Dandruff Associated Changes in Epidermal Morphology

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Introduction

Dandruff is a very common scalp condition reportedly affecting upwards of 50% of the global adult population ⁽¹⁾. Host factors such as sebum production seem to play a key role as dandruff is only present in the post-pubertal population when sebum production increases ⁽²⁾. Microbial colonisation of the scalp also appears to be a key factor in dandruff and advances in the characterisation of microbial populations has enabled a detailed description of the microbial component of dandruff to be elucidated ⁽³⁻⁵⁾. Changes in the homeostasis of skin in dandruff have been demonstrated using various methods. There is evidence of depleted and disorganized stratum corneum lipids resulting in a weakened skin barrier ⁽⁶⁾. Histological studies of dandruff scale show that stratum corneum corneocytes are shed with retained nuclei, known as parakeratosis ⁽⁷⁾. There have been a limited number of histological studies on dandruff scalp skin. One study investigated the histology of dandruff scalp skin both before and after treatment with an anti-dandruff shampoo. This study showed the epidermis was thicker and had a greater number of nucleated cell layers in dandruff lesional skin. Some of these epidermal changes normalised after treatment with an anti-dandruff shampoo ⁽⁸⁾.

This poster describes a comprehensive study of the morphology and cellular proliferation of the epidermis in the scalp skin of subjects with a dandruff phenotype compared to healthy controls. We obtained skin biopsy samples and utilised various epidermal measurement techniques including quantifying epidermal thickness, the interdigitation index ⁽⁹⁾ and the depth of epidermal rete ridges. We characterised the proliferation of epidermal keratinocytes using the well-established cellular proliferation biomarker Ki67 ⁽¹⁰⁾.

Study Design

An ethically approved clinical study to investigate the characteristics of scalp skin in dandruff was conducted. Female subjects (mean age 39.8 +/- 15.4) were recruited and their scalp health graded using total weighted head score ⁽¹¹⁾ and were classified as either healthy (score ≤8) or dandruff sufferers (score ≥32). 4mm scalp skin punch biopsies were collected from 22 healthy subjects and 21 dandruff sufferers from both a lesional and non-lesional site.

Methods

Biopsies were snap frozen and 10µm sections cut, stained using haematoxylin and eosin and images across the whole epidermis gathered using bright field microscopy. Epidermal thickness was calculated using an in house algorithm. The interdigitation index was calculated followed the method described by Timár et al ⁽⁹⁾. Epidermal rete ridge depth was calculated for all visible ridges using ImageJ. Immunohistochemistry for the proliferation marker Ki67 was completed. Image analysis of the expression was performed using Halo® image analysis system and CytoNuclear quantification algorithm (Indica Labs). The percentage of epidermal proliferating cells and the intensity of staining was quantified. All data generated was analysed statistically using JMP 11 (SAS, UK)

Dandruff skin shows significant changes in epidermal morphology

The epidermis was significantly thicker in dandruff lesional skin, mean **95.08µm**, compared to healthy scalp skin, mean **57.08µm**

The dermal epidermal junction was significantly more convoluted in dandruff lesional skin compared to healthy scalp as measured by the interdigitation index.

Epidermal rete ridges were significantly deeper in dandruff skin, mean **83.39µm** compared to healthy scalp skin, mean **47.70µm**.

Non-lesional dandruff skin also showed changes in epidermal morphology suggesting it isn't completely healthy

Dandruff lesional skin corneocyte flakes containing parakeratotic nuclei (↓)

Dandruff skin shows increased expression of the proliferation marker Ki67

Dandruff lesional skin contained a significantly higher percentage of proliferating Ki67 positive keratinocytes, mean **11.84%**, compared to healthy controls, mean **4.22%**

Dandruff lesional skin had a higher expression level of Ki67 protein, mean **27.86**, compared to healthy scalp skin, mean **9.05** as measured using H score

This confirms that in dandruff epidermal keratinocytes are in a hyper-proliferative state

Conclusions

There were significant changes in epidermal morphology in dandruff compared to healthy scalp skin. These changes included an increase in epidermal thickness, a more convoluted dermal epidermal junction and an elongation of epidermal rete ridges. Some of these epidermal morphology changes are characteristic of other inflammatory skin conditions like psoriasis ⁽¹²⁾ and atopic dermatitis ⁽¹³⁾. Changes were also evident in dandruff non-lesional skin suggesting it wasn't healthy.

Analysis of the proliferation marker Ki67 revealed an increase in both the percentage of epidermal keratinocytes expressing Ki67 and the intensity of expression of Ki67 in dandruff compared to healthy scalp skin. This shows that the epidermis is in a hyper-proliferative state in dandruff.

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