Fundamental Assessment of Skin Microbiome Diversity in Three Subject Populations: Normal Skin, Dry Skin, and Dry Skin with a History of Itch

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Introduction

• While it is known that healthy skin has higher microbial diversity and lower *Staphylococcus* colonization than atopic skin, there is little understanding about how the microbiome changes as skin transitions from a healthy state to more compromised conditions with aberrant barrier functions.

• There is increased diversity in dry skin sites as compared to moist or sebaceous sites in healthy individuals.¹

Objectives

• Evaluate the fundamental differences in diversity and composition of the microbiome in normal, healthy skin compared to moderate to severe dry skin with and without a history of itch.

Hypothesis

• Microbial diversity from the same part of the body in dry skin would differ from normal skin across subject populations.

Methods

• CLINICAL STUDY DESIGN
  – Single center, randomized, evaluator-blind clinical evaluation of lateral lower legs
    • 18 to 55 year-old Caucasian females with Fitzpatrick Skin Types I to III
    • 36 subjects were equally stratified according to skin condition:
      • Normal, healthy skin (n = 12)
      • Moderate to severe dry skin (n = 12)
      • Moderate to severe dry skin with a history of itch (n =12)
  – Outcome measures:
    • Clinical grading of dryness (scale = 0 – 8) and erythema (scale = 0 – 4); subjective assessment of itching severity (scale = 0 – 3); and biophysical assessments of skin barrier function (TEWL), skin hydration (conductance and capacitance), and skin surface pH
    • Skin microbiome 16S rRNA (ribosomal ribonucleic acid) gene sequencing

Results

Microbial diversity profile

Species level relative abundance profiles of normal, dry, dry with history of itch

- Microbial diversity was significantly higher in dry skin and dry skin with a history of itch as compared to normal, healthy skin ($p < 0.05$).
- In contrast to what has previously been observed for atopic lesions with a compromised barrier, we observed increased microbial diversity in patients with dry and dry, itchy skin as compared to normal, healthy skin when the skin barrier was intact.

1Relative abundances were compared across three groups using Kruskal-Wallis rank sum tests, and if significant, then pairwise comparison; p values were corrected using False Discovery Rate (FDR) to account for multiple comparisons. Principal Component Analysis (PCA) and Per Mutational Multivariate Analysis Of Variance (PERMANOVA) were used to analyze the relationship between overall microbiome composition and skin type.
Results

- Clinical grading for dryness and skin conductance measurements (skin surface hydration, measurement depth ~ 15 µm) confirmed that the dry skin and dry skin with a history of itch were significantly drier than normal, healthy skin.

- However, no significant differences were observed between the three skin groups with regard to the clinical grading of erythema, subjective assessments of itch (at time of study assessment), hydration measured by capacitance ($p = 0.065$, near significant difference), barrier function as assessed by TEWL, or skin surface pH.

![Graphs showing clinical grading, skin hydration, barrier function, and skin surface pH](image-url)

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Conclusions

• To our knowledge, this is the first study to demonstrate that microbial diversity is increased in subjects with moderate to severe dry skin (with and without a history of itch) as compared to normal, healthy skin.

• These data begin to bring the full spectrum of microbial diversity in normal, dry, itchy, and atopic dermatitis skin into focus, and reveal that the diversity of the microbiome in dry skin with an intact barrier function may be different than what is commonly seen in atopic dermatitis where there is a compromised skin barrier.

• An additional clinical trial in a similar subject population is currently ongoing to confirm and extend the results seen in this pilot clinical study.

• Future work will examine species level microbial differences between normal, dry, and dry skin with a history of itch, to identify new insights into the role of specific skin microbes in skin barrier health.