Microfabricated Biopsy Punch for Minimally Invasive Dermatological Diagnostics

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Skin tissue biopsies are an essential tool for diagnostics in dermatology (Figure 1). This study focuses on the design, fabrication and development of a microbiopsy punch, which can be used in conjunction with molecular diagnostic tools, for minimally invasive diagnosis of cutaneous diseases.

Microbiopsy punches must not only reproducibly insert into a deformable microenvironment (i.e., skin), but must also be mechanically robust for skin tissue collection. To accomplish this goal, several design criteria were considered including: microbiopsy punch material thickness, surface roughness and geometry, as well as insertion speed into skin. Stainless steel sheets, between 0.001" – 0.005" in thickness, were used to fabricate microbiopsy punches via infrared laser ablation; multiple novel designs were considered to latch onto and extract skin tissue. A commercial lancing device was used to propel the micropbiopsy punch at various speeds between 10 - 20 m/s in order to optimize the microbiopsy punch design.

The minimum stainless steel sheet thickness required to successfully insert into *ex vivo* porcine skin was 0.005". Histological evaluation of the insertion site shows mechanical disruption into the papillary dermis (~500 µm deep). Insertion did not extend into the deeper dermal tissue and thus a microbiopsy device may be sufficiently painless not to require local anaesthesia. Extracted skin tissue volume ranged up to 100 nl depending on microbiopsy punch geometry, surface roughness, and insertion speed (Figure 2A). In addition, skin surface damage is sub-millimeter (Figure 2B) suggesting superior wound healing kinetics and minimal scarring relative to traditional punch biopsies, which will be assessed in future *in vivo* studies. Additional on-going studies are addressing further optimization of microbiopsy punch design to increase amount and reliability of tissue collection.

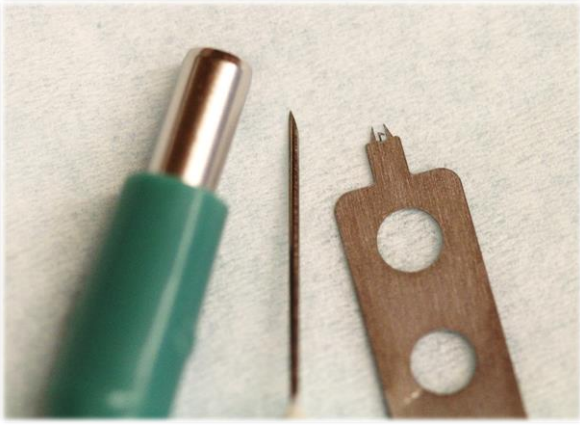


FIGURE 1: (from left to right) 3 mm biopsy punch; 25 gauge hypodermic needle; microbiopsy punch fabricated in this study.

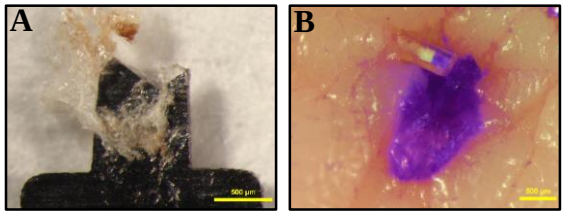


FIGURE 2: (A) Representative image of skin tissue removal from ex vivo porcine skin, and (B) corresponding insertion site in porcine skin stained with gentian violet to show the skin penetration site [scale bar = 500 µm for all images]