MicroHeart: A Novel, Structurally Accurate, Physiologically Relevant, and Scalable Heart-on-a-Chip Platform

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Problem Most drug development costs go toward testing failed drug candidates, slowing innovation and ultimately costing lives. Even then, cardiotoxicity is a leading cause of drug recalls, so current cardiotoxicity screening methods (2D cell culture and animal models) are not accurate enough. Heart-on-a-chip (HoC) combines the accuracy of 3D cell culture with the scalability of microfluidics, but are prohibitively expensive, lag in structural accuracy, and do not output physiologically relevant data. A better solution is critical. Methods Cardiomyocytes (CMs) were derived from induced pluripotent stem cells due to their superior quality and ability for mass production. Prototype One (P1) had a novel light-bioprinted microtissue, maximizing similarity to in-vivo tissue. The microfluidic chip consisted of a central microtissue well, inputs, and channels. Prototype Two's (P2) microtissue was organoid based; bioink laden with CMs was injected into the central well. P1 and P2 were electrically matured. Results Chips were tested with epinephrine, isoproterenol, and verapamil for drug sensitivity. P1 and P2 displayed high responsiveness in contraction amplitude and frequency to all three drugs; however, P1 displayed a more physiological contraction pattern than P2, as well as an unprecedented accuracy high enough to compare potencies of similar drugs, suggesting that the novel light-bioprinted microtissue creates a more accurate model than existing microtissues. Conclusion MicroHeart is the first HoC platform that combines accurate tissue structure, physiologically relevant data, and a non-prohibitive cost, while delivering unprecedented insight into drug candidate function. Although exciting progress has been made, more investigation is required.

Awards Won: