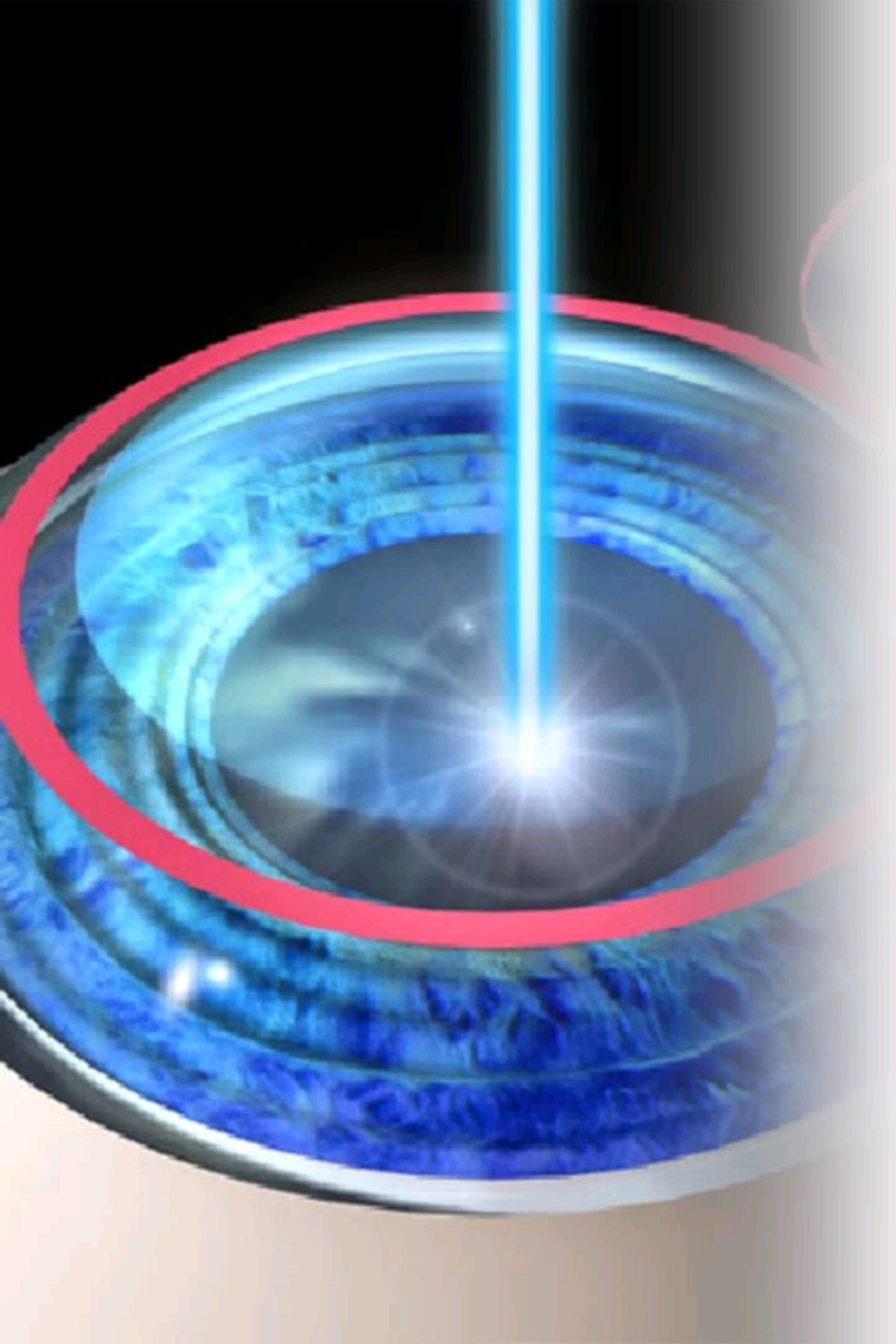




Northern Technical University
College of Health and Medical Technologies
Department of Optics Technology

Laser in ophthalmology





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Laser Definition

LASER: Light Amplification by Stimulated Emission of Radiation. A device emitting a focused light beam with coherence, directivity, and monochromaticity (single wavelength).

Laser properties

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- 1 **Coherence**
Synchronized light waves.
- 3 **Monochromaticity**
Single wavelength; pure color.

- 2 **Directionality**
Narrow, directed beam.
- 4 **High Intensity**
Concentrated energy.

Ophthalmic Laser Applications

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Lasers are used in ophthalmology to treat many conditions due to their precision. Some prominent applications:

LASIK

Corrects myopia, hyperopia, and astigmatism by reshaping corneal tissue.

Cataract Surgery

Fragments cloudy lens, creating incisions with minimal trauma.

Diabetic Retinopathy

Seals leaking vessels, reducing abnormal vessel growth.

Glaucoma Treatment

Reduces intraocular pressure by enhancing fluid outflow.

Macular Hole Repair

Seals macular holes to prevent vision loss.

Ocular Tumor Treatment

Removes small tumors and abnormal tissue growths.

Retinal Detachment

Reattaches separated retinal tissue.

Advantages of Laser Eye Surgery

High Precision

Precise control of treatment depth and area.

Reduced Bleeding

Seals blood vessels during surgery.

Faster Recovery

Speeds up healing process with less invasive procedures.

Minimized Pain

Less pain compared to traditional surgery.

Risks and side effects ✓

1 Dry Eye

2 Temporary inflammation or irritation

3 Problems with night vision

4 In rare cases, loss of vision

Lasers are widely used in medicine due to their precision and ability to perform complex operations with minimal invasiveness.

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1. (CO2 Laser)

- Wavelength: 10,600 nm.
- Applications:
 - Skin surgeries (tumors, warts, scars).
 - Cosmetic surgery (wrinkles, rejuvenation).
 - Mucosal surgeries (mouth, nose, throat).

2. Erbium Laser (Er:YAG Laser)

- Wavelength: 2940 nm.
- Applications:
 - Treatment of skin wrinkles.
 - Scar removal.
 - Dental caries treatment (dentistry).

3. Nd:YAG Laser

- Wavelength: 1064 nm
- Applications:
 - Blood vessel treatment
 - Laser hair removal
 - Eye surgery (retinopathy)

4. Alexandrite Laser

- Wavelength: 755 nm
- Applications:
 - Laser hair removal
 - Pigmentation treatment

5. Diode Laser

- Wavelength: 800-980 nm
- Applications:
 - Hair removal
 - Acne treatment
 - Soft tissue surgeries (dentistry)

6. Argon Laser

- Wavelength: 488-514 nm
- Applications:
 - Eye diseases (retinopathy)
 - Hemangiomas

7. Erbium-Chromium Laser

- Wavelength: 2780 nm
- Applications:
 - Dental surgeries (drilling, gum treatment)
 - Skin surgeries

8. Excimer Laser

- Wavelength: 193 nm (UV)
- Applications:
 - Eye surgery (LASIK)
 - Psoriasis treatment

9. Picosecond Laser

- Wavelength: 532/1064 nm (Variable).
- Applications:
 - Tattoo removal.
 - Pigmentation treatment.

10. Fractional Laser

- Wavelength: 1550/2940 nm (Variable).
- Applications:
 - Skin rejuvenation.
 - Deep scar treatment.
 - Skin texture improvement.

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Laser Safety

Laser safety ensures the safe use of lasers across fields. Mishandling can cause eye/skin injuries or fires. Following guidelines is vital.



safety guidelines :



1 Eye Protection

Safety Goggles: Use laser-specific goggles.

Avoid Direct Vision: Never look directly at the beam.

2 Skin Protection

Avoid Direct Exposure: Prevent skin burns.

Protective Clothing: Use appropriate clothing.

3 Environmental Control

Safe Work Area: Use lasers in a designated area.

Good Ventilation: Ensure proper ventilation.

4 Training and Education

User Training: Train all laser users.

Continuing Education: Regularly update safety knowledge.

5 Regular Maintenance

- Equipment Inspection: Check regularly for safe function.
- Troubleshooting: Qualified technician repairs malfunctions immediately.

6 Classification and Control

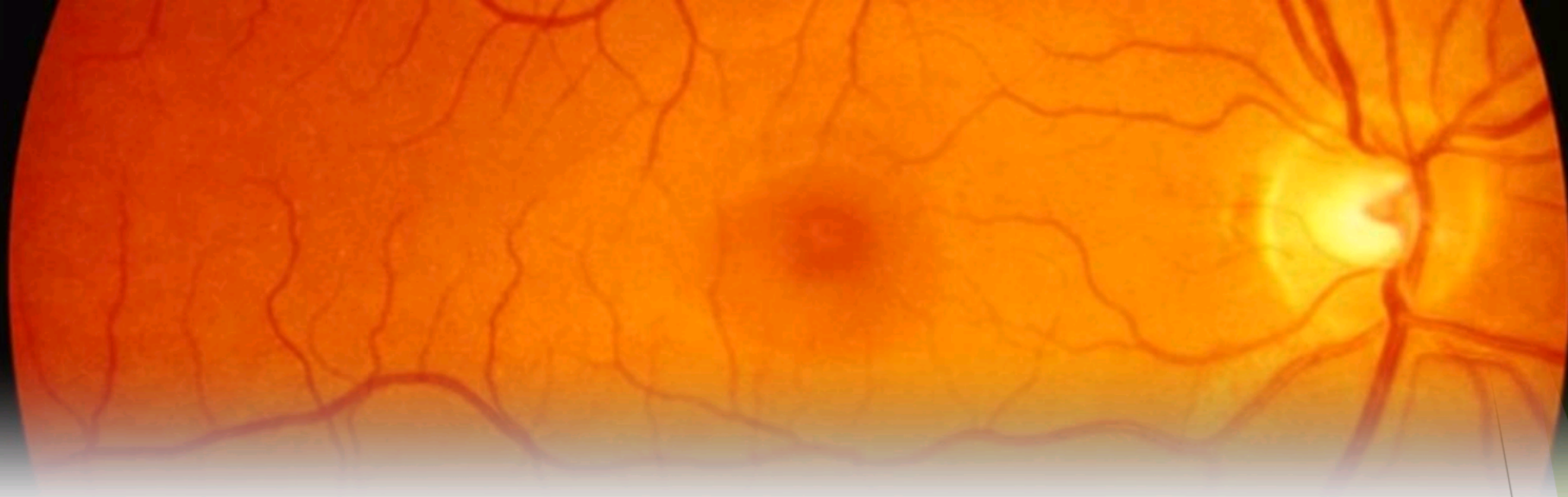
- Laser Classification: Understand laser class (1-4) for safety.
- Access Control: Restrict access to trained personnel only.

7 Incident Handling

- Emergency Plan: Establish a clear incident plan, including first aid.
- Reporting Accidents: Report all laser-related accidents immediately.

8 Safe Storage

- Laser Storage: Store lasers safely in a locked location when not in use.
- Key Protection: Secure laser switches to prevent accidental operation.



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Optical coherence tomography (OCT)

A medical imaging technique using laser light to create high-resolution, three-dimensional cross-sectional images of biological tissues by measuring light reflection.

1. Principle of Operation:

- Low-energy laser scans tissue.
- Light reflects from tissue.
- Interferometry measures reflected light for distance.

2. Applications:

- Ophthalmology: Retina, cornea, optic nerve visualization. Diagnoses:
 - AMD
 - Diabetic retinopathy
 - Glaucoma
 - Retinal issues
- Dermatology: Skin layer imaging; diagnoses tumors/diseases.
- Dentistry: Teeth and gum visualization.
- Cardiovascular: Blood vessel visualization; assesses plaque.

3. Advantages of OCT:

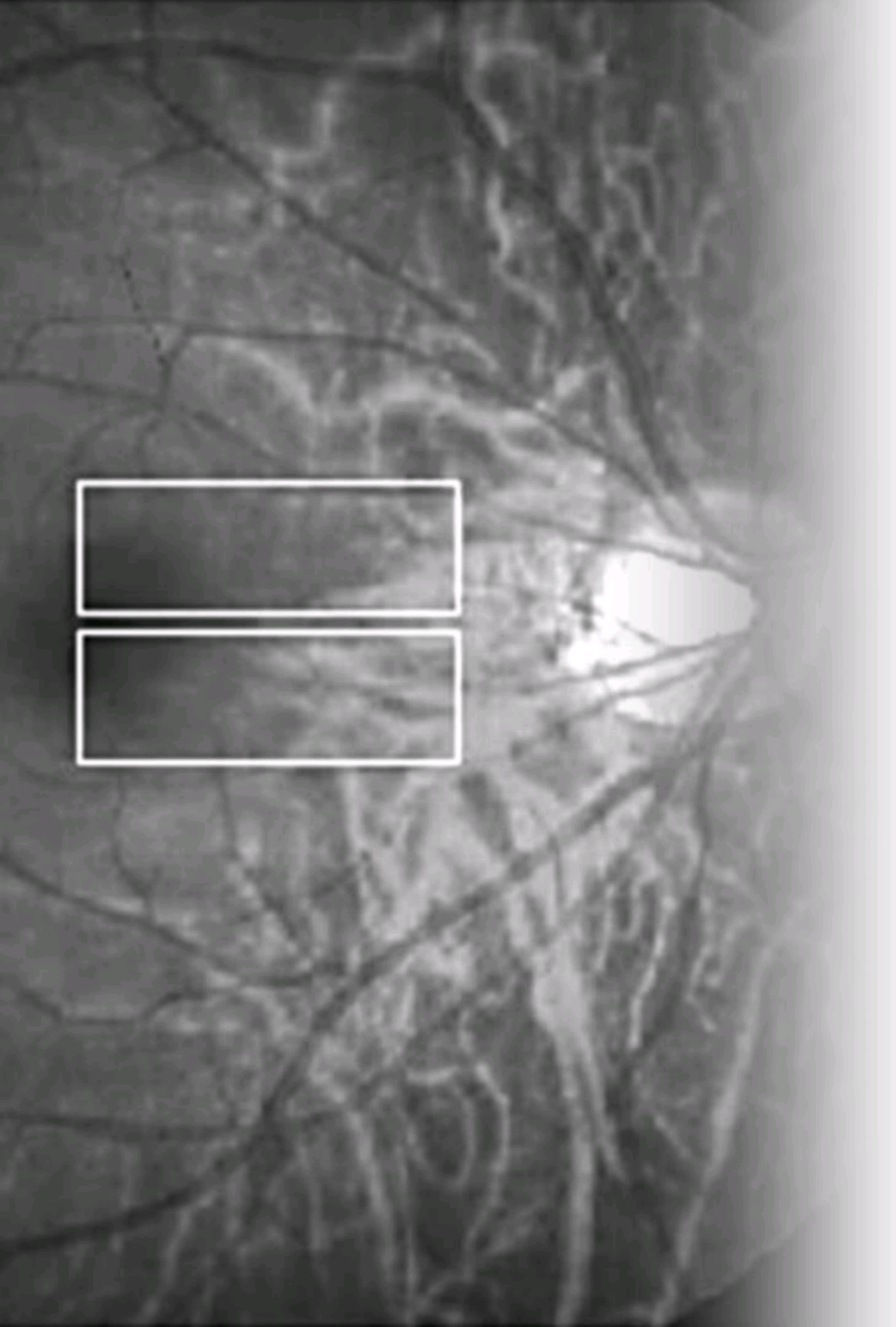
- High resolution: Micrometer detail.
- Non-invasive: No dyes needed.
- Speed: Quick imaging.
- Safe: Low-energy, no damage.

4. Types of OCT:

- Time-Domain OCT: Moving mirror.
- Frequency OCT: Faster, all wavelengths.
- Spectral OCT: Variable laser, high resolution.

5. Future developments:

- Increasing resolution: Improved laser tech.
- Expanding applications: New uses in neuroimaging.
- Integrating AI: AI for diagnosis.



Laser Doppler Flowmetry: Measuring Blood Flow

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Laser Doppler Flowmetry (LDF) is a medical technique that measures blood flow speed in small vessels. It uses the Doppler effect, detecting frequency changes when light reflects off moving red blood cells.

Working Principle and Applications

1

Laser Radiation

A low-energy laser beam is directed at the tissue.

2

Light Reflection

Light reflects off moving red blood cells at a different frequency.

3

Signal Analysis

The change in reflected light frequency is measured.

4

Flow Calculation

Data is converted into blood flow speed and amount information.

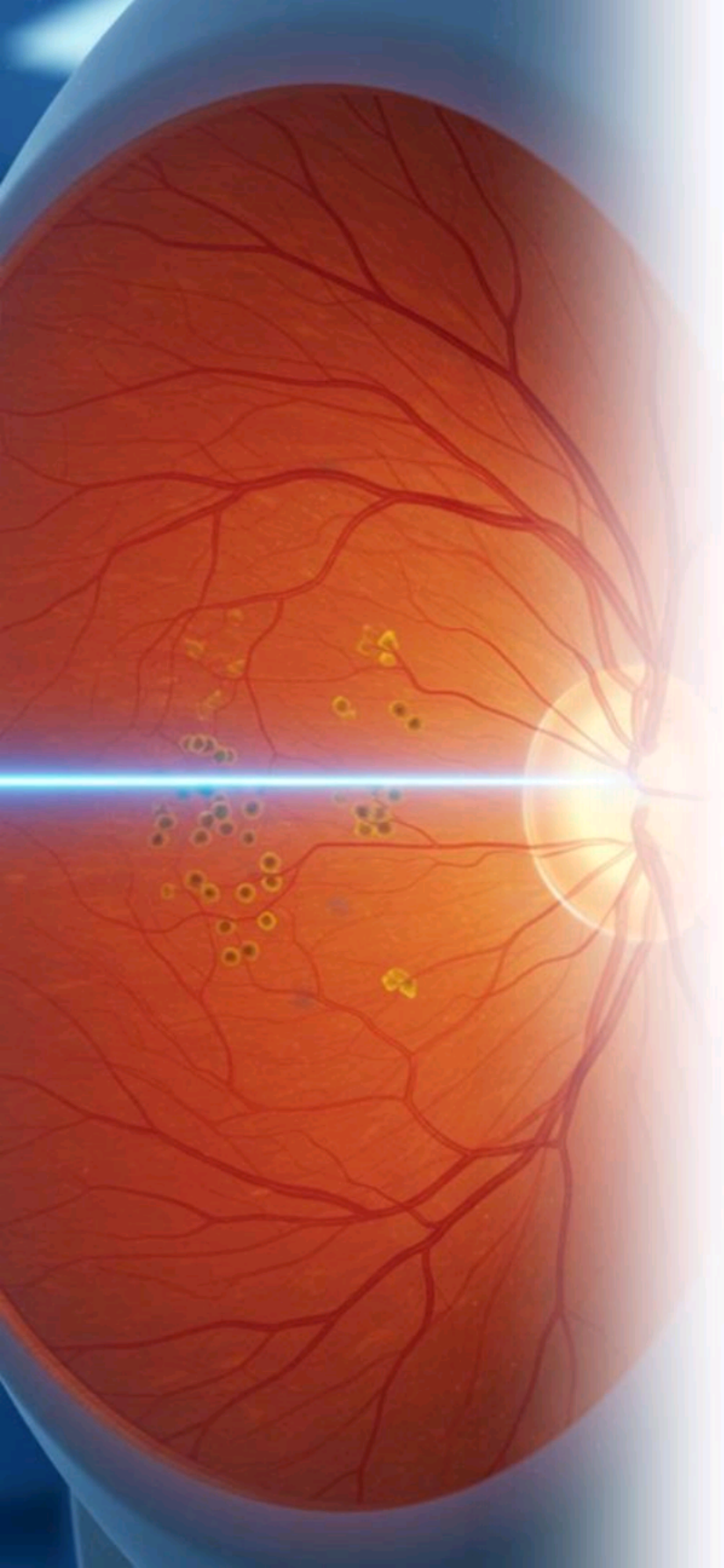
Advantages and Disadvantages

Advantages

- Non-invasive and non-invasive
- Provides real-time measurements
- Sensitive to small blood vessel changes

Disadvantages

- Affected by patient movement
- Inaccurate in deep tissue
- Requires careful calibration



✓ Confocal Laser Scanning Ophthalmoscopy

An advanced imaging technique that creates high-resolution 3D images of the retina using laser technology, enabling precise diagnosis and monitoring of eye diseases.



How It Works ✓

Confocal Laser

Focused laser beam enters the eye while optics collect reflected light from the retina.

Layer-by-layer Scanning

System captures detailed images by sequentially scanning through each retinal layer.

Three-dimensional Imaging

Multiple cross-sections combine to create a complete 3D retinal model.

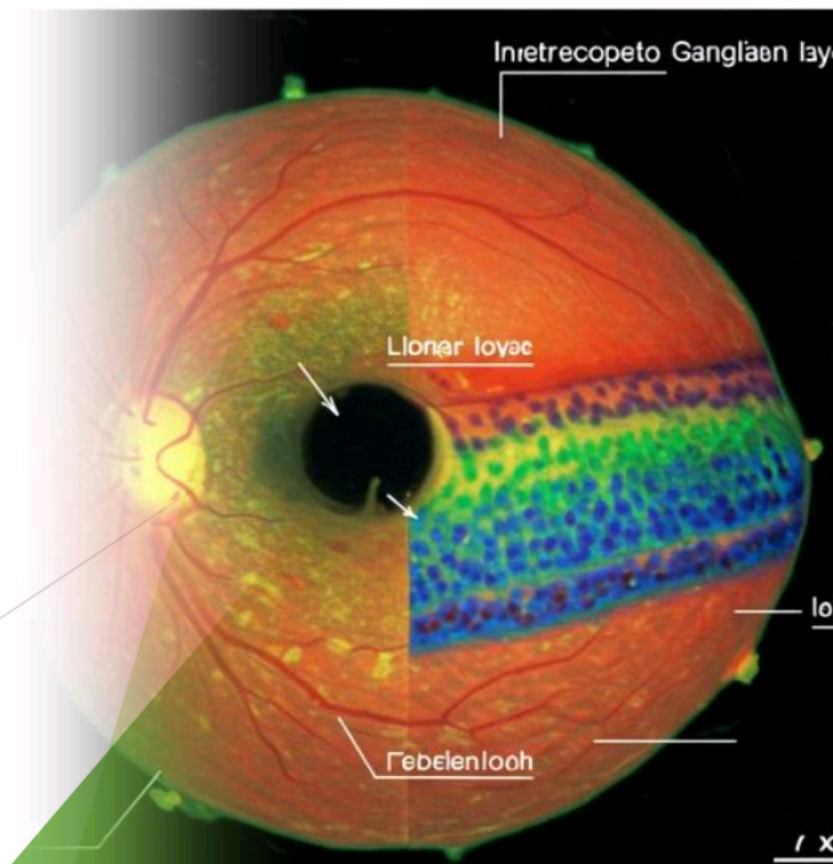
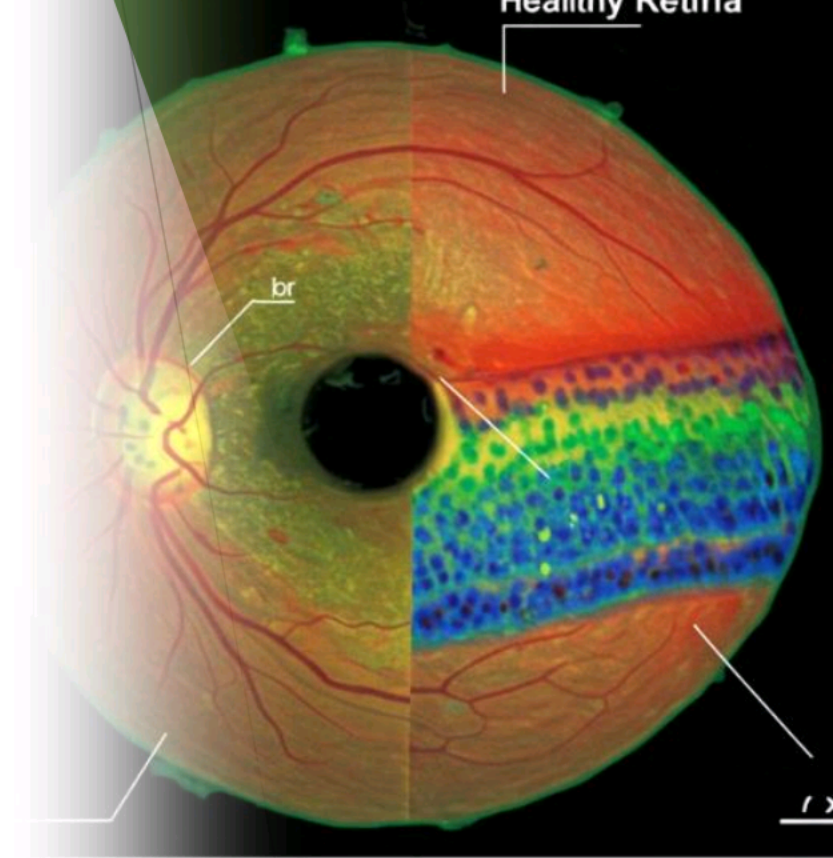
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Benefits of confocal laser ophthalmoscopy:

1. High resolution: Provides detailed images of the layers of the retina, helping to accurately diagnose diseases.
2. Non-invasive: Does not require any surgical intervention or touching the eye.
3. Monitors changes: Helps monitor the progression of diseases such as age-related macular degeneration (AMD) or diabetic retinopathy.
4. Early detection: Can detect subtle changes in the retina before symptoms appear.

Medical Uses ✓

- Diagnosis and monitoring of retinal conditions:
 - Age-related macular degeneration (AMD)
 - Diabetic retinopathy
 - Macular edema and holes
 - Retinitis pigmentosa
- Measuring retina thickness and layers
- Seeing if eye treatments are working



Procedure ✓

1

The pupil is dilated using special drops to improve vision.

2

The patient sits in front of the machine and the head is immobilized.

3

The machine scans the retina using a laser, and the examination usually takes a few minutes.

Photorefractive keratectomy (PRK) or surface laser

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is a refractive eye surgery that corrects myopia, hyperopia, and astigmatism. It uses laser technology to reshape the cornea, improving focus on the retina and reducing dependence on glasses or contacts.



Steps of the procedure: ✓

1-Anesthesia

Numbing eye drops prevent pain.

2-Epithelium removal

Surface layer removed using a tool or alcohol solution. Unlike LASIK, PRK fully removes this layer instead of creating a flap.

3-Laser reshaping

Excimer laser removes corneal tissue based on measurements.

4-Protective lens

Therapeutic contact lens placed to aid healing.

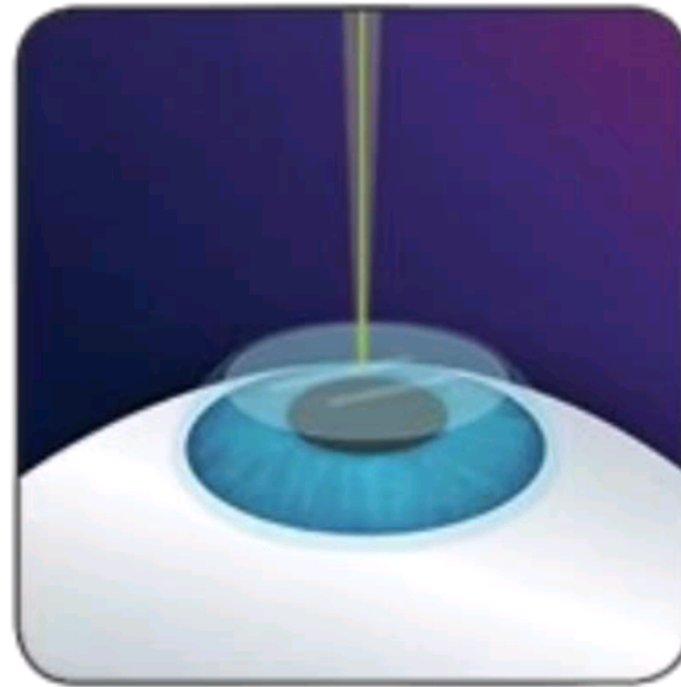
PRK Procedure



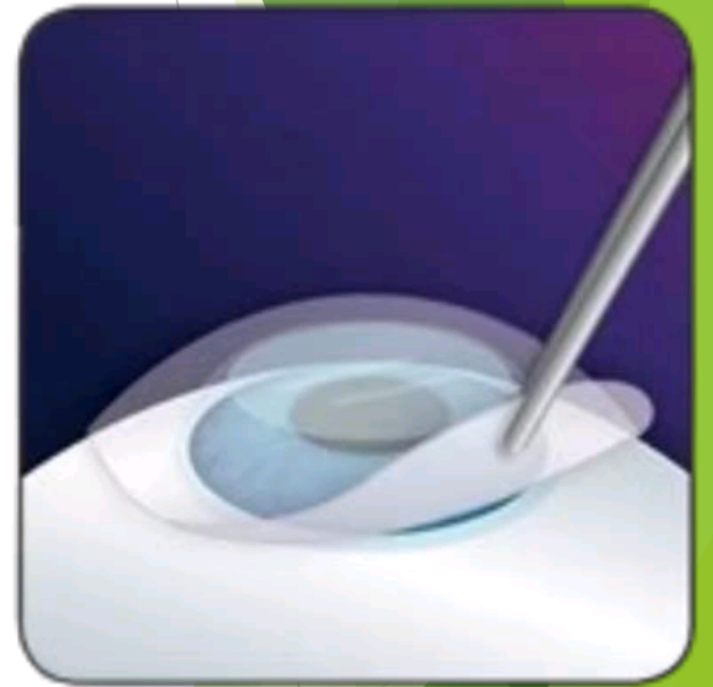
Step 1.



Step 2.



Step 3.



Step 4.



Recovery Period ✓

- First few days: Some pain, discomfort, and blurry vision may occur.
- First week: New cells grow back on the eye's surface.
- Several weeks to months: Vision gets better until reaching its best clarity.

Advantages ✓

- Good option for people with thin corneas who can't have LASIK
- Avoids problems that can happen with the corneal flap

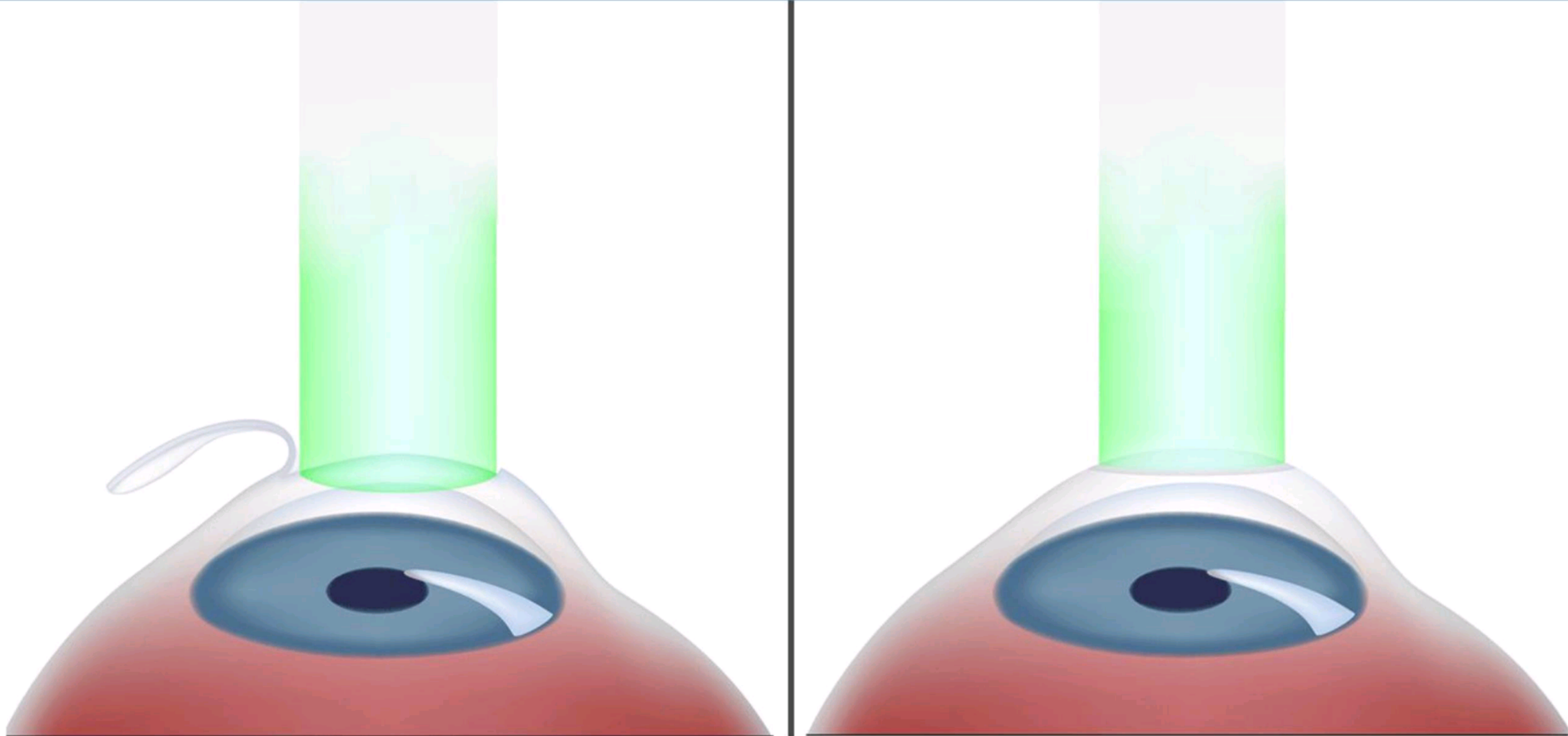
Risks and side effects: ✓

- Pain
- Dry eyes
- Blurred vision
- Risk of corneal infections or scarring (rare)

Difference between PRK and LASIK: ✓

- In LASIK, a thin slice of the cornea is created and then the underlying tissue is reshaped, while in PRK the entire surface layer is removed.
- The recovery period in PRK is longer compared to LASIK.

LASIK *vs* PRK

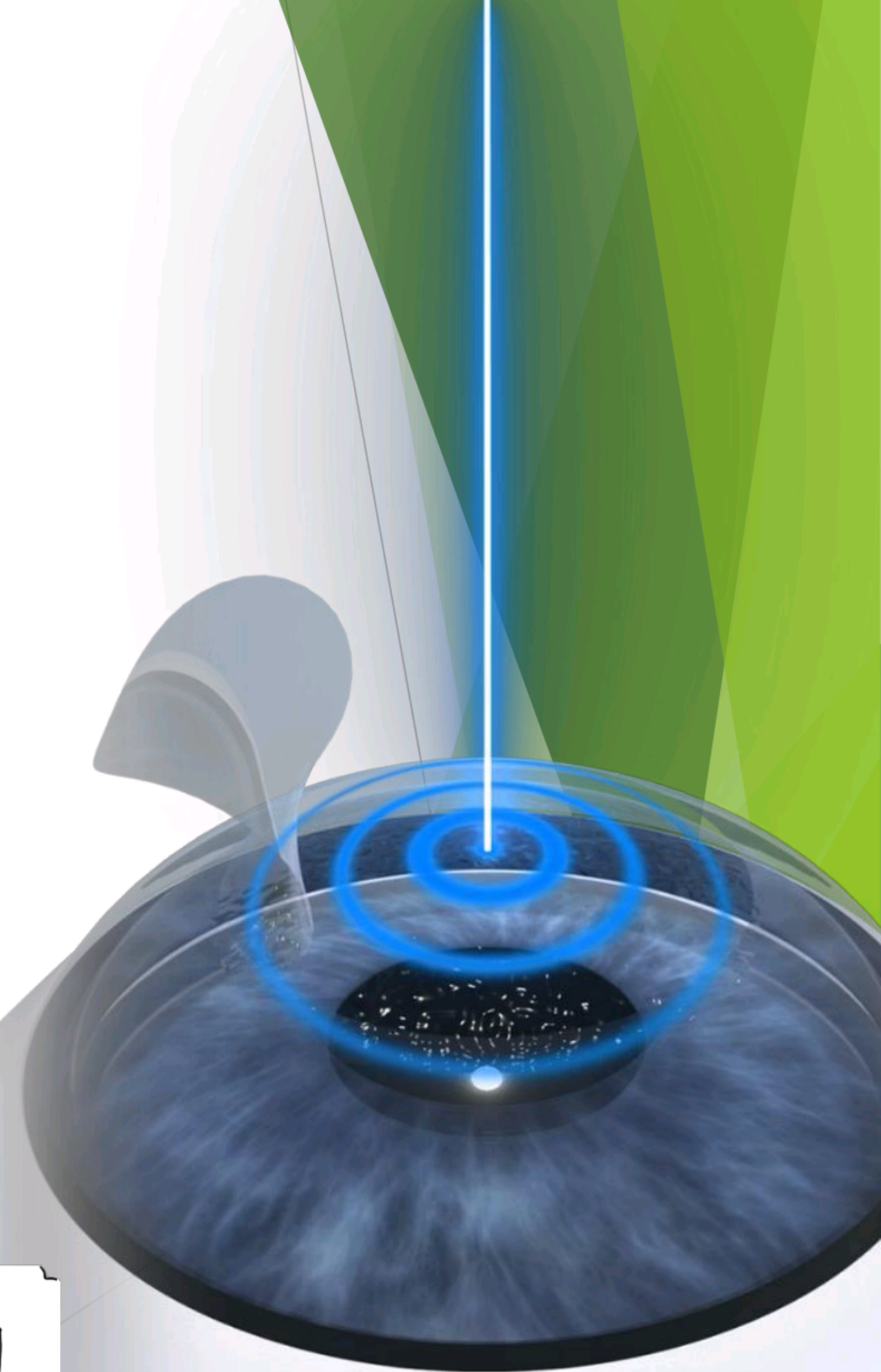


You should consult your ophthalmologist to determine if PRK is the best option for you based on the condition of your eyes and your health history.



Laser eye treatment ✓

is an advanced technique using lasers to reshape eye tissues, particularly the cornea, correcting vision issues and treating diseases. Here's an overview of laser applications in eye care.



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1. Vision correction (LASIK surgery and others)



Refractive Errors Corrected

- Myopia: Distance vision improved.
- Hyperopia: Near vision enhanced.
- Astigmatism: Clarity of vision.
- Presbyopia: Treats near vision issues.



Popular Laser Techniques

- LASIK: Corneal flap and reshaping.
- Femto-LASIK: Precise flap creation.
- PRK: Surface layer reshaping.
- SMILE: Lenticule extraction.



2. Laser Treatment of Retinal Diseases

Lasers treat retinal diseases that can cause vision loss, including:

- 1 Diabetic Retinopathy**
Prevents bleeding by coagulating abnormal blood vessels.
- 2 Retinal Detachment**
Repairs retinal tears.
- 3 Macular Edema**
Reduces macular swelling.



3. Glaucoma Treatment

Lasers lower intraocular pressure in certain glaucoma cases:

- **Laser Trabeculoplasty:** Improves aqueous humor drainage.
- **Laser Iridotomy:** Treats narrow-angle glaucoma.

4. Cataract Treatment

Lasers can assist cataract surgery by breaking up the cloudy lens for easier removal.



5. Treatment of Posterior Capsular Opacification (PCO)

After cataract surgery, a laser creates an opening in the lens capsule to restore clear vision if it clouds.

6. Keratoconus Treatment

Cross-linking strengthens corneal tissue, preventing deterioration.

7. Treatment of Abnormal Blood Vessels

Lasers seal abnormal eye blood vessels (often from retinal diseases), preventing bleeding.

Benefits of Laser Eye Treatment ✓

- High treatment precision
- Fast results
- Reduced dependence on glasses or contact lenses.
- High success rate

Risks and side effects



- 1 Dry eye
- 2 Halos
- 3 Temporary inflammation
- 4 infection





Tips Before and After Laser Treatment

Before

- Comprehensive eye exam for suitability.

After

- Follow doctor's advice; use drops, avoid rubbing eyes.