
A STUDY ON NANOTECHNOLOGY ADVANCES ON ALPECIA

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Abstract

In a particular region of the skin, alopecia is the partial or complete loss of hair that affects millions of men and women worldwide. It is a disease characterised by gradual loss of hair from the scalp or any other region of the body, reflecting the most common complaint in dermatological practise. The most common approved therapies have inconvenient clinical regimens and severe adverse effects. As the psychological distress caused by the altered appearance can lead to decreased self-esteem, resulting in serious symptoms such as depression and anxiety, this condition must not be considered a minor cosmetic problem. Nanoencapsulation has evolved in this situation as a relatively easy technology to boost the therapeutic outcome of this pathology, encouraging the transmission of targeted drugs with improved local bioavailability, that could reduce the negative impacts. In this context, we are discussing some recent research on nanosystems built for the pharmacological treatment of alopecia, highlighting how each device represents an advance in relation to traditional drug products and the potential market opportunities for these emerging technologies.

Keywords: Alopecia, Hair, Follicle, Nanotechnology, Nanosystems.

I. INTRODUCTION

Alopecia is a disease characterised through revolutionary hair loss from scalp or some other body's place representing the most common complaint in dermatological exercise. Literature reports around 50% of fellows among 30 and 50 years and 15–30% of ladies of their 30s increase hair loss. Such ailment have to not be considered a minor beauty trouble, as the mental misery as a result of the altered appearance might result in reduced self-esteem, culminating in intense signs and symptoms together with depression and anxiety[1].

Androgenetic alopecia, the maximum not unusual type of alopecia, is characterised with the aid of miniaturization of hair follicle as a result of a change in capillary cycle and an augmented in levels of the hormone dihydrotestosterone. This hormone is reduced from testosterone by means of the enzyme 5 α -reductase, that is exactly the target for one of the fundamental tablets utilized in therapy, finasteride. Together with finasteride, dutasteride comprise the institution of 4-azasteroids, but, whilst finasteride inhibits selectively and irreversibly best one of the isoforms of 5 α -reductase enzyme, dutasteride inhibits each isoforms 1 and a couple of, thus diminishing dihydrotestosterone levels in about 90%. Appreciably, the usage of enzyme five- α reductase inhibitors is related to systemic

detrimental outcomes consisting of erectile dysfunction, infertility, depression, gynecomastia, teratogenicity, prostate and breast cancer[2].

Minoxidil, the most secure remedy choice to be had inside the marketplace, which is topically implemented, is known to be a vasodilator that prolongs anagen section and additionally participates inside the modulation of prostaglandin ranges; but the whole mechanism of movement remains undefined. Even though minoxidil demonstrates correct outcomes, a enormous amount of ethyl alcohol and/or propylene glycol is present in most of the commercial formulations, which induces inflammation, burning, allergic dermatitis, redness and scalp dryness that may be annoyed through repeated applications. Further, presence of elevated heart fee, hypertrichosis and retention of sodium and water has been also reported.

Currently, in the united states, pharmacological remedies authorised for men and women are best minoxidil 2 and 5% answer or foam – twice an afternoon. In evaluation, oral finasteride is handiest approved for guys with the aid of america FDA. But, pharmacological treatment availability may also vary worldwide. In a few nations, consisting of Korea and Mexico, dutasteride (zero.5 mg in keeping with day) is also authorised for androgenetic alopecia remedy in guys.

Alopecia areata is the second most commonplace type of alopecia. Taken into consideration a complicated genetic ailment, it's far characterized as a chronic recurrent disorder that impacts anagen-like hair follicles. In recent times, therapies to be had aren't curative, hence pharmacological interventions are aimed toward pausing disorder progression. Basically, treatment is based totally on use of high doses of oral corticosteroids to save you relapses, together with topical and systemic routes. Clobetasol propionate has emerged as a promising drug for the remedy of alopecia areata (0.05% once an afternoon), performing on autoimmune reactions. Although it is topically implemented from a ointment, unfavourable effects encompass thinning or epidermal atrophy, infections, consequences on bone boom or integrity, worsening of hypertension or diabetes, and suppression of the pituitary adrenal axis[3].

Nevertheless, an alternative to the research of recent capsules with decrease negative outcomes and higher physicochemical houses and consequently making current treatments viable is the development of innovative formulations. Nanosystems together with liposomes, ethosomes, niosomes, lipid nanoparticles and polymeric nanoparticles were proposed to this cease. Nanosystems now not most effective should overcome troubles associated with patient's compliance but also diminish systemic negative consequences, via controlling drug's launch, proportionating equal impact with much less administrations and fixing irritation troubles related to the formula, with biocompatible structures[4].

Besides that, nanotechnology is especially interesting for remedy of sicknesses compromising hair follicles due to the natural tendency of those systems to accumulate in the follicle casts, elevating neighborhood drug awareness and minimizing facet results. Here, we gift the latest advances of nanotechnology for the remedy of the most common varieties of alopecia.

Follicle-targeted drug delivery

Absorption of medicine through the skin can occur via the intact epidermis (transepidermal pathway) and/or cutaneous appendages (thru transappendageal). The hair follicle, one in all such appendages, is an access point for topically implemented substances, further to

contributing to the delivery of drugs through the skin. Drug accumulation in the follicular units is especially vital for the remedy of illnesses located in the hair follicle, along with alopecia. The focused treatment potentiates drug bioavailability leading to preferred effect with small-drug concentrations. Though, follicular ducts are obviously now not hollow shunts, instead they're replenished by using some of materials, mainly sebum, which serves as a transport pathway for the drugs. Hence, a greater targeted delivery to the hair follicles relies upon on the interaction among the drug and the sebum. On this manner, lipid particles can also assist on such interaction, purpose why they had been appreciably studied for focused on hair follicles[5].

Nanosystems composed of lipids in solid kingdom (solid lipid nanoparticle) or of a strong matrix trapping a mixture of liquid, amorphous or unsaturated lipids (nanostructured lipid service) are a number of the maximum studied systems among the large group of lipid nanosystems.

Particle length is regularly the primary parameter evaluated concerning its effect on drug transport. Certainly, smaller nanoparticles exhibit extra depths of penetration into the hair follicles. The size range beneath a hundred nm is shown to be essential for the initiation of motion on dermal drug launch and consequently becomes an interesting function for topical utility by using promoting accumulation within the hair follicles. Furthermore, diameter values around 200 nm have been favorable for the discharge of drugs up the isthmus a part of the hair follicles. In fashionable, nanoparticulate structures offer superior skin delivery over nonparticulate formulations. Solid lipid nanoparticles encapsulating minoxidil, with diameter of 190 nm, demonstrated a higher accumulation in porcine skin layers when it comes to industrial products. Although strong lipid nanoparticles have presented appropriate permeation outcomes, balance is a steady trouble as solid lipids may also form crystalline networks, main to drug expulsion at some stage in garage, mainly whilst the strong lipid matrix is composed of a distinctly purified lipid[6].

Polymeric nanoparticles

Similarly to lipid nanosystems, polymeric nanoparticles were proposed as drug service systems for the remedy of alopecia.

In the beginning, nanoparticles were received from nonbiodegradable polymers along with polystyrene, polyacrylates, polyacrylamide, poly(methyl methacrylate). As they exhibited inflammatory reactions as well as persistent toxicity, biodegradable and biocompatible polymeric particles turned out to be the primary recognition of researches. Some of the biodegradable polymers ordinarily hired are chitosan, albumin, gelatin and alginate, obtained from herbal source, and poly(ϵ -caprolactone), poly(lactide-co-glycolide) copolymers, poly(amino acids) and poly(lactide), synthetically produced. The development and characterization of poly(lactide-co-glycolide) copolymer nanoparticles containing finasteride confirmed the nontoxicity of this polymer in tests executed with *saccharomyces cerevisiae* version, showing biocompatibility and remarkable capacity of those structures within the remedy of alopecia[7].

Further, polymeric nanoparticles have the capability to guard encapsulated capsules from degradation, growing shelf existence and controlling drug release. Consequently, lecithin/chitosan nanoparticles containing clobetasol propionate have remained solid for three months at room temperature storage. In every other observe, polymeric finasteride

microspheres have shown a non-stop drug launch for as much as 5–6 weeks following an preliminary burst launch. The mechanism of drug launch from these polymeric nanoparticles occurs thru the relaxation of the polymer chains with a mass transfer mediated with the aid of the fickian diffusion of the drug, characterizing an anomalous delivery[8].

As formerly found with lipid nanoparticles, particle length of polymeric structures additionally appears to exert a widespread impact on hair follicle deposition. Debris with a size of approximately five μm seem to be retained best inside the infundibulum of the hair follicles, no longer penetrating the lipid layers of the stratum corneum and in contrast, nanoparticles with smaller sizes (20–40 nm) may reach a deeper penetration into the hair follicles, permitting the shipping of medicine at the level of the capillary bulb, a website of intense significance for capillary growth because of capillary matrix cells and melanocytes.

The nanoparticles with smaller diameters are trapped in the structure of the hair follicle, as they cannot drift thru the sebum, and consequently, they provide more availability of the drug at the site of motion. Apparently, debris with a length among 228 and 365 nm have the capacity to reach a penetration depth similar to the entry of the sebaceous gland, at the isthmus.

Nonetheless, penetration depth won't be translated in delivery efficiency, because it has been noticed minoxidil sulfate chitosan nanoparticles, with an average diameter of $271 \pm$ fifty nine nm, boom by using twofold the drug concentration in the hair follicles in comparison to a manipulate solution after 6 h of test, at the same time as minoxidil sulfate microparticles starting from 2.9 to 4.2 μm increase in sixfold drug accumulation in the hair follicles relative to the identical minoxidil sulfate solution. Another look at with effervescent granules of minoxidil (0.2 mm) changed into capable of increase 2.7-fold drug accumulation in hair follicles. Nonetheless, both nano- and micro-particles were capable of manipulate drug launch, which may additionally render potential blessings in affected person compliance. Consequently, using polymers for drug loading and management within the hair follicles constitute a effective noninvasive direction of management by way of promoting solid and homogeneous structures that launch in a predictable way[9].

Future perspective

Even though there are some consecrated treatment options for alopecia, as the topical management of minoxidil or clobetasol propionate and the oral management of finasteride, plenty of studies display nanosystems may additionally provide good sized improvements in effectiveness. Those include circumventing physicochemical drug issues, mainly low drug solubility and growing formula efficacy providing targeted accumulation on the motion website online, enhancing bioavailability even as diminishing side consequences.

Truely, lipid nanosystems may want to provide blessings for the remedy of alopecia. Using a lipid matrix lets in drug-launch manage, keeping machine biocompatibility. In addition, lipid structures benefit benefits through being solid structures easy to scale up and sterilize. Indeed, there are several products commercialized for extra than 20 years, inclusive of liposomes containing Doxorubicin (Doxoil R[®]) and daunorubicin (DaunoXome R[®]). Other liposomal systems marketed include included amphotericin B (Amphotec R[®] and Ambiosome R[®]), tablets that act inside the treatment of most cancers (Onivyde™) and vaccines (Epaxal R[®] and Inflexal R[®]). Many of the numerous nanosystems said within the literature, niosomes might be those with the higher capability to be permitted and attain the

market in a close to future for the treatment of alopecia. Keeping all of the aforementioned advantages of lipid structures, niosomes have the ability to serve as providers for shipping of each hydrophilic and lipophilic drugs. Besides, they may be biodegradable, biocompatible and nonimmunogenic. As described in medical research, niosomes supplied substantial increase in hair remember, as well as other healing blessings[10].

In spite of all the systems provided in this overview, the need of clinical studies, similarly development and insertion of those systems inside the marketplace grow to be obtrusive. Many research evolved the nanosystems in small scales and completed experiments handiest at the in vitro level via their ability to permeate/penetrate the skin and hair follicles. Closing nanoscale fabrication involves from time to time complicated scaling-up processes and confirmation of clinical effectiveness. Considerably, the approval and market of nanomedicines face numerous regulatory and commercial difficulties as compared with traditional medicines. First, there are the own manufacturing challenges, as reproducible scale-up and manufacturing process want to be extraordinarily managed to achieve a regular product. Second, there are the excellent concerns, as pharmacological behavior is completely dependent on the nanoformulation characteristics, which may additionally have safety implications. Such extra improvement and regulatory concerns additionally increase product fees. Consequently, pharmacological benefits want to compensate some of these problems to permit a hit commercialization. Builders and fitness government will need to discover answers to translate the ultra-modern nanotechnology advances in bedside medicines for the affective treatment of hair loss[11].

II. CONCLUSION

Statistics provided here sincerely evidence the capacity of nanotechnology in circumventing the destructive effects and disadvantages of modern-day treatment plans. In this manner, the restricted alternatives to be had within the market to treat alopecia contrast with the widespread capacity offered with the aid of the nanosystems, either in enhancing the overall performance of normally used pills which include minoxidil and finasteride, or by using permitting the effective administration of latest healing alternatives which include dutasteride or clobetasol propionate. Numerous research show the ability of nanosystems to offer better healing dividends, however plenty remains to be researched. Unique interaction mechanisms with the skin associated with every nanosystem want to be similarly investigated as a way to expand most reliable delivery systems in accordance to drugs physicochemical and pharmacological residences. Clinical research are nonetheless incipient and they may be extraordinarily vital in confirming the benefits to healing regimes.

III. REFERENCES

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