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Review

Use of Exosomes in Hair Therapy: A Systematic Review

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ABSTRACT

Alopecia, especially androgenetic alopecia, affects millions of people worldwide, significantly impacting self-esteem and quality of life. Numerous therapies have been proposed over the years, but the use of exosomes represents an innovative and promising approach in the field of hair regeneration. Exosomes are extracellular vesicles derived from stem cells that contain proteins, lipids and messenger RNA with signaling functions, capable of modulating inflammatory responses and promoting tissue regeneration. This systematic review aims to evaluate the available evidence regarding the efficacy and safety of exosomes in hair therapy, particularly for androgenetic alopecia. A comprehensive search was conducted in PubMed, Scopus, Web of Science and SciELO databases, including studies published between 2014 and 2024. Inclusion criteria encompassed clinical, preclinical and review studies focused on the use of exosomes for hair regeneration. Results indicated significant improvement in hair density, increased anagen phase and reduced follicular miniaturization in both animal and human models. Exosomes derived from mesenchymal stem cells, especially from adipose tissue and bone marrow, were the most frequently used. Although data are promising, methodological heterogeneity, lack of standardized protocols and a limited number of randomized clinical trials remain significant limitations. It is concluded that exosomes have relevant therapeutic potential in alopecia, but more long-term clinical studies are needed to validate their efficacy and safety.

Keywords: Exosomes; Alopecia; Hair therapy; Stem cells; Regenerative medicine

Introduction

Alopecia, particularly androgenetic alopecia, is one of the most prevalent hair disorders, affecting approximately 50% of men and up to 40% of women during their lifetime[7]. It is characterized by the progressive miniaturization of hair follicles, leading to hair thinning and eventual baldness. Various treatments have been proposed, from topical and oral medications such as minoxidil and finasteride to procedures like hair transplantation. However, the effectiveness of these approaches varies significantly among patients and side effects often limit long-term adherence. In this context, regenerative medicine therapies have gained prominence, especially those utilizing stem cells and their derivatives. Among these, exosomes have garnered increasing interest in hair dermatology due to their potential to modulate inflammatory microenvironments and promote tissue regeneration[8,9].

Exosomes are extracellular vesicles with diameters ranging from 30 to 150 nm, secreted by nearly all cell types. They carry bioactive proteins, microRNAs, lipids and growth factors, functioning as intercellular messengers. Recent studies have

shown that exosomes derived from mesenchymal stem cells (MSC-exosomes) can stimulate dermal papilla cell proliferation and prolong the anagen phase of the hair cycle-key factors in hair health and growth. Furthermore, these vesicles exhibit immunomodulatory and antifibrotic profiles, which may benefit patients with inflammatory and scarring forms of alopecia.

Although the exact mechanisms of action are still under investigation, evidence suggests that exosomes activate signaling pathways such as Wnt/β-catenin, essential for hair follicle induction. Experimental models have demonstrated increases in follicular density and hair thickness following topical or injectable application of exosomes. Nevertheless, clinical application remains unstandardized regarding exosome source, dosage, frequency and delivery route. Therefore, this systematic review aims to gather and critically analyze the existing evidence on the use of exosomes in hair therapy, with a particular focus on androgenetic alopecia, discussing potential mechanisms of action, clinical outcomes and future perspectives[10-12].

Objective

To systematically assess the efficacy and safety of exosome use in hair therapy, particularly for androgenetic alopecia, based on recent scientific evidence.

Materials and Methods

A systematic review was conducted following PRISMA guidelines. A literature search was performed in the PubMed, Scopus, Web of Science and SciELO databases, including publications from January 2014 to March 2024.

Discussion

The results of this systematic review demonstrated that exosomes derived from mesenchymal stem cells show significant therapeutic potential in the treatment of alopecia, particularly the androgenetic form. Most of the selected studies showed an increase in hair density, the anagen phase and hair shaft thickness following topical application or delivery through microchannels, a technique known as percutaneous collagen induction (PCI) or drug delivery. Exosomes act as modulators of the follicular microenvironment by promoting angiogenesis, inhibiting inflammatory cytokines and activating signaling pathways such as Wnt/β-catenin, which is crucial for the development and maintenance of hair follicles[1]. In vitro studies have shown increased proliferation of dermal papilla cells and upregulation of hair growth markers following treatment with exosomes[2].

In animal models, particularly DHT-induced alopecia in mice, exosome administration resulted in significant recovery of anagen-phase follicles, along with a reduction in follicular miniaturization[3]. In limited clinical studies, such as Zhang, et al.[4], a 30% increase in hair density was observed after three months of weekly applications, with no relevant adverse effects. The origin of exosomes influences their bioactivity. Exosomes derived from adipose tissue and bone marrow are the most commonly used, preferred for their high regenerative capacity and availability[5]. However, the lack of standardization regarding extraction, concentration and application methods hinders comparability across studies.

Another important point is the safety of exosome use. To date, no serious adverse events have been reported and side effects have been limited to mild local erythema or pruritus. Nevertheless, longitudinal studies are still needed to assess potential immunogenic and oncogenic effects of these vesicles[6]. Despite their promising potential, the clinical application of exosomes still faces regulatory and technical barriers. The lack of standardized protocols for production and administration[13], along with the scarcity of randomized controlled clinical trials, limits the widespread adoption of this technology. Future research should prioritize robust methodological designs[14,15], larger sample sizes, long-term follow-up and comparative analysis with conventional therapies **(Figure 1)**.

Figure 1: Male patient, 74 years old, diagnosed with androgenetic alopecia after four sessions of exosome application over a five-month period

Conclusion

The systematic analysis of available studies demonstrates that exosomes represent an innovative and effective approach to hair therapy, especially in treating androgenetic alopecia. Evidence suggests that exosomes stimulate follicular regeneration through paracrine signaling, extend the anagen phase and reactivate dormant follicles, contributing to increased hair density. Findings show consistent effects in both animal and human models, with visible improvements in hair quality and shaft thickness. Mesenchymal stem cell-derived exosomes particularly those obtained from adipose tissue, bone marrow and human placenta appear to be the most promising. These exosomes are rich in growth factors, microRNAs and proteins with anti-inflammatory, angiogenic and regenerative potential, making them attractive agents for dermatological hair applications.

However, significant gaps remain before this technique can be widely adopted. Variability in exosome production, purification and application methods complicates standardization and cross-study comparison. Furthermore, the scarcity of high-quality clinical trials with control groups and long-term monitoring limits the strength of current evidence. Although current data suggest high safety, further investigation is required, especially regarding potential immunological, oncogenic or bioaccumulative risks. Regulatory approval also remains a hurdle, as exosomes are not yet sanctioned by agencies such as the FDA or ANVISA for routine therapeutic use in hair loss. In conclusion, exosomes present a promising therapeutic tool in regenerative trichology. Still, investment in well-designed clinical trials, standardized protocols and appropriate regulatory frameworks is essential to ensure their safe, effective and accessible clinical use.

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