1 mmHg lower for the clear lens extraction group but with fewer adjunct medications. The rate of being without topical medication was 60% versus 20% in the clear lens extraction and laser peripheral iridotomy groups, respectively.

The use of laser peripheral iridotomy as the primary treatment option for those with primary angle closure has been further questioned following reports suggesting that residual iridotrabecular contact after laser peripheral iridotomy is common (20–80% of cases)[40,41] and that effectiveness may lessen as disease severity increases.[41] Although studies have shown that laser peripheral iridotomy is effective for most PACS eyes, many with primary angle closure, PACG and acute angle closure require additional treatment to control IOP. In alignment with this and the findings of the EAGLE study it has been largely accepted that for those with primary angle closure clear lens extraction is typically effective, safe, cost-effective and benefits the patient's quality of life compared to laser peripheral iridotomy. This has led to a general shift in management away from laser peripheral iridotomy for those with primary angle closure and PACG.

**Summary**

In the present case an elderly, healthy patient treated for right POAG presented for an early follow-up at the ODTC following an eye examination a week previously. Assessment confirmed an elevated right IOP alongside signs of iridotrabecular contact as seen via gonioscopy. A new tentative diagnosis (secondary angle closure glaucoma) was suggested and a management plan was promptly formulated. The patient was listed for phacoemulsification surgery and his topical hypotensive regimen was amended to maximum drop therapy. The surgery was performed 9 months later, postoperative right IOP was measured as 18 mmHg using GAT and his eye drop regimen was returned to g.bimatoprost nocte and fixed-combination g.brimonidine and timolol BD. Long-term management will continue to be dictated by the IOP level and visual function of the affected eye.

**Summary**

This article aligns to the General Optical Council CPD domain 3 (clinical practice). Within this domain the following standards are addressed:

- Keeping your knowledge and skills up to date (s.5)
- Recognise, and work within, your limits of competence (s.6)
- Conduct appropriate assessments, examinations, treatments and referrals (s.7)

**Relevance to practice**

- This article would be of interest to any eye care professional wishing to learn more about glaucoma or who wishes to become accredited with a College of Optometrists higher qualifications in glaucoma
- This article provides information on the definitions and prevalence of glaucoma and covers the classification of the different types of glaucoma
- To facilitate and enhance disc examination clinical signs of glaucoma are introduced
- Interpretation of key investigations, including visual field and OCT-based RNFL analyses, is discussed
- Clinical management guidelines relating to referral refinement and appropriate referral are outlined
- Treatment strategies for different glaucoma subtypes based on research evidence are given

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# CET multiple choice questions

This article has been approved for one non-interactive point under the GOC's continuing professional development (CPD) scheme. The reference and relevant domains are stated at the head of the article.
To gain your point visit the College's website college-optometrists.org/oip and complete the multiple choice questions online. The deadline for completion is 31 December 2024. Please note that the answers that you will find online are not presented in the same order as in the questions below, to comply with GOC requirements.

**CPD exercise**

After reading this article, can you identify areas in which your knowledge of glaucoma has been enhanced?

How do you feel you can use this knowledge to offer better patient advice?

Are there any areas you still feel you need to study and how might you do this?

Which areas outlined in this article would you benefit from reading in more depth, and why?

1. **Your patient has a healthy optic nerve appearance, a normal central corneal thickness, full visual field and a repeatable IOP of 23 mmHg as measured with contact tonometry. What is the most likely diagnosis?**

   a. Primary open-angle glaucoma
   b. Ocular hypertension
   c. Normal-tension glaucoma
   d. Primary angle closure glaucoma

2. **NICE Guideline NG81 (Glaucoma: diagnosis and management) recommends what initial treatment for those with ocular hypertension?**

   a. 360° selective laser trabeculoplasty
   b. Generic prostaglandin analogue
   c. Trabeculectomy with mitomycin C
   d. Topical beta-blocker

3. **Which of the following statements is true?**

   a. Bimatoprost has a lower efficacy than latanoprost
   b. Both bimatoprost and latanoprost should ideally be instilled at night
   c. Latanoprost has been found to cause more side effects than bimatoprost
   d. Fixed-combination latanoprost and timolol should ideally be instilled at night

4. **Which of the following statements is correct about normal-tension glaucoma?**

   a. The prevalence is highest in Asian populations
   b. Hyperopia has been identified as a risk factor
   c. The incidence is higher in males
   d. The incidence is higher in Caucasian than African populations

5. **Those with normal-tension glaucoma:**

   a. Never progress after IOP has been lowered with treatment
   b. Typically have a thicker central cornea than healthy normal individuals
   c. Should only be managed with surgical intervention
   d. May have wider diurnal fluctuations than the normal population

6. **In addition to the specified angle characteristics, which of the following risk factors does not designate a patient as 'PACS plus' as opposed to 'PACS minus'?**

   a. Family history of significant angle closure disease
   b. Diabetes or another condition necessitating regular pupil dilation
   c. Those using antidepressants or medication with an anticholinergic action
   d. High myopia (> −6.00 D)