Volume 8 No 3 - 2025

# OPHTHALMIOPINION

CME Ophthalmology Insights



- Corneal Allogenic Intracorneal Ring Segments (CAIRS): Past, Present and Future
- Local Anaesthetic Injections into the Trigeminal Branches for Chronic Pain Around the Eye
- The Algorithmic Eye: Navigating the Future and Ethics of Artificial Intelligence in Ophthalmology

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# Editorial

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**Dr Brian van Onselen**
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Dear colleagues

Greetings to all from a summery Johannesburg. The rains have started and Christmas is around the corner.

Artificial Intelligence (AI) is a hot topic at the moment. Anyone fortunate enough to have invested in tech shares is now reaping the dividends. AI is here to stay in terms of medical applications and ophthalmology is at the forefront of medical applications using AI. We have an excellent article in this issue detailing the pitfalls and possible benefits of AI.

Keratoconus management is constantly evolving. Intrastromal rings provided a valuable adjunct in stabilising the cone, but there were issues with the material. Corneal Allogenic Intracorneal Ring Segments (CAIRS) are a novel treatment that offer all the benefits of extra stability but with biologically compatible tissue. Read on for an overview of the CAIRS procedure as well as some valuable treatment tips.

Our third article concerns those difficult cases of patients with chronic orbital pain due to various causes. Blepharospasm is often allied to this and these patients are notoriously difficult to treat. Local anaesthetic injections in targeted trigeminal nerve trigger points can be a valuable treatment option and this article details how to perform the simple procedure.

Stay safe and have a blessed festive season.

Brian


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# Corneal Allogenic Intracorneal Ring Segments (CAIRS): Past, Present and Future

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**Affiliation: Stellenbosch University Health Sciences, Ophthalmology Department**

Keratoconus remains one of the most challenging corneal ectatic disorders, often affecting young patients and leading to progressive visual impairment.[1] The incidence of keratoconus is 1.5 to 25 cases per 100 000 people, though prevalence is higher, potentially affecting 1 in 700 to 1 in 2,000 people globally. Keratoconus is under diagnosed and it varies in incidence in different populations. Traditional management strategies have ranged from spectacles and rigid gas-permeable lenses to intracorneal ring segments (ICRS) and, ultimately, corneal transplantation.[2] Over the past decade, Corneal Allogenic Intracorneal Ring Segments (CAIRS) have emerged as a promising alternative to synthetic polymethylmethacrylate (PMMA) rings, offering biocompatibility, reversibility, and potential long-term stability.[3]

## Historical Background

The concept of reshaping the cornea by inserting ring segments dates back to the late 20th century with synthetic ICRS (e.g. Intacs, Ferrara rings).[4] These devices mechanically altered corneal curvature, improving visual acuity in keratoconus and post-LASIK ectasia.[5] However, complications such as extrusion, infection, neovascularisation, and biomechanical mismatch with native tissue limited widespread adoption.[6] Intrastromal corneal ring channels can form dense acellular intrastromal scar formation and mild inflammation. **(Figure 1)**

The idea of using donor corneal tissue rather than synthetic material was pioneered by Pradhan et al. (2018),[7] introducing CAIRS as a biologically integrated alternative. By harnessing preserved human corneal stroma, CAIRS avoids issues of foreign-body intolerance, while still providing the mechanical flattening effect necessary for keratoconus stabilisation. **(Figure 2 and 3)**

## Surgical Approaches

Two main surgical methods have evolved for CAIRS implantation:

**1. Trephine-Assisted Dissection[8]**

- Involves manual creation of intrastromal tunnels using trephines and lamellar dissectors.
- Although cost-effective and feasible in resource-limited settings, reproducibility and precision depend heavily on surgeon experience.

**2. Femtosecond Laser–Assisted Technique[9]**

- Allows creation of highly precise stromal tunnels at predetermined depths and diameters.
- Provides consistent outcomes, improved centration, and reduced risk of perforation.
- Increasingly considered the gold standard in well-equipped centers. **(Figure 4, Figure 5)**

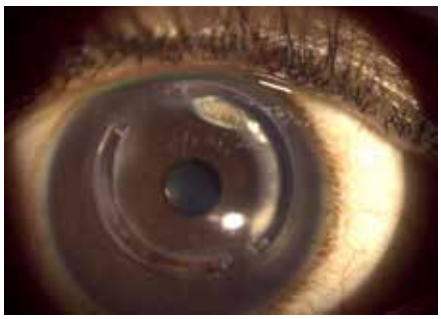


*Figure 1. Scarring around intracorneal ring segment. (Courtesy the author)*

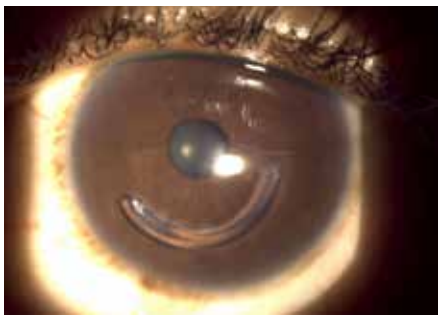


*Figure 2. Intracorneal PMMA ring segment. (Courtesy the author)*

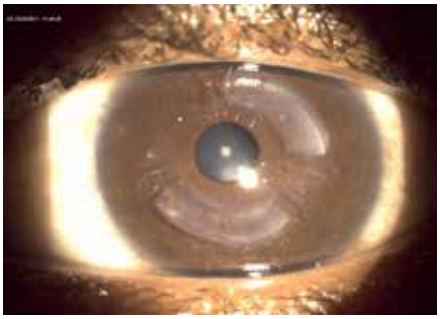


*Figure 3. CAIRS segment in keratoconus eye. (Courtesy the author)*

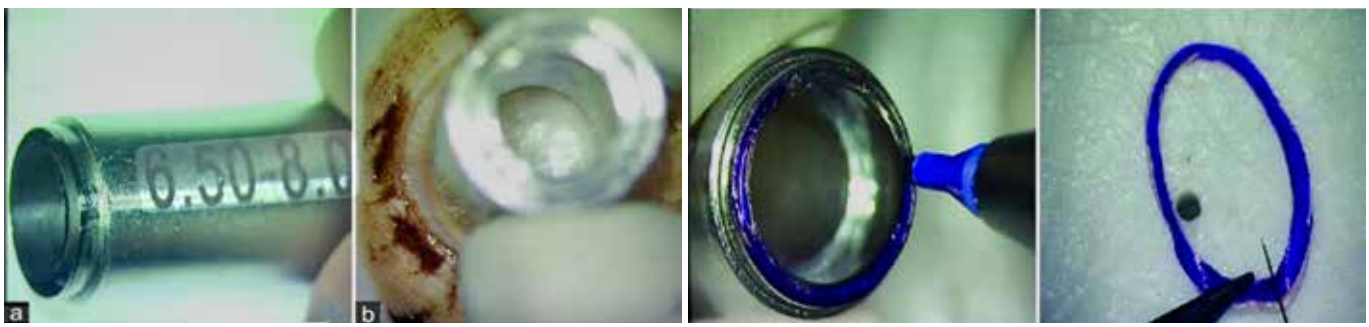



*Figure 4. Trephine (Soosan Jacobs trephine.)[8]*

## Nomograms and Planning Software

The evolution of CAIRS has been paralleled by the development of nomograms to guide surgical planning.[10] These consider cone location, corneal thickness, K values, and refractive error.

- Early approaches adapted existing PMMA ICRS nomograms, but with modifications to account for the biological nature of allogenic tissue[11]
- Dedicated CAIRS nomograms now provide guidance on segment thickness, arc length, and depth of placement, tailored to the severity and asymmetry of keratoconus.[12] **(Figures 6-8)**

Modern planning software integrates corneal topography and tomography data, enabling surgeons to simulate the impact of CAIRS on corneal curvature.[13] Customised surgical plans, often linked directly to femtosecond laser platforms, improve predictability. Drs Gunn and Cronin have developed a user-friendly planning software programme with which CAIRS is customised. (CAIRS PLAN).

## Surgical Technique

The procedure typically involves the following steps:[14]

- Preoperative imaging with the MS39 tomography and pachymetry.
- Tunnel creation — either femtosecond-assisted or manual.
- Preparation of allogenic ring segments from donor stromal tissue, shaped according to planned arc and thickness.
- Drying of the segment – my preferred technique. Followed by insertion of the CAIRS into stromal tunnels.
- Postoperative regimen includes topical antibiotics, corticosteroids, and close monitoring for immune reaction or extrusion. **(See Figures 9-16)**

Compared with synthetic ICRS, the biological integration of CAIRS reduces the risk of extrusion and enhances long-term stability.

## Clinical Outcomes

Early studies report encouraging results:[15,16]

- **Visual acuity:** Improvement in uncorrected and best-corrected visual acuity in most patients.
- **Keratometry:** Significant flattening of steep keratometry values, with improvement in regularity indices.
- **Tolerance:** Lower risk of foreign-body complications, extrusion, or corneal melting compared to synthetic devices.
- **Reversibility and repeatability:** Segments can be exchanged or adjusted as disease progresses.

In **Figures 17-20 (page 7)**, note the improved corneal curvature. Best corrected and uncorrected acuity improved in this patient.

## Customised CAIRS

The most exciting development lies in customised CAIRS,[11] designed to match each patient's ectatic pattern. Using donor corneal tissue shaped by femtosecond laser or excimer-based sculpting, customised rings can be manufactured with variable arc lengths, thicknesses, or asymmetric profiles. This approach allows targeted flattening of steep meridians, maximising optical benefit while minimising tissue manipulation. Ziemer (Ziemer Ophthalmic Systems AG) have developed a customised CAIRS programme for the design of the segments which will be released soon by the final quarter of this year. CAIRS segments are cut precisely at a pre-determined depth under OCT guidance.



*Figure 5. Photo of tunnel with laser (Courtesy the author)*

**Nomogram for the Insertion of CAIRS[a]**

| Parameter | Segment Size[b] (µm) | Depth (µm) |
|---|---|---|
| Decentered cone: 1 segment | | |
| Kmax - Kcenter (D) | | |
| > 6.00 | 750 | 250 |
| 4.00 to 6.00 | 750 | 300 |
| 3.00 to 4.00 | 500 | 250 |
| < 3.00 | 500 | 300 |
| Centered cone: 2 segments | | |
| SimK > 52.00 D | 750 | 250 |
| SimK < 52.00 D | | |
| MRSE (D) | | |
| > -8.00 | 750 | 250 |
| -5.00 to -8.00 | 750 | 300 |
| -3.00 to -5.00 | 500 | 250 |
| < -3.00 | 500 | 300 |

*CAIRS = corneal allogenic intrastromal ring segments; Kcenter = central keratometry; Kmax = maximum keratometry; MRSE = manifest refraction spherical equivalent; SimK = simulated keratometry*
*[a]Adapted and modified from the nomogram used by the authors for the insertion of polymethylmethacrylate ring segments.*
*[b]Segment sizes are determined based on the size of the double-bladed trephine, with segment arc length 160 to 170°.*

*Figure 6. Table 1: Shady Awwad nomogram*

- 180° arc, corneal stromal tissue (approximately 500 µm)
- 2 mm wide
- Channel diameters and depth
  - Inner diameter: 4 mm
  - Outer diameter: 7.5 mm
  - Depth: 200 µm
- Incision Cut Energy: 1.30 µJ
- Ring Energy: 1.30 µJ
- Incision Cut Length: 1.5 mm
- Incision Axis: steep
- Cones
  - Asimetric cone: single segment implantation
  - Central cone: symmetric two segment implantation

*Figure 7. Table 2: Surgical and laser parameters of the Istanbul Nomogram*

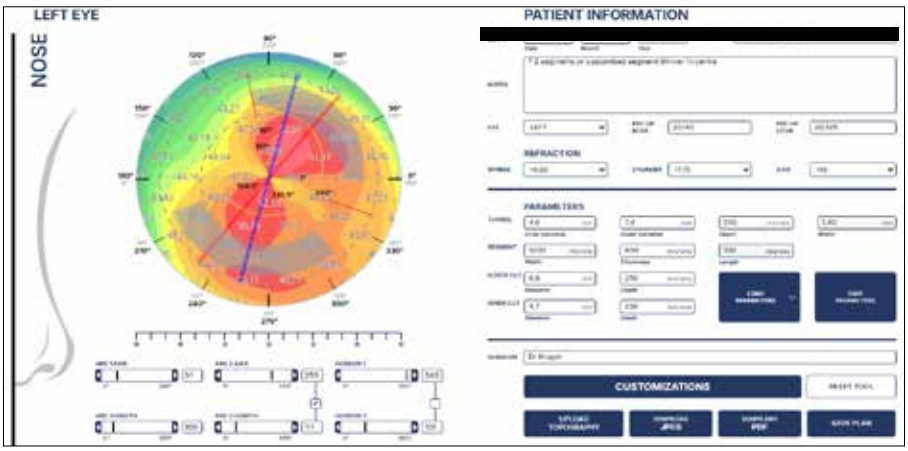



*Figure 8. CAIRS Planning software incorporating the MS39 (Courtesy the author)*

In **Figure 21** we see the asymmetric profile where the segment is cut thinner for the lesser ectasia area. **(See Figures 21-24)**

## Customised CAIRS Case Study

One of my cases which I did customised CAIRS on in the left eye was preoperatively 20/125 uncorrected vision and best corrected was 20/40 (-6.00/- 7.75 x 145) **(Figures 17, 24)**. Four weeks post-op uncorrected vision was 20/32 (+0.5/-1.50 x175). Segments were cut with the Ziemer Z8 (Ziemer Ophthalmic engineering, Switzerland).

In my own series I have seen visual improvement in most cases. Visual improvement is remarkable. **(Figures 1 25-27 and also Figures 18-20)** In cases where there is scarring centrally it requires DALK (Deep lamellar keratoplasty).

## Future Developments

The future of CAIRS is tied to three parallel advances:

- Tissue engineering: Development of standardised, sterilised, ready-to-use stromal segments from eye banks,[18] potentially using decellularised or cross-linked corneal tissue. KeraNatural from VisionGift, Boston, Massachusetts is already available for implantation.
- Integration with cross-linking: Combining CAIRS implantation with corneal cross-linking (CXL) may provide both biomechanical stabilisation and optical rehabilitation.
- Artificial intelligence planning: Machine-learning–driven software could predict outcomes and personalise CAIRS design beyond current nomogram limitations.[14]

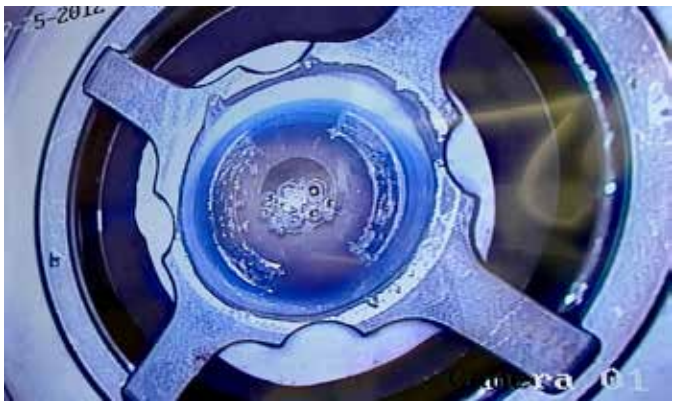


*Figure 9. Artificial chamber (Courtesy the author)*

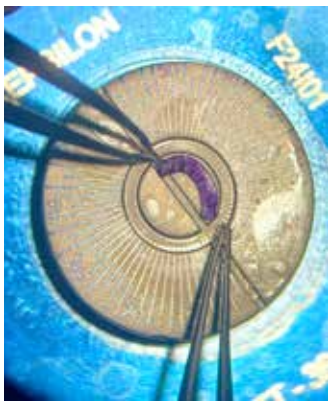


*Figure 10. Preparing segments. (Courtesy the author)*

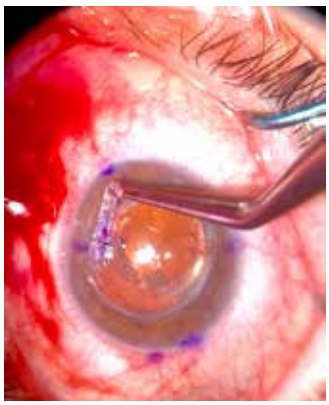


*Figure 11. Inserting the segment. (Courtesy the author)*



*Figure 12. Artificial chamber (Courtesy the author)*

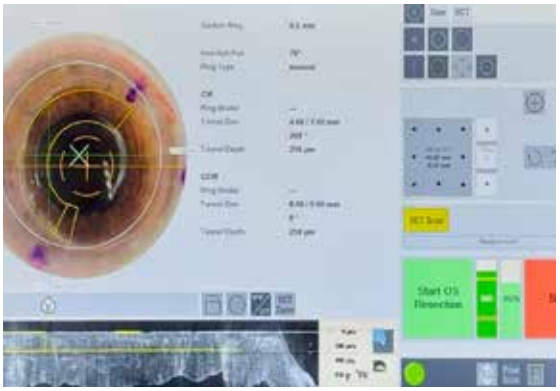


*Figure 13. Intra-operative OCT Image. (Courtesy the author)*



*Figure 14. Tunnels cut with the laser (Courtesy the author)*

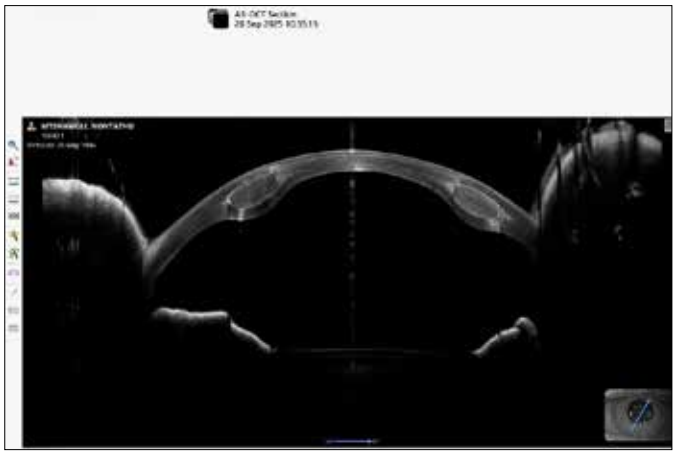


*Figure 15. MS 39 Image of CAIRS Courtesy the author)*



*Figure 16. Warming cup to dry segments (Courtesy the author)*

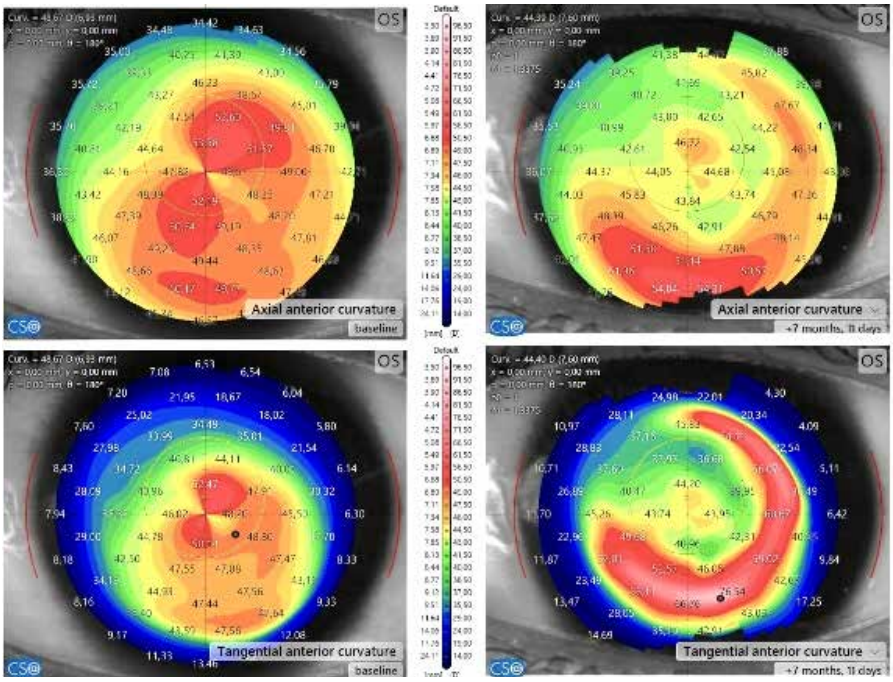



*Figure 17. MS39 Scan of pre-and post-op after CAIRS (Courtesy the author)*

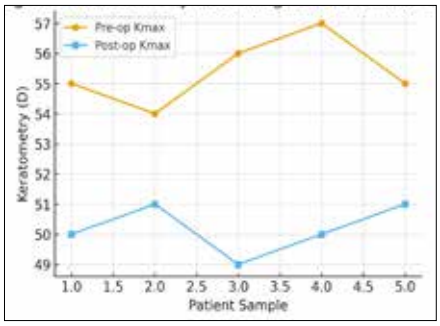



*Figure 18. KMax pre- and post-CAIRS (Courtesy the author)*

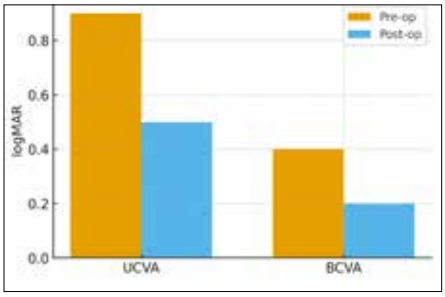



*Figure 19. Visual Improvement after CAIRS. (Courtesy the author)*

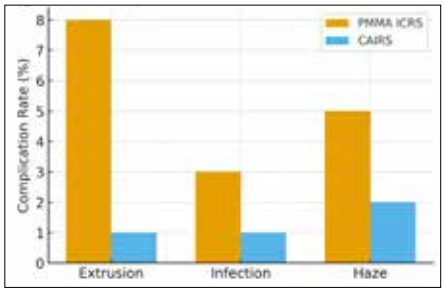



*Figure 20. Complication rates CAIRS vs PMMA ICRS. (Courtesy the author)*



*Figure 21. Planning of segments on Donar tissue for CAIRS. (Courtesy the author)*



*Figure 22. Intra-operative OCT of the Donar tissue (Courtesy the author)*

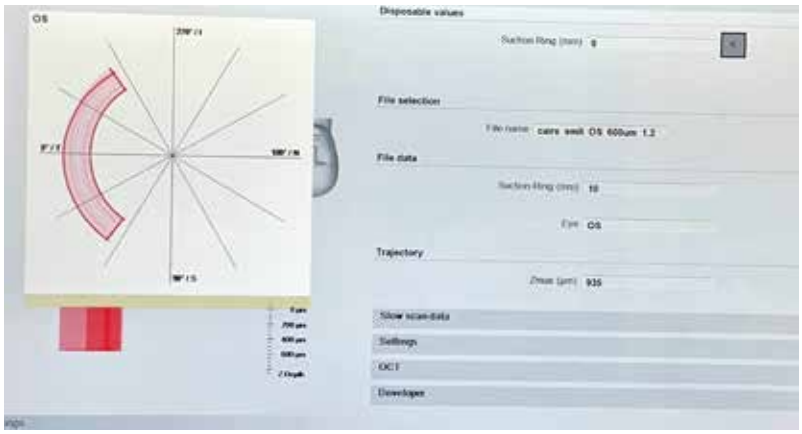



*Figure 23. Customised planning figure (Courtesy the author)*

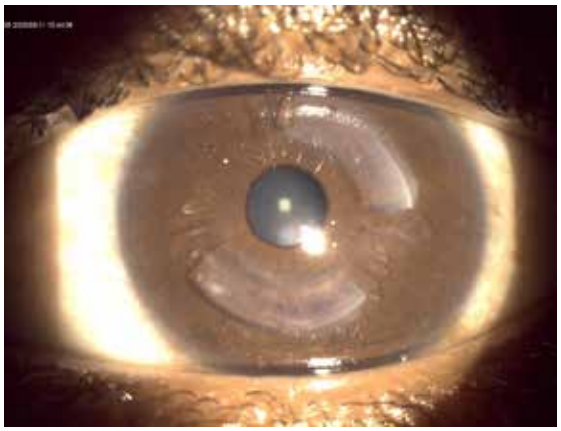


*Figure 24. Photo of Asymmetric CAIRS in situ (Courtesy the author)*

## Factors Influencing Outcomes

Several variables affect success rates:[15]

- **Disease stage:** Best results occur in moderate keratoconus with central or paracentral cones. Advanced ectasia with severe thinning may require transplantation.
- **Surgical precision:** Depth, centration, and arc length directly impact visual gain.
- **Tissue quality:** Donor stromal clarity and uniformity play key roles in optical performance.
- **Adjunct therapies:** Use of corneal cross-linking enhances long-term stability.
- **Patient selection:** Careful screening for corneal scarring, extreme thinning, or endothelial dysfunction is essential. In central corneal scarring it is best to rather do deep lamellar keratoplasty (DALK) or penetrating keratoplasty.

## Crosslinking (CXL)

Crosslinking can be done after CAIRS implantation. My practice is not to do crosslinking too early as the CAIRS segment effect and stabilisation is completed by 6 (six) months. Most of the effect

is in the first 3 (three) months following implantation. Soosan Jacob et Al[16] published accelerated CXL results and showed significant improvement in corrected and uncorrected DVA. They also did not have any cases in which keratoconus progressed.

It is better to crosslink after CAIRS, as crosslinking prior to CAIRS reduces the effect of CAIRS. Segments can be pre-crosslinked and dried and then inserted. This improves handling (less deformity) better maintenance of shape and volume.

## Topo-guided TransPRK (tPRK/ TG-tPRK)

As emerging adjunct to CAIRS and corneal crosslinking (CXL) is topo-guided transepithelial photorefractive keratectomy (TG-tPRK), 6 (six) months after the crosslinking when most of the effect and flattening of crosslinking has occurred. This aims to further regularise the anterior cornea surface and enhance optical quality. This improves BCVA compared with crosslinking alone. CAIRS provides biomechanical support and CXL ensures stability, residual higher-order aberrations and irregular astigmatism may still limit visual potential. TG-tPRK, performed after corneal stabilisation (typically 3–6 months post-CAIRS), has been shown in studies following ICRS and CXL to reduce corneal irregularity, improve topographic symmetry, and yield additional lines of uncorrected and best-corrected distance visual acuity.[16] The procedure is typically limited to a therapeutic ablation of ≤50 µm, with concomitant mitomycin-C application to mitigate haze. The mechanical reshaping of CAIRS, the biomechanical stiffening of CXL, and the optical smoothing of TG-tPRK, offers a synergistic pathway for visual rehabilitation in advanced keratoconus. Although specific long-term data in the CAIRS population remain limited, early reports suggest that this multimodal strategy may represent a significant advance in personalised keratoconus management. My approach is to wait for 6 months after the CXL, as CXL done first gives flattening. Pre-pachymetry and epithelial mapping is essential. I limit stromal ablation to 50 microns, typically using MMC 0.02 % for 12 -20 seconds.

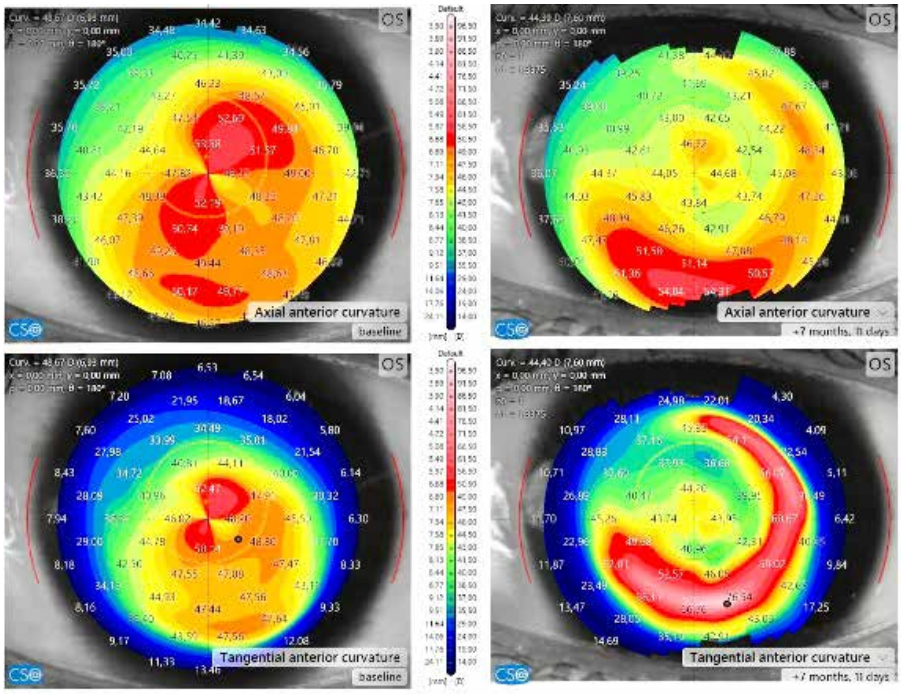



*Figure 25. Topography of Case, before and after. (Courtesy the author)*

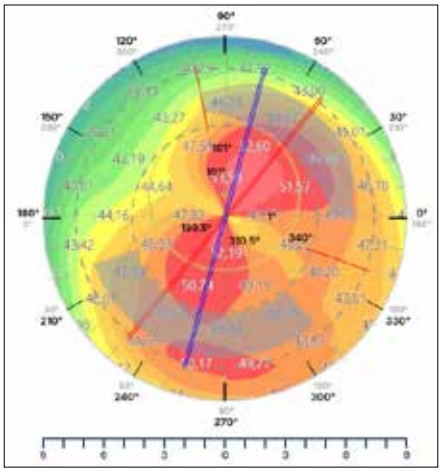


*Figure 26. Planning of Customized CAIRS case on the MS 39. (Courtesy the author)*

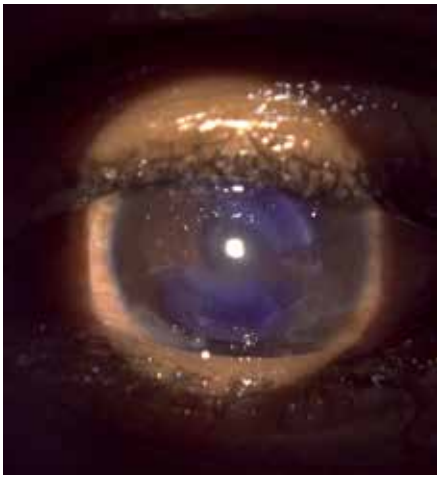


*Figure 27. CAIRS in Situ one day after surgery. (Courtesy the author)*

## Conclusion

CAIRS represents a paradigm shift in the management of keratoconus and related ectatic disorders.[16] By replacing synthetic material with biocompatible corneal tissue, this technique combines optical rehabilitation with biological integration. While still in its early stages, CAIRS offers the potential for safer, more customisable, and more sustainable treatment compared to synthetic ICRS or keratoplasty. Ongoing refinements in nomograms, imaging, and tissue engineering are likely to expand their role in modern corneal surgery. CAIRS reduces the need for grafts and improves vision in most cases.

Nomograms for CAIRS are emerging, though not universally accepted, with examples developed by Jacob, the Istanbul group, and Awwad, who adapted an Intracorneal Ring Segment (ICRS) nomogram. Surgical planning for CAIRS has now moved to personalised nomogram-guided methods, accounting for the wide morphological variability of keratoconus.

**References available on request.**

# The Use of Local Anaesthetic Injections into the Trigeminal Branches for Chronic Pain Around the Eye

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Chronic pain around the eye is a complex and often debilitating condition that can stem from various causes, including neuropathic pain syndromes, trauma, surgical interventions, and idiopathic facial pain disorders. When conventional treatments fail to provide relief, interventional procedures targeting the trigeminal nerve — particularly through local anaesthetic injections — may offer diagnostic advantages and therapeutic benefit. There was an interesting talk by Dr Erin Shriver at the WOC in Vancouver and this article explores the treatment strategies she employs. This strategy is also effective for essential blepharospasm where trigeminal irritation is often a trigger.

## Anatomy of the Trigeminal Nerve

The trigeminal nerve (cranial nerve V) is the primary sensory nerve of the face, with three major divisions:

- Ophthalmic division (V1) – Supplies the scalp, forehead, upper eyelid, and the eye itself, including the conjunctiva and cornea.
- Maxillary division (V2) – Innervates the lower eyelid, cheek, upper lip, and upper teeth.
- Mandibular division (V3) – Contains both sensory and motor fibres, supplying the lower face, jaw, and muscles of mastication.

For chronic periorbital pain, the ophthalmic (V1) and occasionally the maxillary (V2) divisions are the primary targets.

Branches of the ophthalmic division that are often involved in periorbital pain include:

- Supraorbital nerve
- Supratrochlear nerve
- Infratrochlear nerve
- Lacrimal nerve
- Nasociliary nerve

These nerves exit through foramina in the skull to reach the periorbital soft tissues, making them accessible for targeted local anaesthetic injections. **(Figure 1)**

## Understanding Chronic Periorbital Pain

Chronic periorbital pain can arise from multiple etiologies:

- Post-herpetic neuralgia (after herpes zoster ophthalmicus)
- Post-surgical pain, particularly after procedures involving the orbit, eyelids, or sinuses
- Traumatic neuropathic pain, e.g. following orbital fractures
- Migraine and trigeminal autonomic cephalalgias
- Idiopathic orbital pain syndromes, such as chronic periorbital neuralgia
- Painful post-blepharoplasty syndrome
- Orbital myofascial pain or tension-type headache referred pain

In many of these conditions, especially where neuropathic mechanisms dominate, local anaesthetic injections can help modulate peripheral nociceptive input and provide temporary or even lasting pain relief.

## Indications for Local Anaesthetic Injections

Local anaesthetic nerve blocks are used for two primary purposes:

**Diagnostic Blocks**

A local anaesthetic block can confirm whether pain originates from a particular nerve branch. For instance, temporary relief following a supraorbital nerve block suggests involvement of that branch in the pain pathway.

**Therapeutic Blocks**

Local anaesthetic injections may provide temporary symptom relief, and in some cases, repeated blocks can "reset" pain pathways, particularly in cases of peripheral sensitisation. When combined with corticosteroids or neurolytic agents, the duration of analgesia may be extended.

## Injection Techniques

**Supraorbital Nerve Block**

- **Anatomy:** The supraorbital nerve exits the orbit via the supraorbital notch or foramen, approximately

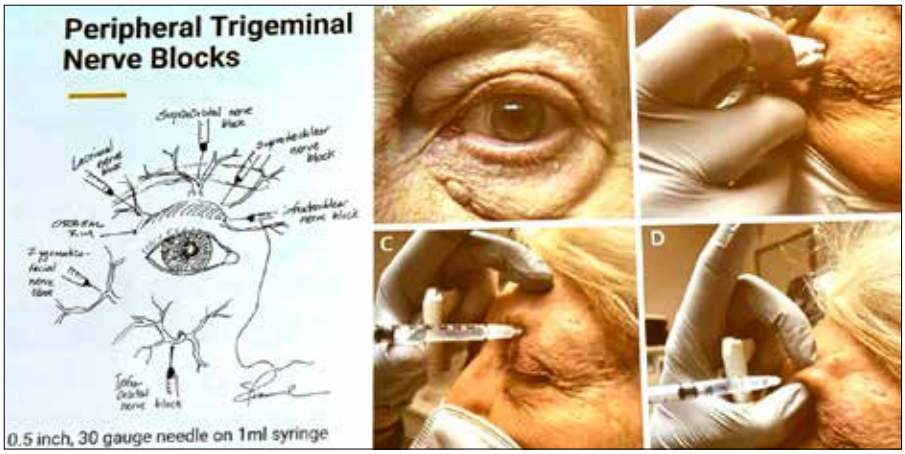



*Figure 1.*

2.5 cm lateral to the midline of the forehead.
- **Technique:**
  - Palpate the supraorbital notch.
  - Insert a small-gauge needle (e.g. 27G) perpendicular to the skin until the bone is gently contacted.
  - Withdraw slightly and inject 1–2 mL of local anaesthetic (e.g. 1 % lidocaine or 0.5 % bupivacaine).
- **Indications:** Pain in the forehead, upper eyelid, and scalp.

**Supratrochlear Nerve Block**
- **Anatomy:** This nerve lies medial to the supraorbital notch, exiting above the trochlea of the superior oblique muscle.
- **Technique:**
  - Insert the needle 1 cm medial to the supraorbital notch.
  - Inject 0.5–1 mL of local anaesthetic.
- Indications: Pain over the medial upper eyelid and medial forehead.

**Infratrochlear and Lacrimal Nerve Blocks**

These are less commonly targeted but can be approached with careful anatomical knowledge. They are mainly used in cases of medial or lateral periorbital pain.

**Infraorbital Nerve Block (V2)**
- **Anatomy:** The infraorbital nerve exits through the infraorbital foramen, approximately 1 cm below the infraorbital rim.
- **Technique:**
  - Palpate the foramen below the orbit.
  - Use a short needle to inject 1–2 mL of local anaesthetic.
- **Indications:** Involvement of midface structures including lower eyelid pain.

## Choice of Local Anaesthetic

The selection depends on the goal of the injection:
- Short-acting (e.g. lidocaine 1 % ) for diagnostic purposes.
- Longer-acting (e.g. bupivacaine 0.5 % ) for therapeutic relief.
- Adjuncts: Corticosteroids (e.g. dexamethasone) may be added to prolong relief and reduce inflammation.

Repeated blocks may be considered if initial response is positive.

## Mechanism of Action

Local anaesthetics work by blocking voltage-gated sodium channels, which prevents depolarisation of nerve membranes and propagation of pain signals. In chronic pain states, especially those involving peripheral sensitisation, this interruption can reduce ectopic discharges and interrupt pain feedback loops.

Additionally, nerve blocks may have secondary effects:
- Modulation of central sensitisation
- Resetting of pain memory
- Reduction in neurogenic inflammation
- Relief of associated muscle tension or autonomic dysfunction

## Clinical Evidence

There is limited high-quality randomised controlled trial evidence for local anaesthetic blocks in periorbital pain, but multiple case series, cohort studies, and anecdotal reports support their use.

**Post-Herpetic Neuralgia**

In patients with V1 involvement from herpes zoster, supraorbital nerve blocks with bupivacaine and steroids have demonstrated moderate to significant relief, especially in early stages before central sensitisation dominates.

**Migraine and Cluster Headache**

Peripheral nerve blocks (e.g., supraorbital or infraorbital) have shown benefit in aborting or reducing the frequency of migraine attacks, possibly via interruption of trigeminovascular activation.

**Idiopathic Orbital Pain**

In patients without clear radiographic or inflammatory causes, supraorbital and supratrochlear nerve blocks can be both diagnostic and therapeutic, with some achieving months of relief from single injections.

## Risks and Complications

When performed properly, these injections are generally safe. However, potential complications include:
- Local bruising or hematoma
- Transient ptosis or diplopia (if anaesthetic diffuses into adjacent orbital structures)
- Infection (rare with aseptic technique)
- Inadvertent intravascular injection
- Temporary numbness or dysesthesia
- Allergic reactions (rare with amide-type local anaesthetics)

Clinicians should avoid deep orbital injection and always aspirate before injection to minimise vascular complications.

## Contraindications

- Local infection at the injection site
- Known hypersensitivity to local anaesthetic agents
- Coagulopathy or use of anticoagulants (relative contraindication)
- Lack of anatomical landmarks in post-surgical or trauma patients

## Role in Multimodal Pain Management

Local anaesthetic blocks are most effective when integrated into a broader pain management strategy, including:
- Pharmacological treatment (e.g. anticonvulsants, antidepressants)
- Physical therapy (especially for cervicogenic contributions)
- Psychological support (for chronic pain coping)
- Surgical referral in refractory structural cases

In some patients, successful nerve blocks may help avoid long-term use of opioids or other systemic medications with more side effects.

## Future Directions

Emerging techniques such as ultrasound-guided blocks offer enhanced accuracy and safety, especially for deeper or less accessible branches. Additionally, use of radiofrequency ablation and neurolytic agents (e.g., alcohol or phenol) may provide longer-term solutions in select patients with refractory pain.

Neuromodulation approaches, including trigeminal nerve stimulation, are also being explored for chronic trigeminal pain, offering non-destructive alternatives to repeated injections.

## Conclusion

Local anaesthetic injections targeting the trigeminal nerve branches provide a valuable tool in the diagnosis and management of chronic pain around the eye. While not curative, they can significantly improve quality of life for patients with neuropathic or idiopathic periorbital pain, especially when used judiciously within a multimodal treatment plan.

Proper patient selection, anatomical understanding, and technique are critical to achieving safe and effective outcomes. As research continues, these minimally invasive procedures may play an expanding role in the field of pain management and neurology.

I have tried this approach on a number of patients, including post-herpetic neuralgia, thyroid eye disease and essential blepharospasm. The success rate is around 70 % with repeat injections every 8 weeks as needed.

## References


1. Özer D, Bölük C, Altun D, et al. Greater occipital and supraorbital nerve blockade for the preventive treatment of migraine: a single–blind, randomized, placebo-controlled study. Curr Med Res Opin.2019;35(5):909 915. doi:10.1080/03007995.2018.1532403 Taylor & Francis Online
2. Ilhan Alp S, Alp R. Supraorbital and infraorbital nerve blockade in migraine patients: results of 6 month clinical follow up. Eur Rev Med Pharmacol Sci. 2013;17(13):1778 1781. European Review
3. Demiral GZ, Boluk C, Gumus H, et al. Comparison of greater occipital and supraorbital nerve block with amitriptyline use in migraine treatment. Dusunen Adam J Psychiatr Neurol Sci. 2024;37(3):122 129. Dusunen Adam Journal
4. Cruz AB, Pareja JA. Supraorbital Neuralgia: A Clinical Study. Cephalalgia. 2001;21(7):780 785. SAGE Journals
5. Alp Ilhan S, Alp R. Supraorbital and infraorbital nerve blockade in migraine patients: results of 6 month clinical follow up. Eur Rev Med Pharmacol Sci. 2013;17(13):1778 1781. (same as reference 2) European Review



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# The Algorithmic Eye: Navigating the Future and Ethics of Artificial Intelligence in Ophthalmology

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## A New Paradigm in Vision Care

Ophthalmology, a speciality intrinsically reliant on high-resolution imaging, stands at the vanguard of the artificial intelligence (AI) revolution in medicine.[1] The vast quantities of structured data generated from modalities such as optical coherence tomography (OCT), fundus photography, and visual field testing provide fertile ground for machine learning and deep learning algorithms. These systems can process immense datasets, identify complex patterns often imperceptible to the human eye, and generate actionable insights that promise to enhance diagnostic accuracy, improve workflow efficiency, and increase healthcare accessibility.[1,2] Given the rising global burden of visual impairment, which disproportionately affects ageing populations and developing nations with a severe maldistribution of ophthalmic specialists, AI presents a powerful tool to bridge critical gaps in care.[2]

However, this transformative potential is shadowed by a complex array of ethical, legal, and practical challenges that demand careful consideration.[1] A significant gap persists between the demonstrated technical prowess of AI algorithms in research settings and their limited adoption into routine clinical practice. Surveys of ophthalmologists reveal a strong interest in AI's potential, yet active use remains low.[1] This implementation gap is not a failure of technology but a reflection of profound, unresolved issues surrounding trust, regulatory clarity, institutional readiness, and the need for robust ethical frameworks.[1] This article will explore the expanding clinical applications of AI in ophthalmology, critically examine the core ethical dilemmas it presents, and propose a framework for its responsible integration into the future of vision care.

## The Expanding Clinical Frontier: Current and Future Applications of AI

AI is rapidly moving beyond theoretical applications to become a tangible force across ophthalmic subspecialties, shifting the paradigm from static disease detection towards dynamic, predictive, and personalised care.

### AI in Retinal Disease Screening and Management

The most mature applications of ophthalmic AI are in the screening and management of retinal diseases. For diabetic retinopathy (DR), several autonomous AI systems have received regulatory approval from bodies like the U.S. Food and Drug Administration (FDA). These algorithms analyse fundus photographs to detect referable DR (i.e., more than mild DR) with high sensitivity and specificity, often exceeding 85 %, thereby alleviating the immense screening burden on healthcare systems and enabling earlier intervention for patients with diabetes.[3]

In age-related macular degeneration (AMD), AI is proving invaluable for diagnosis, staging, and management. Deep learning models can automatically segment and quantify key biomarkers from OCT scans, such as drusen, intraretinal fluid (IRF), and subretinal fluid (SRF).[4] This automated analysis not only improves efficiency but also facilitates the prediction of disease progression to late-stage AMD and helps forecast individual patient responses to anti-VEGF therapies, paving the way for more personalised treatment regimens.[4]

### AI in Glaucoma Detection and Progression Monitoring

Glaucoma, the "silent thief of sight," benefits significantly from AI's ability to detect subtle, early-stage structural changes. Deep learning models can analyse fundus photographs and OCT scans to identify glaucomatous optic neuropathy with an accuracy rivalling human experts.[5] Crucially, some models have shown the potential to predict the development of glaucoma years before a clinical diagnosis is made.[5] Beyond initial detection, AI is being applied to longitudinal data to forecast visual field progression, integrating both structural (OCT) and functional (visual field) data to create more accurate and individualised risk assessments. Furthermore, AI is beginning to leverage molecular and genomic data to identify novel biomarkers, pushing glaucoma care towards a more precise, risk-stratified approach.[5]

### AI in Medical Education

Beyond diagnostics, AI is emerging as a powerful tool in medical education. It can assist ophthalmology residents in honing their diagnostic skills by providing instant feedback on image interpretation and is being explored in surgical training to evaluate and guide performance in procedures like cataract surgery.[6]

## The Ethical Gauntlet: Navigating the Core Challenges of AI in Clinical Practice

The integration of AI into ophthalmology necessitates a confrontation with several profound ethical challenges. Failure to address these issues proactively risks undermining clinician and patient trust, exacerbating health disparities, and creating significant legal and moral ambiguity. A survey of Swiss ophthalmologists found that major ethical and legal concerns, including unresolved liability (74.8 %), informed consent (66.7 %), and data protection (49.5 %), are primary barriers to adoption.[1] **Table 1** summarises these key challenges and outlines potential mitigation strategies.

A pivotal shift occurred in August 2025, when the South African Health Products Regulatory Authority (SAHPRA) published new risk-based requirements for AI-enabled medical devices.[11] This new guidance (MD08-2025/2026) marks a crucial move from a reactive to a proactive regulatory posture. It incorporates international standards and clarifies expectations for safety, transparency, and risk management. The guidance stipulates that all AI-enabled medical devices must undergo authorisation from SAHPRA, be classified according to an existing four-tier risk system, and comply with a robust Quality Management System (QMS). Crucially, it requires mandatory post-market monitoring for adaptive and autonomous systems, acknowledging that AI models can "drift" in performance over time. While this is a significant step forward, the guidance still leaves some gaps in areas like specific patient consent for algorithmic use and the clear allocation of liability in complex cases.

## The Spectre of Hallucination in Ophthalmic Diagnosis

A particularly insidious risk associated with advanced AI, especially large language models (LLMs), is the phenomenon of "hallucination," or what may be more accurately termed "confabulation".[8] This occurs when an AI model generates a convincing, contextually coherent, but entirely fabricated response that is not based on its training data. This is not a simple error but a fundamental characteristic of current probabilistic models, which can extrapolate incorrectly or "fill in the gaps" with plausible-sounding falsehoods when faced with uncertainty or incomplete data.[8] In the high-stakes environment of ophthalmology, such confabulations pose a direct threat to patient safety. This can manifest in several dangerous ways: An LLM-based clinical decision support tool could recommend a flawed diagnostic workup or an inappropriate surgical intervention.[6]

Most dangerously, these systems can invent non-existent medical journal citations to support their erroneous claims, creating a veneer of evidence that could mislead clinicians, particularly trainees, who are learning to rely on evidence-based practice. The danger lies not just in the error itself, but in its plausibility, which creates a trap that can override a clinician's scepticism and, over time, risk a gradual de-skilling of fundamental interpretive abilities if not met with constant critical vigilance.[6]

**Table 1. Key Ethical Challenges of AI in Ophthalmology and Proposed Mitigation Strategies**

| Ethical Challenge | Clinical Manifestation in Ophthalmology | Proposed Mitigation Strategy |
|---|---|---|
| **Accountability & Liability** | A misdiagnosis of referable DR by an autonomous AI system leads to preventable vision loss. Who is responsible: The developer, the clinician, or the institution? | Establish clear shared responsibility frameworks. Developers can assume a degree of liability through contractual agreements and insurance, as pioneered by IDx-DR.2 Institutions must create protocols for human oversight and validation. |
| **Algorithmic Bias & Inequity** | A DR detection model trained on a predominantly Caucasian dataset demonstrates lower accuracy in patients with darker retinal pigmentation, leading to missed diagnoses in underrepresented groups.[2] | Mandate the use of diverse, representative training datasets that reflect the target population. Conduct rigorous pre- and post-deployment bias audits. Standardise reporting of dataset demographics in regulatory submissions.[2,7] |
| **Transparency & Interpretability ("Black Box" Problem)** | An AI algorithm flags an OCT scan for neovascular AMD, but the clinician cannot understand the model's reasoning, making it difficult to trust the recommendation or explain it to the patient. | Prioritise the development of inherently interpretable models that provide human-understandable rationales for their outputs, especially for high-risk decisions.[2] |
| **Data Privacy & Security** | Sensitive patient retinal images, which contain unique and potentially re-identifiable vascular patterns, are compromised in a data breach or used without appropriate consent. | Employ advanced anonymisation techniques such as differential privacy or the use of synthetic data generated by Generative Adversarial Networks (GANs). Implement robust cybersecurity protocols to protect data in transit and at rest.[2] |
| **Informed Consent & Patient Autonomy** | A patient undergoes an eye exam where an AI system is used for screening, but they are not informed of the AI's role, its limitations, or that a human is not the primary interpreter. | Develop new, hybrid consent models that explicitly describe the function and limitations of the AI tool being used. Ensure patients understand the role of human oversight and are offered non-AI alternatives where feasible to preserve autonomy.[1,2] |

## Forging a Path Forward: A Framework for Responsible AI Integration

Navigating the complexities of AI requires a multi-pronged approach encompassing robust regulation, comprehensive education, and steadfast institutional governance.

### The Evolving Regulatory Landscape

Effective regulatory oversight is critical to ensuring the safety and equity of AI medical devices. Regulatory bodies in the United States, European Union, and China are developing distinct frameworks, focusing on market adaptability, data security, and process-oriented controls, respectively.[9] However, significant challenges remain. A critical failing of the current system is the lack of transparency regarding training data; a review of FDA-approved AI/ML devices from 1995-2023 found that only 3.6 % reported the race or ethnicity of the data subjects, a gap that must

be closed to address algorithmic bias systematically.[7]

**The Educational Imperative**

The widespread sentiment among ophthalmologists of being unprepared for the AI transition underscores an urgent need for new educational curricula.[1] Training programmes for both residents and practising clinicians must evolve to include fundamental AI principles, ethical guidelines, data literacy, and, most importantly, the skills to evaluate and verify AI-generated outputs critically.[6] Education should focus on fostering a healthy scepticism and reinforcing the primacy of clinical judgment.

**Institutional Governance and Human Oversight**

Beyond national regulations, healthcare institutions must develop their own clear guidelines for the procurement, validation, and clinical implementation of AI tools.[1] The overwhelming consensus among clinicians - with over 93 % endorsing AI in an assistive rather than an independent role - supports a "human-in-the-loop" model.[1] This framework positions AI as a powerful decision-support tool that augments, but never replaces, the ophthalmologist's expertise and ethical responsibility to the patient.

## Conclusion: Augmenting, Not Replacing, the Ophthalmic Professional

Artificial intelligence is poised to become an indispensable part of ophthalmic practice, offering unprecedented capabilities to detect disease earlier, predict outcomes more accurately, and expand access to care. However, its successful and ethical integration is not a foregone conclusion. It requires a concerted effort from all stakeholders - clinicians, researchers, developers, regulators, and patients - to build a socio-technical ecosystem founded on principles of safety, equity, transparency, and accountability. By embracing AI as a tool to augment clinical intelligence and judgment, rather than replace it, the field of ophthalmology can harness its immense power to preserve and restore sight while upholding the highest standards of patient-centred care.

**Table 2. Key Legislation and Identified Gaps for AI**

| Legislation | Key Provisions Relevant to AI | Gaps/Challenges for AI |
|---|---|---|
| **NHA (2003)** | Consent, patient rights, and health quality | No clear rules for AI validation, data governance, or AI-related errors |
| **POPIA (2013)** | Lawful health data processing, subject rights | The "data minimisation" principle conflicts with AI's need for large, diverse datasets. |
| CPA (2008) | Strict liability for defective goods | The definition of a "defective good" is debated for adaptive AI software. |
| **SAHPRA** | Medical device registration, oversight | Frameworks were outdated for adaptive SaMD solutions; new SAHPRA rules address some, but not all, of the gaps. |
| **HPCSA Guidelines** | Telehealth, general ethical conduct | Lacks specific guidance for algorithmic bias, transparency, and clinical responsibility in AI use. |

## References


1. Hirt, N., et al. Artificial intelligence in clinical practice: a survey of Swiss ophthalmologists on adoption, readiness, and ethical concerns. Graefes Arch Clin Exp Ophthalmol. 2025; [Epub ahead of print].
2. Kulkarni, S., et al. The application of artificial intelligence in the vision sciences: a narrative review of diagnostic innovation, ethical implementation, and equitable deployment. J Ophthalmol. 2025;2025:6624831.
3. Lee, A.Y., et al. Artificial Intelligence and Diabetic Retinopathy. Diabetes Care. 2023;46(10):1728-1738.
4. Sacconi, R., et al. Artificial intelligence and age-related macular degeneration: a panoramic review of the applications of machine learning in the management and screening of the disease. J Clin Med. 2024;13(6):1644.
5. Wang, M., et al. Applications of Artificial Intelligence in Glaucoma: A Comprehensive Review of the Current Literature and Future Directions. Int J Mol Sci. 2025;26(10):4473.
6. Wong, K.J., et al. A Review of Ophthalmology Education in the Era of Generative Artificial Intelligence. Asia Pac J Ophthalmol (Phila). 2024;13(4):379-387.
7. Gichoya, J.W., et al. AI/ML-enabled medical devices: an analysis of the FDA-approved devices and their clinical performance. NPJ Digit Med. 2024;7(1):145.
8. Özer, M.A. AI Hallucination or Confabulation? Turk Psikiyatri Derg. 2024;35(2):147-148.
9. Wu, H., et al. Regulatory approaches towards AI Medical Devices: A comparative study of the United States, the European Union and China. Health Policy. 2025;153:105260.
10. Char, D.S., et al. Ethical considerations for artificial intelligence in ophthalmology: from the D.O.C.T.O.R. AI framework. Transl Vis Sci Technol. 2022;11(10):11.
11. South African Health Products Regulatory Authority (SAHPRA). Regulatory Requirements of Artificial Intelligence and Machine Learning-enabled Medical Devices. Issue No.: MD08-2025/2026 [Internet]. 2025. Available from: https://www.sahpra.org.za/wp-content/uploads/2025/08/MD08-20252026_-SAHPRA-Communication-to-Industry-AI-Medical-devices-pdf.pdf

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