

Non-Invasive Transdermal Delivery of Exosomes via Iontophoresis in Female Androgenetic Alopecia: A Case Series

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Abstract

Introduction: Female androgenetic alopecia (FAA) is a condition that may affect up to 50% of adult women. Its etiopathogenesis involves androgenic influence, genetic predisposition, and lifestyle factors. It is a chronic, progressively evolving condition requiring continuous treatment. Pathophysiologically, FAA is characterized by microinflammation of the dermal papilla of the hair follicle, leading to progressive miniaturization of hair fibers and their transformation into vellus-type hairs — thinner, shorter, and less pigmented — resulting in reduced hair density and significant aesthetic impact.

Case Report: This report presents three patients with a confirmed diagnosis of female androgenetic alopecia who underwent hair treatment combining iontophoresis with exosomes over five sessions at 20-day intervals. Iontophoresis is a non-invasive technique that uses an electric field to optimize transdermal delivery of active agents. Exosomes are extracellular nanovesicles that carry proteins, RNA, and growth factors, promoting intercellular communication, repair, and tissue regeneration.

Conclusion: The combination of iontophoresis/electroporation with exosomes demonstrated high efficacy over a short period, increasing hair density, improving hair quality, and reducing scalp inflammation. No discomfort was reported during the procedure. Further studies are needed to confirm its efficacy.

Keywords: Female Androgenetic Alopecia; Iontophoresis; Electroporation; Exosomes

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1. Introduction

Androgenetic alopecia (AAG) is a common form of hair loss that may affect up to 50% of adult women and represents a chronic condition [1]. This pathology is directly linked to an exacerbated response to androgenic hormones and generally affects the vertex region of the scalp in predisposed women, causing terminal hairs to become vellus (thin and depigmented) [2]. Iontophoresis is a non-invasive technique that uses an electric field to enhance the administration of drugs or specific active agents for the desired treatment. It drives charged molecules through the skin using a low-intensity current influenced by an external electric potential difference, facilitating active penetration [3].

Exosomes are membrane-enclosed vesicles secreted by cells into the surrounding medium. They transport proteins, lipids, and other important actives for cellular metabolism, playing vital roles in homeostatic balance and intercellular communication [4].

1.1 Female Androgenetic Alopecia (FAA)

FAA presents with follicular miniaturization resulting in thinner, less pigmented hairs, caused by shortening of the anagen phase of the hair cycle, and is characterized by diffuse thinning in the parietal region [5]. Its pathogenesis involves genetic predisposition, wherein follicles respond to androgenic hormones such as testosterone and DHT (dihydrotestosterone). In the presence of these hormones, the dermal papilla of the hair follicle releases inflammatory cytokines that may cause inflammation and subsequent reduction of the anagen phase [6].

Women affected by this alopecia may experience problems with self-esteem and self-confidence, with a negative impact on social interaction and quality of life [7].

1.2 Iontophoresis and Electroporation

Iontophoresis is a technique used to facilitate transdermal permeation of actives through the application of a subsensory electric current, which can be combined with electroporation and sonophoresis. In addition to increasing active permeation, it carries a low risk of side effects [8].

The skin is a natural barrier of the body against external agents and crossing it for active delivery is difficult — impossible for some high-molecular-weight actives. Iontophoresis facilitates the passage of selected actives with therapeutic purposes [9].

1.3 Exosomes

Exosomes are nanovesicles that transport drugs, proteins, and enzymes, assisting in cellular communication for therapeutic purposes [10]. According to Tenchov et al. (2022), exosomes have intrinsic stability, low probability of immune-related adverse events, are biocompatible, and have good capacity to penetrate membranes. They also offer advantages such as biocompatibility with living tissues, low toxicity, high circulatory capacity, and targeted delivery of actives to specific cells [11, 12].

2. Case Report

Three patients with a diagnosis of androgenetic alopecia confirmed by digital trichoscopy (Dino-Lite® trichoscope) and medical evaluation underwent hair treatment using an iontophoresis and electrotherapy device (IONNIZ®, Dermius) combined with exosomes. Five sessions were performed at 20-day intervals, at 40% intensity with the comb transducer, with a 40-minute application per session. Hair was moistened with water, then 3 mL of curcumin-derived exosomes were applied to the entire scalp and the comb was passed slowly and continuously. Patients reported no discomfort during the procedure. No topical hair tonic was prescribed for home use.



Figure 1: Image **A** was taken in July 2025. Image **B** in November 2025. Image **C**: digital trichoscopy performed in July 2025, presence of vellus hairs with inflammation and mild scaling. Image **D**, taken in November 2025: presence of anagen hairs and scalp with reduced inflammatory process.



Figure 2: Patient underwent 5 treatment sessions according to the protocol described. **A-** July 2025. **B-** November 2025. **C-** Digital trichoscopy, July 2025. **D-** Digital trichoscopy, February 2026 (Green arrow pointing new hair growth).

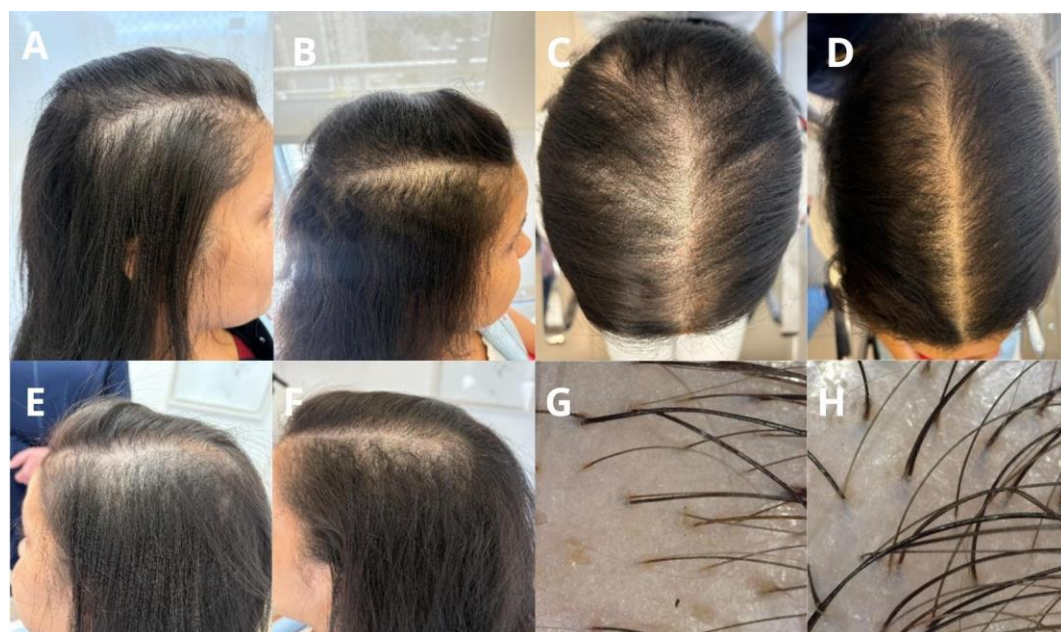


Figure 3: **A-** July 2025. **B-** November 2025; **C-** July 2025. **D-** November 2025. **E-** July 2025. **F-** November 2025. **G-** Digital trichoscopy, July 2025. **H-** Digital Trichoscopy, November 2025 (reduction of kenogenous ostia).

3. Conclusion

The three patients underwent five treatment sessions with the iontophoresis device combined with electroporation to optimize exosome delivery. Androgenetic alopecia is a chronic condition requiring continuous therapeutic approaches. The combination of iontophoresis and electroporation for exosome delivery demonstrated high short-term efficacy, increasing hair density, improving hair quality, reducing scalp inflammation, reducing scaling, and

decreasing keratinogenesis. However, further studies are needed to validate its efficacy with greater scientific rigor.

It is important to note that no discomfort was reported by the patients during the device application, which may suggest greater treatment adherence.

Declaration of Patient Consent: The author certifies that all appropriate patient consent forms have been obtained. In the form, the patient's parent/guardian has given consent for the patient's images and other clinical information to be reported in the journal. They understand that the patient's name and initials will not be published and that due efforts will be made to conceal her identity.

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