OPEN

What Does Biomicroscopy Mean?

Raluca Bievel Radulescu, MD,† Jesper Hjortdal, MD, PhD,‡ Jacinto Sánchez Ibáñez, MD, PhD,§ Massimo Busin, MD, PhD,¶ Gilles Thuret, MD, PhD,‖ and Diego Ponzin, MD**

The term biomicroscopy entered ophthalmology in the early 20th century with the revolutionary slit lamp, which brought microscopic examination to the living eye without tissue removal. For decades, biomicroscopy meant slit-lamp examination of the anterior segment. However, as imaging technologies such as ultrasound, confocal microscopy, and optical coherence tomography (OCT) advanced, the term expanded to encompass any microscopic observation of living tissues.

This terminological flexibility has become a liability. When research reports corneal evaluation "by biomicroscopy," the specific method remains unclear—slit-lamp microscopy, ultrasound, OCT, or confocal microscopy? Each provides fundamentally different information, with distinct strengths and limitations.

The terminological confusion surrounding biomicroscopy creates several problems:

1. Research reproducibility: Studies become difficult or impossible to replicate when imaging methods are inadequately specified
2. Quality assurance: In tissue banking, unclear evaluation methods compromise the assessment of donor suitability and storage efficacy
3. Clinical training: Students and residents receive inconsistent instruction when terminology lacks precision
4. Scientific communication: Meaningful comparison between studies becomes impossible when methods are ambiguously described.

Slit-lamp microscopy deserves its full name as the foundational technique. It combines stereoscopic visualization with precisely controlled illumination (diffuse, focal, retroillumination, specular reflection) at 6×–40× magnification, creating a narrow beam of light that can be manipulated in width, height, angle, and intensity to reveal three-dimensional tissue architecture in unprecedented detail.[1,2] Custom optical devices, such as the biomicroscope described by Acquart et al for noninvasive donor corneal evaluation, extend this principle while maintaining the core concept of live microscopic observation. This system—comprising a light source, stage, backlit chart, cornea, objective, and charge-coupled device (CCD) sensor—was used for the noninvasive measurement of transparency, arcus senilis, and scleral rim diameter in donor corneas of the eye bank.[3]

Ultrasound biomicroscopy (UBM) uses high-frequency transducers (35–100 MHz) for anterior segment imaging with a resolution of 20–50 μm, trading penetration for detail. This differs fundamentally from conventional 10-MHz ocular ultrasound.[4,5]

In vivo confocal microscopy achieves 7.6-μm axial resolution, often termed "optical biopsy" for its histology-like images.[6]

This imprecision becomes particularly problematic in tissue banking, where evaluation methods directly affect donor suitability assessments and transplantation outcomes. Each modality provides different information: slit-lamp microscopy reveals surface morphology and transparency, UBM demonstrates stromal integrity, and OCT provides cross-sectional microstructural detail. Reports of tissue deemed "acceptable by biomicroscopy" lack scientific value without method specification. Modern biomicroscopy enables unprecedented evaluation of donor corneas, real-time monitoring during storage, and sensitive detection of posttransplantation changes.[7,8]

From the *Fondazione Banca Degli Occhi del Veneto, Venice, Italy; †"Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania; ‡Department of Ophthalmology, Aarhus University Hospital, Aarhus, Denmark; §Tissue Establishment and Cryobiology Unit, A Coruña University Hospital, A Coruña, Spain; ¶Department of Translational Medicine, University of Ferrara, Ferrara, Italy; and ‖Ophthalmology Department, University Hospital, Saint-Etienne, France.

To restore clarity and precision to ocular imaging terminology, we propose the following standards:

1. Use "slit-lamp microscopy" for the foundational visible-light examination technique
2. Maintain full descriptive names: "ultrasound biomicroscopy (UBM)," "optical coherence tomography (OCT)," and "in vivo confocal microscopy"
3. Avoid the standalone term "biomicroscopy" in scientific publications

Perhaps biomicroscopy's true meaning lies not in a single definition, but as a diagnostic field: the family of in vivo microscopic techniques—optical, acoustic, and interferometric—that collectively visualize microscopic physiology of living systems. Its significance lies not in any single instrument, but in their collective diagnostic power.

The evolution from gross observation to high-resolution, multimodal microscopy has transformed donor evaluation and recipient follow-up in transplantation sciences. However, this progress demands terminological precision. Journals, eye banks, and researchers should explicitly name modalities used, ensuring clarity in communication and comparison.

A consensus definition of biomicroscopy as an overarching field of in vivo microscopic imaging could provide a framework while preserving each technique's specificity. This terminological precision has real consequences for clinical practice, research reproducibility, and patient care—particularly in tissue banking, where precise evaluation methods directly affect outcomes.

REFERENCES

1. Kaur Kirandeep, Gurnani Bharat, Slit-lamp biomicroscope. 2023. Accessed Aug 24, 2025. [Online]. Available at: https://www.ncbi.nlm.nih.gov/books/NBK587440/
2. Shu X, Wang J, Hu L, "A review of functional slit lamp biomicroscopy," *Eye Vis*, vol. 6, no. , p. 15, 2019,
3. Acquart S, Campolmi N, He Z, et al. Non-invasive measurement of transparency, arcus senilis, and scleral rim diameter of corneas during eye banking," *Cell Tissue Bank*, vol. 15, no. , pp. 471–482, 2014,
4. de Boer JF, Cense B, Park BH, et al. "Improved signal-to-noise ratio in spectral-domain compared with time-domain optical coherence tomography," *Opt Lett*, vol. 28, no. , p. 2067, 2069, 2003,
5. Huang D, Swanson EA, Lin CP, et al. Optical coherence tomography," *Science (1979)*, vol. 254, no. , pp. 1178–1181, 1991,
6. Zhivov A, Stachs O, Stave J, et al. "In vivo three-dimensional confocal laser scanning microscopy of corneal surface and epithelium," *Br J Ophthalmol*, vol. 93, no. , pp. 667–672, 2009,
7. Cruz GKP, Júnior MAF, Goldiano JAS, et al. "Donation process and evaluation of corneal tissue in a slit lamp," *Transpl Proc*, vol. 54, no. , pp. 1190–1196, 2022,
8. Patil M, Lune A, Paranjape R, et al. Qualitative and quantitative evaluation of donor corneal tissue by slit lamp and specular microscopy," *Cureus*, 14, e24700, 2022,