Title: Application of Artificial Intelligence in Cell Viability Analysis for Tissue Banking

Authors: Gabriel Fletscher, Maria Torres, Astrid Malagon

Abstract

Cell viability assessment is essential in evaluating the quality of osteochondral allografts, which are increasingly used in reconstructive procedures. Traditional methods rely on specialized equipment like fluorescence microscopes or plate readers, which are often inaccessible in many tissue banks. To explore how artificial intelligence (AI) can assist in analyzing cell viability from standard photographic images of resazurin-based assays and fluorescence microscopy, streamlining evaluation processes where conventional equipment is unavailable. Images from 96-well plates and dual-channel fluorescence microscopy were processed using AI-assisted analysis tools. The resazurin assay, which changes color in response to metabolic activity, served as a visual indicator of cell viability. AI models quantified fluorescence intensities and colorimetric changes from standard camera images. AI-based image analysis provided quantifiable and reproducible viability data comparable to readings from specialized lab equipment. This enabled an objective assessment using only photographic images, significantly reducing analysis time. This approach is especially valuable for tissue banks that lack access to expensive readers or microscopes. By using AI to analyze resazurin-stained plate photographs, viability testing becomes more feasible, cost-effective, and scalable, allowing broader implementation of viability monitoring protocols. Integrating artificial intelligence into cell viability analysis represents a transformative advancement in tissue banking. It enhances the accessibility and efficiency of quality control processes, supporting better graft selection and biotechnological standards in health applications.

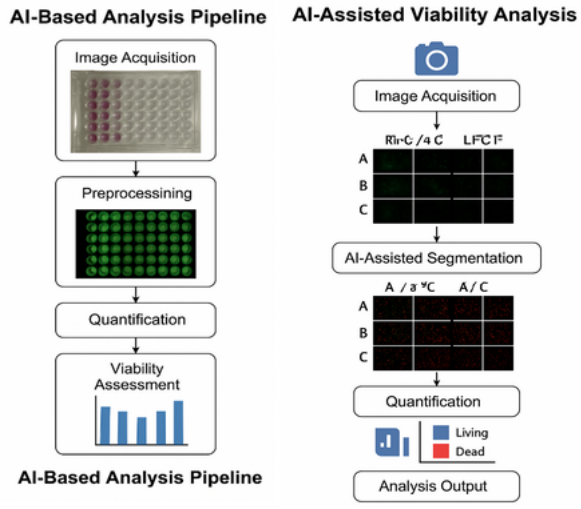
APPLICATION OF ARTIFICIAL INTELLIGENCE IN CELL VIABILITY ANALYSIS FOR TISSUE BANKING

FLETSCHER GABRIEL[1]; TORRES MARIA ALEJANDRA[1] AND MALAGÓN ASTRID[1]
DISTRICT TISSUE BANK, DISTRICT INSTITUTE OF SCIENCE, BIOTECHNOLOGY AND INNOVATION IN HEALTH BOGOTÁ, COLOMBIA

IDCBIS
Instituto Distrital de Ciencia, Biotecnología e Innovación en Salud

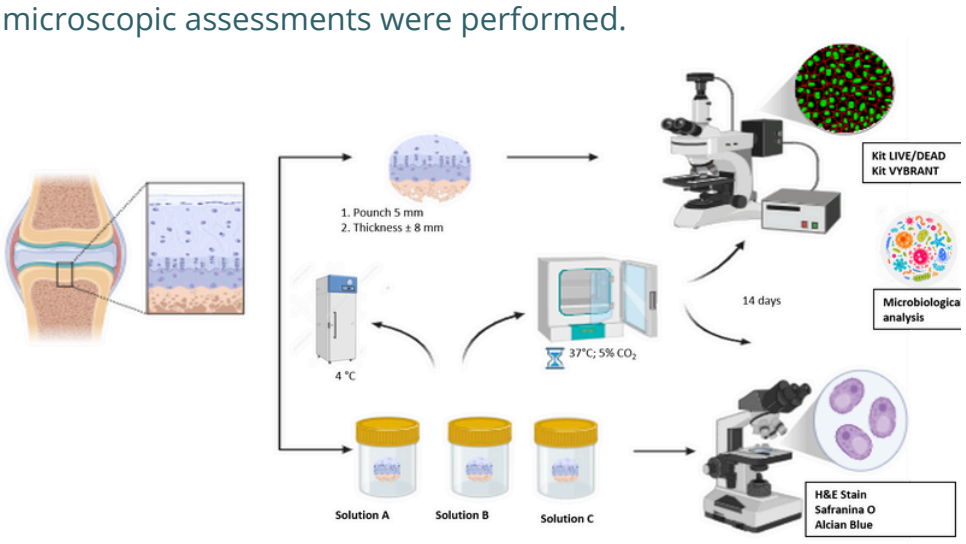
BACKGROUND

Accurate assessment of cell viability in osteochondral allografts is essential for ensuring transplant quality and therapeutic success. However, many tissue banks lack access to advanced equipment such as fluorescence microscopes and plate readers. This study explores the use of artificial intelligence (AI) to analyze viability via image-based fluorescence of resazurin-stained samples, offering a practical and scalable solution for tissue viability assessment



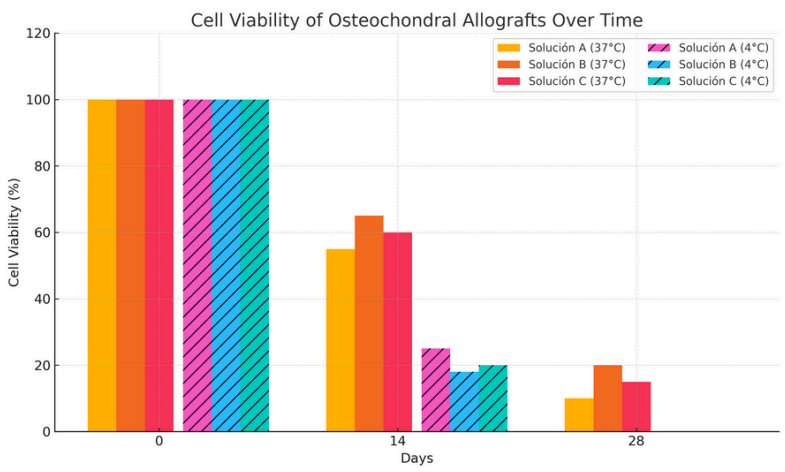
METHODS

Osteochondral allograft samples were stored under varying conditions (4 °C and 37 °C in 5% CO_2) and treated with different preservation solutions (A, B, and C). Cell viability was measured using a resazurin and fluorecence assay, and images were captured with standard digital cameras. A computer vision pipeline implemented in Python was used to extract average fluorescence intensities from each well. Results were compared against baseline and control samples. Parallel microscopic assessments were performed.



RESULTS

The AI-based analysis enabled consistent detection of fluorescence intensity across experimental conditions. Quantitative data revealed distinct viability profiles correlating with storage time, temperature, and solution type. The method accurately differentiated between viable and non-viable samples and aligned with results from fluorescence microscopy. Notably, allografts stored at 37 °C in solution B retained the highest viability after 28 days.



Quantitative analysis of cell viability in osteochondral allografts under different storage conditions using AI-assisted fluorescence image processing. The AI pipeline allowed precise estimation of fluorescence intensity from resazurin assays and cell viability stains, highlighting higher viability in grafts stored at 37 °C, especially with Solution B, compared to cold storage conditions.

DISCUSSION

The integration of artificial intelligence into viability assessment protocols presents a transformative approach for tissue banking operations. Traditional viability analysis methods often require access to specialized equipment such as fluorescence microscopes or plate readers, which may not be available in all facilities. Our findings demonstrate that by using AI-assisted image analysis—processing standard photographs of Resazurin-stained 96-well plates and fluorescence images—it is possible to generate consistent, quantifiable viability data. This approach not only enhances objectivity and reproducibility but significantly reduces the time and technical barriers associated with manual analysis. In resource-limited settings, this method could democratize access to quality assessment tools, improving graft selection and overall tissue preservation outcomes. Moreover, the automation potential of AI pipelines enables rapid scalability, which is essential for high-throughput screening in clinical and biotechnological applications. These results underscore the growing importance of AI in advancing regenerative medicine and optimizing biotechnological workflows in healthcare.

CONCLUSION

Artificial intelligence-assisted analysis of images is a promising tool for viability evaluation in tissue banks. It provides a cost-effective alternative when conventional equipment is unavailable, potentially improving allograft quality assurance. The integration of AI in tissue banking workflows represents a significant step in the application of biotechnology to enhance healthcare delivery.

Ethical Considerations:
All osteochondral allografts used in this study were obtained from voluntary human donors through a certified tissue bank, in accordance with Colombian national laws (Ley 1805 de 2016) governing the donation and use of anatomical components. The procedures adhered to ethical standards for biomedical research and were approved by the relevant ethics committee.