Proceedings of ICBioMed 2024 Workshop: Computational Proteomics in Drug Discovery and Development from Medicinal Plants
DOI: 10.54254/2753-8818/65/2024.LA18221

Explore the influence of circadian clock on acne

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Abstract. Acne is a disease which have some stimulate compound secret on our face surface or other parts of our body. Acne is a chronic inflammatory skin disease that affects the sebaceous gland units of the skin, characterized by open and closed comedones, papules, pustules, and cysts. It impacts nearly 50 million individuals in the United States. Its pathogenesis involves follicular hyper-keratinization, inflammation, in part generated by Cutibacterium acnes (formerly Proprionibacterium acnes) and hormonal alterations acne. The circadian clock was shown to be strongly correlated. As a natural rhythm in the body, the circadian clock can regulate and control a variety of physiological activities and behaviors. Its disturbance not only affects the quality of sleep, but also further affects endocrine, skin metabolism and other aspects, thus becoming an important factor in the generation of acne. The purpose of this paper is to summarize the influence of the circadian clock on acne generation, and to explain how the disturbance of the circadian clock leads to the occurrence and aggravation of acne through comprehensive analysis of existing research results.

Keywords: Acne, circadian clock, review.

1. Introduction

Acne is a common skin problem, especially in teenagers [1]. Its occurrence is related to many factors, including excessive secretion of sebum, abnormal keratosis of sebaceous duct of hair follicle, inflammatory reaction, bacterial infection and so on. The main treatments for acne include improved lifestyle, the use of effective drugs (such as topical retinoids, peroxybenzoyl peroxides, antibiotics, etc.), and the use of physical therapy (such as photodynamic therapy and laser therapy). A high-sugar diet, whole milk, hot environment, excessive stress and staying up late could accelerate the onset of acne.

The circadian clock controls human body circadian rhythms and help our physiology adapts to our environment. The circadian clock anticipates and regulates our physiology to adapt to different stages of the day. A proper body clock helps regulate sleep patterns, eating behavior, hormone release, blood pressure, and body temperature. The circadian clock, colloquially known as the body clock, allows us to do the right thing at the right time, which is also linked to our happiness and health. In recent years, more and more research has shown that the disruption of the circadian clock may play an important role in the development of acne [1]. This paper will explore the basic principle of the circadian clock, the influence of the circadian clock on physiological activities, and the relationship between the disturbance of the circadian clock and acne, which will provide some references for the corresponding study.

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2. The basic principles of the circadian clock

Brain gives the information to the adrenal gland, to secret cortisol. Circadian clock refers to a biological time perception and regulation mechanism in the body, which enables organisms to maintain their own rhythm in periodic environmental changes, such as circadian rhythm and seasonal rhythm. The molecular mechanism of the circadian clock is mainly composed of a group of "clock genes" and "clock proteins", which form a self-regulating circadian clock system through interaction and regulation. The circadian clock is an endogenous, autonomous biological rhythm that does not depend on environmental changes. The circadian clock is not an exact 24-hour cycle, but something close to it. The circadian clock has the performance of temperature compensation and remains stable under different temperature conditions. Studies found that the suprachiasmatic nucleus at the anterior end of the hypothalamus is a key element in initiating circadian clock through rat experiments [2]. When the suprachiasmatic nucleus is artificially damaged, the endocrine rhythm and behavioral rhythm of rats are lost, so it is concluded that the suprachiasmatic nucleus may be the pacemaker of the circadian clock of rats. At the same time, the circadian clock assumes the function of regulating life activities. Sleep, exercise, alertness, hormone levels, body temperature, immune function, and digestive function are all regulated by the suprachiasmatic nucleus [3]. Without the suprachiasmatic nucleus, these biorhythms disappear. Although later studies have found that many other cells and tissues in the body also have their own 24-hour circadian clock, the suprachiasmatic nucleus plays a role in regulating and coordinating the circadian clock of surrounding tissues to keep in sync, thus becoming known as the "master clock".

3. The basic principles of skin metabolism

Sebaceous gland is a very important accessory organ of the skin. Everyone person has a large number of sebaceous glands, most of the skin on the body has an average of 100 persquare centimeters sebaceous glands, the face and scalp can be as high as 400-900 per square centimeters The sebaceous glands on the forehead and back of the nose are the largest, while the rest are smaller. The sebaceous duct opens directly on the skin surface. Its core function is to secrete sebum, the main function of sebum is to form a protective film on the surface of the skin, help the epidermis prevent water loss, and have a mild antibacterial effect on bacteria and fungi. However, if the oil secretion is too prosperous, not only in the appearance of the oily skin would give people a sense of impurity, but also would create a good living environment for lipophilic bacteria, fungi or parasites, and their excessive reproduction, which will lead to a series of skin problems. It is the common pursuit of all people to keep the skin with the right amount of oil, moisturizing and soft, but not oily. Therefore, about it is important to acknowledge the factors affecting oil secretion and the main methods of oil control. The main factors that affect oil secretion is male hormones. Current researches believe that hair follicle sebaceous glands are mainly affected by male hormones. Androgen mainly come from the testicles and adrenal glands for male. For female, the androgen is mainly come from the ovaries and adrenal glands. Although the androgen of women in the blood are lower than men, but the secretion of sebum and the incidence and severity of acne have not been seen to be different between different gender. The secretion of male hormone is strong, and the secretion of sebaceous glands is active. In both men and women, the sebaceous glands are obviously developed during puberty. As a result, acne is more common in adolescents.

4. The relationship between circadian clock and skin metabolism

The circadian clock regulates an organism's sleep-wake cycle, making it easier for the organism to fall asleep at night and stay awake during the day. This rhythmic change is essential for maintaining the homeostasis of the organism. Secondly clock can also regulate endocrine metabolism. The circadian clock can also regulate the changes of endocrine metabolism, affecting the secretion of adrenocortical hormones, sex hormones and other hormones. These hormones play an important role in maintaining skin health and regulating sebum secretion [4].

The body clock also has a significant impact on skin metabolism. Under the normal circadian rhythm, the skin is able to maintain a normal metabolism and promote cell renewal and repair. However, when

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the circadian clock is disrupted, the metabolism of the skin will be seriously affected, leading to problems such as excessive sebum production and clogged hair follicles, which can lead to acne [4].

5. Mechanisms of acne production

Sleep will promote the body's very important cortisol hormone secretion, thyroid stimulating hormone and sex hormone secretion. Abnormal sleep will reduce the secretion of these important hormones, long easy to induce endocrine diseases. Lack of sleep will cause the stress response of body, make the body's sympathetic nerve overexcited, secrete more glucocorticoid, resulting in blood sugar regulation disorder, blood sugar increase, which would increase the risk of diabetes. In addition, chronic sleep problems will also affect the secretion of melatonin at night, resulting in sleep rhythm disorders, further aggravating sleep disorders. Androgens are steroid hormones derived from the gonads and adrenal glands, including androgen precursors and active androgens. Androgen precursors include dehydroepiandrosterone, dehydroepiandrosterone sulfate and androstenedione. Active androgens include testosterone and dihydrotestosterone (DHT). Sebaceous gland, as the main synthetic site of hormones in human skin, has the function of processing synthetic androgens. In human skin, androgen precursors produce the active androgen-testosterone under the action of the dermal steroid-producing enzyme, which is converted to the more active DHT under further metabolic action of 5A-reductase. The androgen receptors produced by sebaceous cells bind to DHT and stimulate sebaceous gland hyperplasia, thus producing more thick sebum. When sebum is secreted too much, it blocks the sebum excretion channel, which causes acne.

6. Relationship between circadian clock disturbance and acne formation

6.1. Sleep deprivation and acne

Studies have shown that incorrect sleep or not getting enough sleep is an important factor in worsening acne. Lack of sleep will disrupt the normal rhythm of the circadian clock, resulting in endocrine and metabolic disorders, especially the abnormal secretion of adrenocortical hormones and sex hormones [5]. As the objective acne severity score increased, the subjective sleep score decreased (i.e., worsened). In 2015, a French study showed a strong positive correlation between acne and fatigue levels after waking up in adults. In any case, the result showed a pattern of this study, and the disruption of the circadian clock greatly affects the secretion of testosterone and cortisol [6]. Based on the mechanisms of previous acne production, it can be seen that clock interference is positively correlated with acne.

6.2. Hair follicle sebaceous gland dysfunction

In the case of the disturbance of the circadian clock, the function of the hair follicle sebaceous glands will also be affected, and there will be a dysfunction. This dysfunction will lead to excessive sebum secretion, hair follicle blockage and other problems, providing favorable conditions for the occurrence of acne [4]. Acne is a chronic inflammatory skin disease that infects the sebaceous unit of the hair follicle and is characterized by open and closed pimples and inflammatory papules, pustules, and cysts. It affects nearly 50 million people in the United States [7]. Particularly affected groups include 85 % of adolescents and 12 %of adult women.

6.3. Increased inflammation

Disruption of the circadian clock also increases the secretion of cytokines, which produce a pro-inflammatory response. This inflammatory response can exacerbate the condition of acne, making acne more difficult to cure [3]. In summary, the circadian clock plays an important role in the development of acne. The disturbance of the circadian clock can lead to sleep deprivation, endocrine and metabolic disorders, hair follicle and sebaceous gland dysfunction, and increased inflammation, which can cause and aggravate acne. Therefore, maintaining a good circadian rhythm is of great significance for the prevention and treatment of acne. It is recommended that people maintain a regular rest time, avoid staying up late and lack of sleep, pay attention to healthy diet, etc., in order to maintain the normal rhythm of the circadian clock and reduce the occurrence and aggravation of acne [8].

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7. Discussion

When discussing the impact of circadian clock disruption on acne production, we need to gain a deep understanding of the complex mechanisms behind it. First, the circadian clock not only regulates our sleep-wake cycle, but is also widely involved in the regulation of the endocrine system. When the circadian clock is disrupted, such as staying up late for a long time, irregular work and rest, it will lead to the secretion of key hormones such as adrenal cortex hormones and sex hormones. The abnormal secretion of these hormones directly affects the activity of sebaceous glands, promotes the increase of sebum secretion, and provides a material basis for the occurrence of acne. Based on the above mechanisms, we recognize that maintaining the normal rhythm of the circadian clock through lifestyle adjustments is important for the prevention and treatment of acne [8]. This includes keeping a regular sleep schedule, avoiding late nights and lack of sleep, and managing meals properly. With these measures, we can help restore the balance of the circadian clock and reduce endocrine and immune system disorders, thereby reducing the risk of acne [9].

8. Limitation and Future research direction

Although a large number of studies have revealed the relationship between circadian clock disruption and acne development, there are still many questions that need to be further explored. For example, we need to better understand the specific mechanisms by which circadian clock disturbances lead to hormone secretion imbalances, and how these hormones interact with sebaceous gland cells to affect sebum secretion. In addition, it is also an important direction in the future to study the regulatory mechanism of the circadian clock on the immune system and inflammatory response. This will help us develop more accurate and effective acne treatments [10].

9. Conclusion

In summary, the circadian clock plays an important role in the development of acne. The disturbance of the biological clock can lead to sleep deprivation, endocrine and metabolic disorders, hair follicle and sebaceous gland dysfunction, and increased inflammation, which can cause and aggravate acne. Therefore, maintaining a good circadian rhythm is of great significance for the prevention and treatment of acne. It is recommended that people maintain a regular rest time, avoid staying up late and lack of sleep, pay attention to healthy diet, etc., in order to maintain the normal rhythm of the biological clock and reduce the occurrence and aggravation of acne.

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