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Current laboratory research into novel burn treatments relies on porcine skin models to analyze wound healing behavior and cellular regeneration. To preserve tissue viability during sample culturing and imaging, subcutaneous fat must be removed to enable the uptake of culture media. Currently, cylindrical biopsy samples are manually secured with tweezers and sliced using a scalpel, which results in uneven cuts, safety risks, and ergonomic discomfort. Commercially available slicing matrices fail to secure samples and are costly. This design provides a shape-tailored, low-cost alternative for accurate and efficient tissue slicing. The Biopsy Press is a crucial tool for improving small tissue processing for researchers across dermatology, plastic surgery, and gastroenterology studies to generate quantifiable results.

The Biopsy Press design consists of a rubber base, tissue slicing matrix, and pressure applicator. The tissue slicing matrix snaps into the rubber base for stability and is constructed from layered polycarbonate components that are secured to a nylon part with pegs. This matrix is a two-well system with guided blade tracks for making horizontal and vertical cuts. Samples are placed in the wells and stabilized using a 3D-printed PLA pressure applicator during slicing.

User survey results led to several design iterations of the Biopsy Press, which improved cutting accuracy, ergonomics, and structural stability. The sample well was positioned to accommodate a #11 surgical blade, while the blade track width and well depth were optimized to reduce angle variability and improve cut precision. The pressure applicator was extended for improved grip, and overall device dimensions were increased to enhance user safety. A rubber base was incorporated to improve traction between the device and lab benchtop. Initial connector designs were replaced with a layered assembly to improve stability, cleanability, and visibility through the implementation of polycarbonate components.

After design iterations were complete, the design was validated through functionality, sterilization ability, and strength analyses. Users with tissue handling experience completed surveys assessing slicing performance and evaluating sample uniformity. Sterilization was evaluated using a UV-tagged coating, intended to represent the buildup of fat within the device over time. Cleaning protocols involved using ethanol or soap and water, which exhibited the matrix's ability to be cleansed, and autoclaving revealed that the polycarbonate and nylon components maintained structural integrity. FEA confirmed the device withstood expected user-applied loads of 50 N to the main biopsy press and 22 N to the pressure applicator without deformation or component disassembly. Through rigorous testing, the device consistently surpassed previously established performance and quality benchmarks.

The Biopsy Press meets the defined requirements by enabling consistent and controlled fat removal while reducing user variability and tissue damage. Guided cutting tracks constrain the blade motion, improving repeatability. Enclosed blade pathways enhance safety and usability, while nylon and polycarbonate components provide mechanical strength and compatibility with standard sterilization methods. Testing demonstrated improved slice consistency and reduced deformation compared with manual techniques, with strong user survey agreement in terms of blade control, device safety, and ease of use.

The Biopsy Press improves user performance by reducing the skill required for precise biopsy preparation, increasing efficiency and reproducibility. Standardizing the slicing process minimizes the inter-user variability and supports consistent experimental outcomes. The ergonomic, guided design reduces physical strain, while integrated safety features lower injury risk. The device enables faster, more consistent sample preparation that directly supports improved tissue preservation and data reliability.