Introduction to 3D bioprinting: Mechanism, application, and ethical considerations in artificial tissue fabrication: A scoping review

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ABSTRACT

Introduction: Three-dimensional (3D) bioprinting is an innovative technology that integrates engineering, biology, and medicine to create artificial tissues and organs. It offers solutions to pressing healthcare challenges such as organ shortages and the demand for personalized treatment. Despite its potential, clinical application raises ethical, regulatory, and religious concerns. This scoping review explores the mechanisms of 3D bioprinting, its biomedical applications, and associated ethical implications. **Materials and Methods:** A scoping review was conducted following PRISMA guidelines. Eight peer-reviewed articles published between 2020 and 2025 were analyzed. Studies that addressed bioprinting mechanisms, tissue applications, and ethical or legal considerations were included, while abstract-only and irrelevant papers were excluded. **Results:** 3D bioprinting involves a structured process that begins with digital modeling followed by deposition techniques such as extrusion-based, inkjet, and laser-assisted printing. Bioinks, composed of natural, synthetic, hybrid, or stimuli-responsive polymers, are critical for cell viability and structural integrity. Applications include tissue regeneration (skin, cartilage, bone), organoid modeling, and pharmaceutical testing. Ethical challenges include organ ownership, informed consent, fair access, and regulatory oversight. From an Islamic perspective, bioprinting is permissible if aligned with Maqasid al-Shariah and uses halal sources, although concerns remain regarding human dignity and enhancement. **Conclusion:** 3D bioprinting holds transformative potential for regenerative medicine and personalized healthcare. However, its successful integration into clinical practice depends on addressing technical limitations, regulatory frameworks, and ethical issues. Collaboration across disciplines and efforts to improve affordability are essential to ensure fair access worldwide.

KEYWORDS: 3D bioprinting; tissue engineering; bioink; ethics; regenerative medicine