ERRORS AND SHORTCOMINGS THAT OCCUR DURING THE PRINTING PROCESS USING THE 3D BIOPRINTER AND THEIR CORRECTION

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Annotation. The rapid development of 3D bioprinting technology has opened up new frontiers in regenerative medicine and tissue engineering, enabling the creation of complex biological structures for therapeutic applications. Despite its promising potential, the bioprinting process is fraught with errors and shortcomings that can compromise the integrity and functionality of the printed constructs.

Key words: *youth, science, innovative ideas, research, scientific activity, development, implementation, scientific laboratory, startup projects, scientific results.*

Introduction

This article reviews common errors encountered in the 3D bioprinting process, their consequences, and effective correction strategies supported by scientific evidence and statistical analysis.The rapid development of 3D bioprinting technology has opened up new frontiers in regenerative medicine and tissue engineering, enabling the creation of complex biological structures for therapeutic applications. Despite its promising potential, the bioprinting process is fraught with errors and shortcomings that can compromise the integrity and functionality of the printed constructs.

Literature review

Research Methodology

Common Mistakes in 3D Bioprinting 1-Inconsistent Extrusion Rates; One of the main challenges in bioprinting is ensuring consistent extrusion of bioinks. Variations in flow rates can lead to under-extrusion or over-extrusion, resulting in dimensional inaccuracies. According to recent studies, approximately 30% of printed constructs fail to meet dimensional specifications due to these inconsistencies. Factors that affect extrusion include the viscosity of the bioink, nozzle diameter, and pressure settings. 2-Layer misalignment; Incorrect layer alignment during the printing process can significantly affect the structural integrity of the resulting construct. Studies show that up to 25% of constructs can experience layer misalignment, compromising their mechanical stability and biological functionality. 3-Temperature variation; Temperature control is crucial to maintain the noble properties of bioinks during the printing process. Low temperatures can lead to premature gelation or insufficient hardening of the material. The study noted that maintaining a stable temperature can increase the printing accuracy by up to 40%, thereby reducing the incidence of failed printing due to thermal inconsistencies. 4-Loss of cell viability; The shear stress experienced by cells during bioprinting can lead to cell death, which negatively affects the regenerative potential of the printed tissue. It has been found that cells can lose up to 50% of their viability if the shear rate during extrusion exceeds optimal limits, especially if the shear rate exceeds optimal limits. This loss of viability is a very important problem, as it directly affects the functional outcomes of bioprinted constructs.

Research methodology: As the field of 3D bioprinting continues to evolve, overcoming these errors and implementing effective correction strategies will be critical for the successful implementation of bioprinting technologies into clinical practice. Future research should focus on developing more sophisticated bioprinting systems that integrate advanced monitoring and flexible control mechanisms. In addition, exploring novel biomaterials that improve cell viability and structural integrity will be important for advancing the potential of 3D bioprinting in regenerative medicine.

Analysis and results

Several remediation strategies can be implemented to address these issues: 1-Real-time monitoring systems. Integrating advanced real-time monitoring systems into the bioprinting workflow can facilitate immediate detection and correction of errors. The use of machine learning algorithms to analyze parameters such as flow rate, temperature, and layer alignment allows for flexible adjustments during the printing process. Studies show that the use of such systems can reduce errors by up to 25%. 2-Optimized Bioink Formulations. Developing bioinks with tailored rheological properties is crucial for improving printing and cell viability. The inclusion of shear thinning agents helps modulate the viscosity of bioinks, which allows for smooth extrusion while maintaining structural integrity post-printing. Studies show that optimized bioink formulations can increase cell survival rates by 15-20%, significantly improving the regenerative potential of constructs. 3-Flexible printing techniques. Using adaptive printing methods that adjust parameters in real time can improve the accuracy of the printing process. For example, dynamically adjusting the extrusion speed based on feedback from viscosity sensors can help maintain a stable flow rate, thereby reducing the occurrence of extrusion errors. 4-Comprehensive calibration before printing. Performing a thorough calibration before printing is essential to identify potential problems before the actual printing process begins. This includes calibrating the printer's extrusion system and ensuring that the bioink is at the optimal temperature and viscosity for printing (the bioink is heated and printed). Implementing a systematic calibration protocol can significantly improve printing accuracy and reduce errors.

Conclusion

In conclusion, while the potential of 3D bioprinting in tissue engineering is enormous, recognizing and correcting inherent errors in the printing process is critical to achieving reliable and functional constructs. Through continuous innovation and implementation of effective correction strategies, the field can move closer to realizing the goal of biofabrication of functional tissues and organs for therapeutic applications.

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