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Beta 1 Integrin in Hair Follicles of Patients with Androgenetic Alopecia

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Abstract

Background: Androgenetic alopecia (AGA) is a hereditary hair loss illness characterized by a slow but steady transition from terminal to indeterminate and, eventually, vellus hairs. The process by which cells adhere to both the extracellular matrix and other cells is mediated by heterodimeric transmembrane proteins called integrins, which include of an α and a β component. The purpose of this paper is to examine the association between the severity of AGA etiopathogenesis and the tissue expression of β1 integrin, as well as to evaluate its participation in this process. Results: Beta 1 integrin has the potential to be an indicator of AGA severity and a key player in the disease's etiology.

Key words: Androgenetic alopecia (AGA), β1 integrin

Introduction

Androgenetic Alopecia, which goes by a few other names, is the most prevalent form of progressive hair loss. These include male pattern hair loss (MPHL) and female pattern hair loss (FPHL). Anxieties about hair loss may have a major detrimental effect on a patient's physical and mental health, and studies show that 80% of men and 50% of women will have AGA at some point in their lives [1].

The action of dihydrotestosterone (DHT) on androgen-sensitive hair follicles causes these cells to shrink and shorten the hair development cycle, ultimately leading to hair loss. Baldness, thinning hair on the vertex of the scalp, and receding hairline are the symptoms that men experience. Hair loss above the scalp's vertex is the most common symptom in women [2].

Endothelial cells, pericytes, fibroblasts, and tumor cells have heterodimeric complexes of integrins, which are composed of α and β subunits that are not covalently bonded together. There are eight β subunits and eight α subunits in mammals. They create a minimum of 24 αβ integrin heterodimers via their mutual interactions. Half of these include the β1 subunit [3].

Materials and methods

Data Sources: The material on AGA's etiology, pathophysiology, and the function of β1 integrin in the disease's decrease till 2024 was retrieved from Medline databases (Pub Med and Medscape).

Choosing the Right Study: The inclusion of all research was determined by separate evaluations. They were considered for inclusion if they met the following requirements: 1. Expressed and made public in English. 1. Featured in journals that undergo a rigorous peer review process.3. Talk about the function of β1 integrin in AGA and go over the etiology and pathophysiology of the condition.

When extracting data, studies were discarded if they did not meet the inclusion criteria. Ethical permission, clear eligibility criteria, suitable controls, sufficient information, and well-defined evaluation measures were all variables in determining the study's quality. We used a data collecting form to independently extract information relevant to our research results from all qualifying studies.

Literature review:

Alopecia areatrica (AGA)

When it comes to hair loss that doesn't leave scars, the most prevalent culprit is androgenetic alopecia (AGA). AGA is a condition caused by an overreaction to androgens that runs in families. The gradual thinning down of the scalp's hair at the ends, which may happen at any point after puberty and affects both sexes equally, is the hallmark of this condition [4].

Clinical research

Worldwide, the most frequent kind of hair loss is androgenetic alopecia, which goes by a few other names: MPHL, FPHL, and female pattern hair loss. The prevalence is expected to reach 80% in males and 50% in women by the age of 70 [5].

The origins of disease

There is a complicated interaction between hereditary, hormonal, and environmental variables in the etiology of AGA. There is still a lack of clarity on the chemical processes at work [6].

The amount of hairs on a person's scalp decreases as they age because the anagen phase is shorter and the latency interval between telogen hair loss and anagen regeneration gets longer. Along with these changes in the hair cycle comes a worldwide shrinkage of the follicles, which impacts the papilla, matrix, and hair shafts in the end [7].

Variables at the genetic level:

Hereditary factors account for about 80% of the tendency to baldness and have the greatest impact on AGA susceptibility. The wide variety of clinical symptoms and early changes seen in people with AGA are explained by the fact that it

follows a polygenic model with variable expression levels [8].

In comparison to occipital follicles, frontal hair follicles in AGA patients have higher amounts of the 5-α reductase enzyme and androgen receptor (AR). By increasing AR gene activity in hair follicles induced by DHT binding, AGA is caused by Xq12 chromosomal modifications of the AR genes [9].

The development of alopecia in people from families with bald adult males during androgenic medication provides evidence of a reciprocal interaction between genetics and androgens, and some insight into the complicated heritability of AGA has been shown by studies [10].

The genitourinary tract, hair follicles, and prostate all express the steroid 5 alpha reductase type 2 (SRD5A2). According to previous research, SRD5A2 is linked to AGA.

Hormonal elements

Symptoms of AGA may manifest as a hormonal imbalance, such as an excess of androgens or a deficiency of estrogens. Hair loss, including AGA, is a common symptom of hormonal imbalance-related disorders, such as polycystic ovarian syndrome (PCOS) in women [12].

In comparison to women, males have three times the activity of alpha-reductase type I and type II in their frontal hair follicles. The function of androgen signaling in females is still unclear, whereas male androgenetic alopecia is thought to be an androgen dependent disorder [8].

Androgens change interactions between mesenchyme and epithelial cells in the hair follicle, which impacts hair development, dermal papilla size, and keratinocyte and melanocyte functions [10].

The fact that AR is located in the dermal papilla rather than the epithelial cells in the hair follicle suggests that the dermal papilla is the primary target of androgens in this structure. However, there is a difference in AR expression in the frontal dermal papilla between people with AGA and those without, according to hormone binding assays. This suggests that increased AR expression in AGA can increase the sensitivity of dermal papilla cells to androgens.

The type II 5-alpha reductase enzyme (5-αR2) converts free testosterone into dihydrotestosterone (DHT), which then binds to an AR. The miniaturization and sensitivity of AGA-prone hair follicles to DHT causes hair loss and, in the long run, AGA, as DHT builds up in androgen-sensitive AGA tissues.The development of AGA may also be influenced by external variables, such as the environment [14]. Psychological stress, high blood pressure, diabetes, smoking, having many marriages, not wearing sunscreen, having a high salary, and not exercising much were all on the list [15].

Stress: Excessive and persistent stress might throw off your hormone balance and make AGA worse. The principal stress hormone, cortisol, may influence the activity of hair follicles and contribute to hair thinning or loss[16].Issues with Proper Diet: Hair health and AGA may be compromised by an inadequate consumption of vital nutrients, such as biotin, vitamin D, iron, zinc, and other minerals.Exposure to heavy metals, air pollution, cigarette smoke, and other environmental contaminants may cause inflammation and oxidative stress in the scalp, which can lead to hair loss [17].[18]AGA is one of many hair problems that may be associated with microbiome dysbiosis, which is defined as changes in the scalp microbiome and marked by an imbalance in microbial populations.AGA and poor hair health might result from a diet high in processed meals, sugary snacks, and bad fats, which can increase inflammation and insulin resistance [19].Hair thinning and AGA are adverse effects that may be caused by some medicines, such as anticoagulants, cholesterol-lowering drugs, and antidepressants [20].Microinflammation, which is defined as cellular-level low-grade inflammation, has been linked to the development of AGA [21]. It is thought that the inflammatory response in AGA has a role in the shrinkage of hair follicles and the ultimate loss of hair [22].

Genetic susceptibility, hormone abnormalities, and environmental stresses are among the potential triggers of microinflammation in AGA. Follicle shrinkage occurs as a result of inflammatory mediator release, which interrupts the hair development cycle. Another factor that might exacerbate hair loss is chronic inflammation, which can hinder the activity of stem cells found in hair follicles [23].

The scalps of people with AGA show elevated levels of pro-inflammatory cytokines, including tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6).

Medical Image

The first sign of hair loss is a receding frontal hairline, which is followed by thinning hair all over the vertex and eventually baldness in the middle of the vertex. After the bald spot at the vertex meets the receding hairline in the front, a patch of hair remains on the scalp in the front. The parietal and occipital zones are the only ones left with hair once this island fades away. The following are some less frequent patterns of hair loss: a Ludwig-type pattern in which the frontal hair line is preserved, a pattern in which the vertex region loses hair more quickly than the frontal area, and a pattern in which the frontal hairline loses hair before the vertex bald patch forms. If you want to know how bad androgenetic alopecia

is in males, use the Hamilton-Norwood scale. If you want to know how bad it is in women, use the Ludwig scale [25].

The patient's medical history and physical symptoms are the main components of an AGA diagnosis. Considerations such as the extent to which hair has thinned or shed, the length of time it has persisted, and the area in question are crucial. Beta 1 integrin in those experiencing excessive shedding or hair loss [26]

One member of the integrin family of heterodimeric receptors that may bind with a wide variety of ligands is beta 1 integrin, a transmembrane protein. These molecules play an essential role in signaling and homeostasis by mediating interactions between cells and the extracellular matrix (ECM)[27].

Every single one of the 26 specimens that were examined, as well as every single vellus and terminal hair, had beta 1 integrin immunostaining. In every single instance, it was found in every single portion of the follicle, including the outer root sheath (ORS), inner root sheath (IRS), bulb, isthmus, and primitive epithelium. From the 12-week placode phase to the 23-week fully mature follicle stage, its immunostaining was seen in all of the follicles. The lower portions of the ORS and the placode exhibited the highest levels of immunoexpression, respectively, in the primitive follicle [28].

Integrin beta 1 functions:

Cell adhesion, migration, and signaling are all greatly impacted by beta 1 integrin. It plays a role in embryonic development, wound healing, cancer metastasis, and a number of other physiological and pathological processes. Furthermore, fibronectin, collagen, and laminin are extracellular matrix proteins that beta 1 integrin interacts with to mediate cell-extracellular matrix adhesion.[29]

A hair follicle's beta-1 integrin and its function:

In specifically, the stem cells located in the bulge area of the hair follicle express beta-1 integrin. Throughout the hair development cycle, stem cells found in the hair follicle are in charge of restocking the hair follicle's cell supply. For these stem cells to adhere to the ECM, stay alive, and proliferate, beta-1 integrin expression is critical. The dermal papilla cells, found at the base of the hair follicle, also express beta-1 integrin. By communicating with epithelial cells and delivering signals critical for hair follicle formation and maintenance, dermal papilla cells regulate hair follicle growth and cycling [30].

One possible role for beta 1 integrin is to control the morphogenesis and cycling of hair follicles. Evidence suggests it mediates cell-matrix adhesion and signaling pathways crucial to hair follicle formation and function by interacting with a variety of extracellular matrix components, including collagen and laminin [31].

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