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Dynamic control of needle-free jet injection.

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Abstract

Many modern pharmaceutical therapies such as vaccines and macromolecular drugs benefit from transdermal delivery. Conventional transdermal drug delivery via hypodermic needles causes pain, non-compliance, and potential contamination. Alternative transdermal strategies that deliver drugs in a quick, reliable, painless, and inexpensive way are needed. Jet injectors, which deliver drugs through the skin using a high-speed stream of liquid propelled by compressed springs or gasses, provide a needle-free method of trandermal drug delivery. However, poor reliability as well as painful bruising and bleeding characterize these devices, due in part to the high and constant jet velocity with which drugs are delivered. Toward improved reliability and reduced pain, we have developed a jet injector capable of dynamic control of jet velocity during a single injection pulse. Using this device, we demonstrate that temporal control of jet velocity leads to independent control of penetration depth, by adjusting time at high velocity, and delivered dose, by adjusting time at low velocity, in model materials. This dynamic control of jet velocity creates the potential for better control of needle-free injections, as demonstrated through injection studies on whole ex vivo human skin samples.