

An Adhesive Patch–Based Skin Biopsy Device for Non-Invasive Gene Expression Analysis in Dermatology

Zuxu Yao, PhD, Talisha Allen, BS, Margaret Oakley, BS, and Burkhard Jansen, MD, DermTech, La Jolla, CA, United States

Introduction

Currently, many clinical diagnoses in dermatology depend on histopathologic confirmation. This image recognition-based confirmation is not only subjective, it also always requires a surgical biopsy. A paradigm shift from a subjective image-based method to a more objective gene expression analysis appears highly desirable. It is on the horizon with the recent development of a non-invasive gene expression test for pigmented skin lesions^{1,2}.

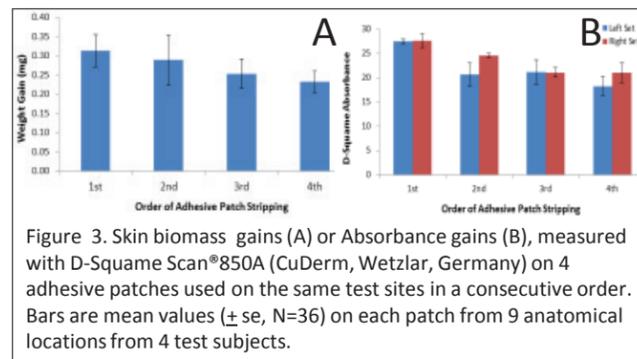
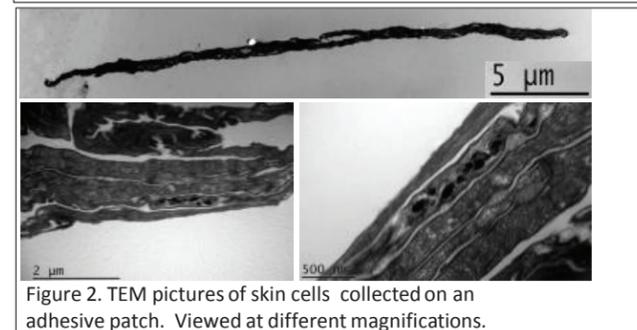
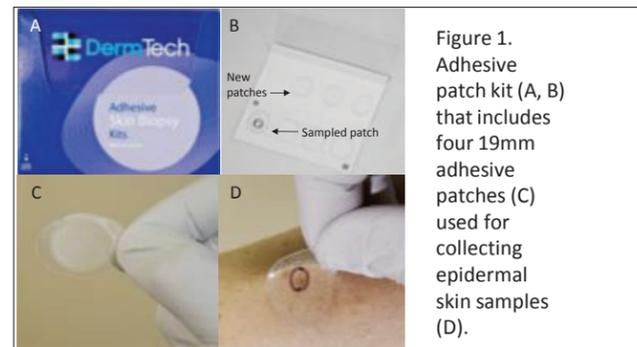
This study describes in detail an adhesive patch-based skin biopsy device that can be used to non-invasively collect skin tissue samples for gene expression analyses and other uses.

Materials and Methods

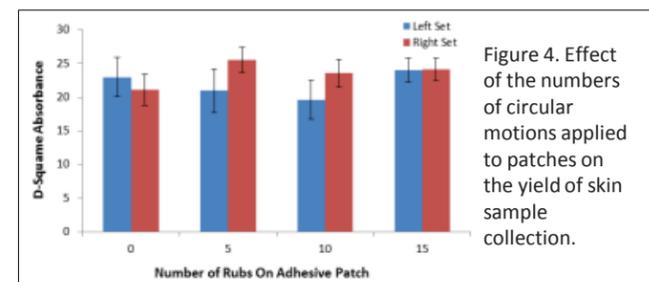
Epidermal skin samples were collected with an adhesive patch-based skin biopsy device (Figure 1) manufactured by DermTech (La Jolla, USA), and skin collection performance of the device was evaluated with complementary technologies including assessment of sample biomass, electron microscopy, total RNA isolation and gene expression analysis. In addition, the impact of this non-invasive sampling on skin was also examined.

Results and Discussion

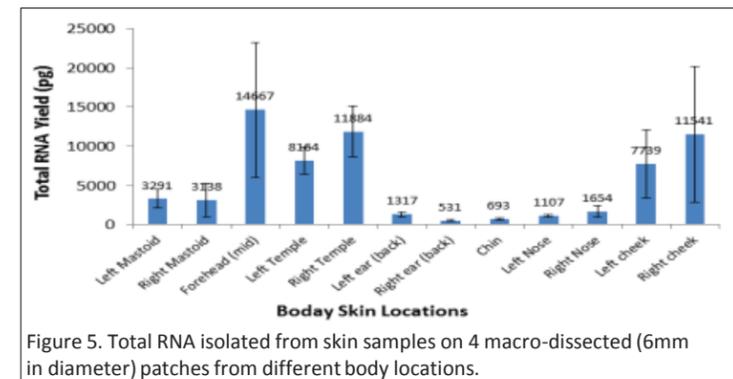
Figure 2. shows the transmission electron microscopy (TEM) pictures of stratum corneum skin samples collected via an adhesive patch. This result provides direct evidence of successful collection of 2-4 layers of cells on each patch through a non-invasive approach. More skin cells were collected on the first harvested patch and the cell numbers collected appear to decrease with additional patch sampling from the same site, confirmed through both biomass gain and patch absorbance gain measurements (Figure 3). With one adhesive patch kit (4 patches), a total of about 1mg of skin biomass (combined from all 4 patches) could be collected, which is sufficient for most gene expression analyses.



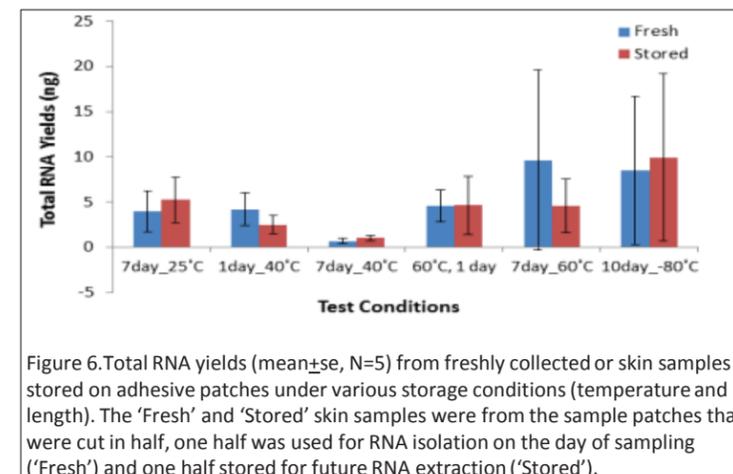
The adhesive patch technology is easy to use and works robustly on collecting skin samples. Figure 4 shows that sufficient amounts of skin tissue could be collected using various harvesting techniques.



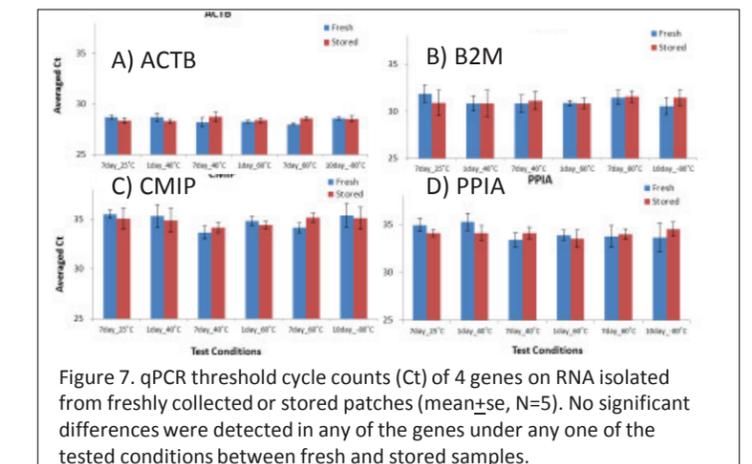
The adhesive patches successfully collected epidermal skin samples at different body locations for total RNA isolation (Figure 5). Although the total RNA yields varied from site to site, ranging from 2-14ng from 4 full patches (per test site) or 0.5-2ng from 4 macro-dissected 6mm-diameter areas of patches, the amounts of total RNA were sufficient for most molecular analysis in dermatology.



RNA molecules (from a variety of cell types not limited to keratinocytes) in the patch collected skin samples were stable under various storage conditions (Figure 6) as RNA molecules are more protected from nucleases in dried cells. This proved quite advantageous as the skin samples collected via the adhesive patch technology at various clinics and physician offices can simply be shipped to the analysis laboratories by regular mail or courier at ambient temperatures.



Total RNA isolated from both freshly collected samples or samples stored on patches had demonstrated similar quality sufficient for qPCR-based gene expression analysis for a wide range of genes (in low to high expression levels, Figure 7). RNA collected through this patch sampling method is now used in a commercially available gene expression test for melanoma and to assess inflammatory skin conditions.¹



Conclusion

The adhesive patch-based skin sample collection device is an easy to use, safe and robust method that can be used to non-invasively collect epidermal tissue samples for molecular analyses (and potentially other applications as well). Samples collected via the adhesive patch biopsy method are stable and can be shipped cost effectively to analysis laboratories at ambient temperature by mail or standard courier service avoiding the need for special storage and handling.

References

- Gerami et al., Development and validation of a non-invasive 2-gene molecular assay for cutaneous melanoma; JAAD-D-16-00647R1, 2016.
- Yao et al., Analytical Characteristics of a Noninvasive Gene Expression Assay for Pigmented Skin Lesions; ASSAY and Drug Development Technologies, Vol.14 No.6, 2016.

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