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FRACTIONALLY INTENSIFIED CHEMEXFOLIATION (FICEX): A NOVEL CONCEPT IN CHEMICAL PEELS

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ABSTRACT

Background: Chemical peels involve the application of a chemical agent to the skin to induce controlled injury to the epidermis, with or without involvement of the dermis. The depth of penetration of the peeling solution is mainly determined by its ingredients and their concentrations. The basic paradigm of chemical peels is that deeper penetration provides more significant clinical results but is associated with longer downtime and increased risk of complications. **Objective:** This study introduces the FICEX (fractionally intensified chemexfoliation) concept - a technique that combines fractionated controlled mechanical skin wounding (microneedling) with superficial peeling. **Methods:** Skin specimens harvested from cosmetic surgeries were treated by microneedling only, by application of Alcian blue-stained 30% glycolic acid solution, or by a combination of application of Alcian blue-stained 30% glycolic acid solution followed by microneedling. All the specimens were examined histologically. **Results:** Microneedling, using 1.5 mm length needles, created slits in the epidermis. Alcian blue-stained 30% glycolic peeling solution was found only in the uppermost layers of the epidermis. In the skin treated by application of the peeling solution followed by microneedling, columns of Alcian blue-stained 30% glycolic acid were found in the mid-dermis. **Conclusions:** This study validates the clinical hypothesis that controlled mechanical skin wounding intensifies the depth of penetration of the peeling solution. This intensification goes beyond the depth of the microchannels created by the microneedling. These findings substantiate the mechanistic rationale for combining microneedling with chemical exfoliation, affirming that the synergistic approach facilitates deeper, more targeted delivery of peeling agents within the skin.

KEYWORDS: Chemical peels, FICEX, microneedling.

INTRODUCTION

Chemical exfoliation has long served as a cornerstone modality in medical and aesthetic dermatology, offering predictable stimulation of epidermal turnover and dermal remodelling through controlled chemical injury.[1] The depth of penetration of a peeling agent - ranging from strictly epidermal in superficial peels to papillary or even reticular dermal involvement in medium and deep peels - remains the principal determinant of both therapeutic benefit and risk profile. While deeper peels predictably yield more pronounced clinical effects, they are also associated with more extended downtime, greater discomfort, and a higher incidence of potential complications, including dyspigmentation, scarring, and delayed healing.[2]

To optimize outcomes while maintaining safety, various strategies have been developed to modulate peel depth without escalating acid concentration. Sequential peels use different peeling agents to enhance penetration, segmental peeling customizes agents to anatomic subunits based on clinical findings and variable skin thickness, whereas "switch peels" dynamically adjust formulations across treatment sessions to match evolving skin response.[3,4] Targeted techniques, including punctuated application of high-strength trichloroacetic acid (TCA) in the CROSS method, enable focal treatment of deep dermal pathologies while sparing surrounding tissue from unnecessary injury.[5]

Microneedling is a technique in which small needles mechanically pierce the stratum corneum, creating multiple reversible microchannels.[6] The production of numerous microchannels activates wound healing in the skin layers and concomitantly serves as an effective delivery system for macromolecules such as cosmeceuticals, pharmaceuticals, peptides, and gene therapy and vaccines for therapeutic and cosmetic utility.[7,8,9]

It has been clinically reported that combining microneedling with superficial peels (using 35% glycolic or 15% trichloroacetic acids) or more intense solutions (trichloroacetic acid 33%) provides better results than microneedling or peeling alone, when treating atrophic acne scars, whether the peeling solution was applied before or after microneedling.[10,11] Since microneedling-induced injuries initiate a wound-healing cascade, releasing growth factors and activating fibroblasts, it is unclear whether the better outcomes of a combined treatment (microneedling and chemical peel) are due to the simple summation of the biological effects of both treatments or are related, at least partially, to a focally intensified penetration of the peeling solution to deeper skin layers.

The goal of the current study is to assess whether a combination of superficial peeling solution application and skin microneedling enables deeper penetration of the solution, thereby supporting the Fractionally Intensified Chemexfoliation (FICEX) concept.

MATERIALS AND METHODS

Four full thickness human abdominal skin 5 cm × 5 cm specimens were obtained post-surgery and prepared within 4 hours.

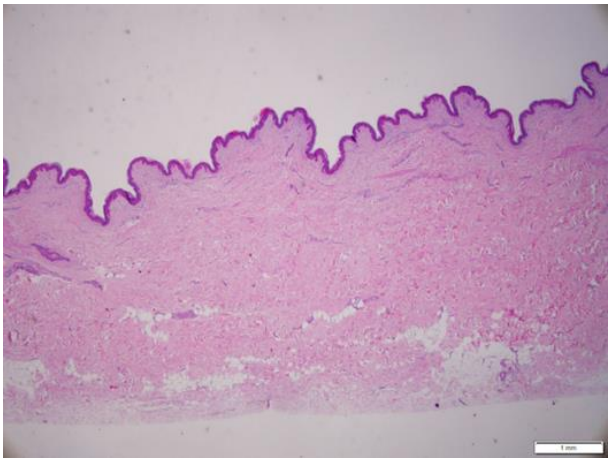
While sample 1 served as a control and was left untreated, sample 2 was treated by microneedling using an automated microneedling device (EXCEED by AmieaMed, MT.DERM GmbH, Berlin, Germany, FDA cleared), which consists of a handpiece, a needle cartridge and a control unit. The needle cartridge contains six needles, each of 0.35 mm gauge. During the study, needle penetration was calibrated to 1.5 mm depth, with a needle stroke frequency of 100Hz. Sample 3 was treated with Alcian blue-stained 30% glycolic acid solution application, and sample 4 with Alcian blue-stained

30% glycolic acid solution application followed by microneedling, using the aforementioned treatment parameters. Microneedling was performed for 1 min by multiple passes in the vertical, horizontal, and diagonal directions to cover the 5X5 cm specimen.

Thirty minutes after the treatment, all the specimens were fixed in 10% formalin, paraffin-embedded, and sectioned. Histological examination was conducted using hematoxylin and eosin (H&E) staining. Dye penetration and morphological changes were assessed and compared across the samples (Fig. 1).

RESULTS

In the microneedled skin, perpendicular slits were visible in the epidermis (Fig. 1b). Glycolic acid 30% solution in non-pretreated skin was found in the corneal layer only (Fig. 1c). In the skin treated by glycolic acid 30% application, followed by microneedling, islands of 30% glycolic acid solution were demonstrated in the dermis, significantly deeper than the lower border of the slits caused by the microneedling. (Fig. 1d and Fig 2)



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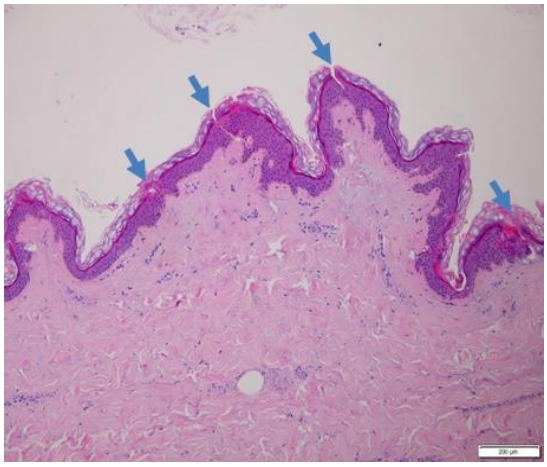

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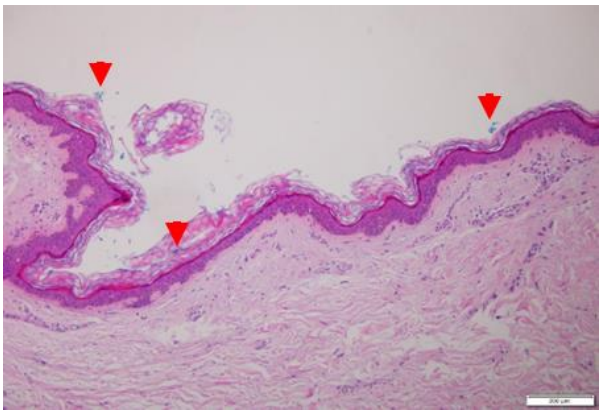

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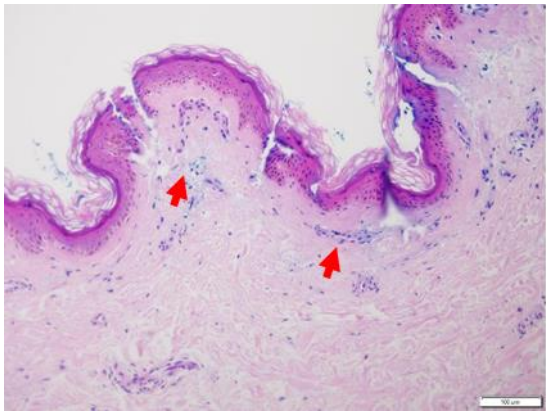

1d

Fig. 1: Histological sections of ex-vivo abdominal skin after the treatments: a. non- treated skin; b. epidermal slits created by microneedling; c. Alcian blue stained 30% glycolic acid in the corneal layer after its application; d. islands of Alcian blue stained 30% glycolic acid found in the dermis after microneedling following glycolic acid solution application (H&E 40x magnification).

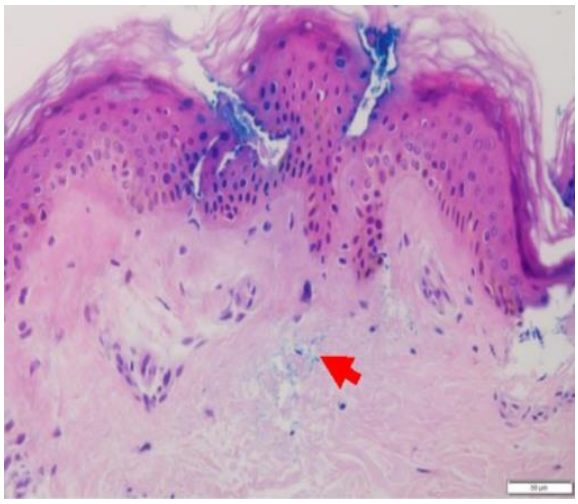

Fig. 2: "Islands" of Alcian blue stained 30% glycolic acid found in the dermis after microneedling of the skin following 30% glycolic acid solution application (H&E 100x magnification).

DISCUSSION

Chemical peels and microneedling are both well-established modalities for skin rejuvenation, and their combination has gained increasing clinical popularity over the past decade. Several randomized controlled trials have shown that combining microneedling with chemical peels yields superior clinical outcomes compared with either modality alone, particularly for atrophic acne scars.[7,8] These studies consistently demonstrated improved scar depth, texture, and patient satisfaction when a peeling solution was applied after microneedling, suggesting a synergistic effect. However, these publications offered no mechanistic or histological explanation for the enhanced outcomes, leaving unresolved whether the benefits were due to the summation of each treatment's independent biological effects or to enhanced penetration of the peeling solution through microneedling-created channels.

To date, only limited histological evidence is available demonstrating the ability of microneedling to enhance the penetration of certain substances. Prior studies have shown deeper delivery of tattoo pigment and macromolecules such as topical pharmaceuticals, peptides and platelet-rich plasma (PRP).**Error! Reference source not found.**[12,13,14] None of the investigations evaluated skin penetration of chemical peeling agents combined with microneedling.

The present study introduces mechanistic validation of the clinically proven synergistic effect of both procedures. By applying the peeling solution before microneedling, we demonstrated for the first time that controlled mechanical skin injury can physically drive a superficial peeling agent deeper into the skin. Histological examination showed that 30% glycolic acid, which remains confined to the stratum corneum, reached the papillary dermis when microneedling was performed after solution application. Not only that, but solution penetration was beyond the depth of the actual slits created by microneedling injury. Our assumption is that focal mechanical elimination of the epidermal skin barrier by microneedling changes the paradigm of chemical peelings. In the focal absence of epidermal protective structures induced by microneedling, 30% glycolic acid solution delivered directly into the uppermost dermis can penetrate and disperse into deeper dermal layers, far beyond the existing microchannels. The histological findings support the concept of fractionally intensified chemexfoliation (FICEX).

In summary, our study provides the first histological proof that controlled mechanical skin wounding can actively intensify the penetration of a peeling solution when applied beforehand. By establishing a mechanistic foundation for

FICEX, it offers a new conceptual and practical framework for combining microneedling with chemical exfoliation, expanding the therapeutic potential of superficial peeling agents, and supporting future evidence-based protocol development. By establishing the mechanistic foundation of this approach, we aim to open new avenues for controlled, predictable, and safer enhancement of chemical peel efficacy.

CONCLUSION

Fractional peeling provides a novel, hybrid strategy in aesthetic dermatology by combining microneedling with chemical peeling. It enhances superficial peels by leveraging microneedling to increase penetration depth without altering the chemical composition or concentration of the peeling agent. This technique bridges superficial and medium-depth peels, offering enhanced outcomes with minimal downtime. Based on ex vivo histology, fractional peeling warrants further clinical evaluation and protocol development. This technique represents a promising advancement in chemical peeling protocols, expanding the range of effective and safe skin resurfacing options.

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