

MAJ, Adrian and WARNO, Martyna. Innovative Approaches and Comprehensive Strategies in the Treatment of Acne Vulgaris. A Multi Faceted Review. Quality in Sport. 2024;16:52886. eISSN 2450-3118.
<https://dx.doi.org/10.12775/QS.2024.16.52886>
<https://apcz.umk.pl/QS/article/view/52886>

The journal has been 20 points in the Ministry of Higher Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024. No. 32553.

Has a Journal's Unique Identifier: 201398. Scientific disciplines assigned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).

Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 r. Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398.

Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

© The Authors 2024;

This article is published with open access at Licensee Open Journal Systems of Nicolaus Copernicus University in Torun, Poland Open Access. This article is distributed under the terms of the Creative Commons Attribution Noncommercial License which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author (s) and source are credited. This is an open access article licensed under the terms of the Creative Commons Attribution Non commercial license Share alike. (<http://creativecommons.org/licenses/by-nc-sa/4.0/>) which permits unrestricted, non commercial use, distribution and reproduction in any medium, provided the work is properly cited.

The authors declare that there is no conflict of interests regarding the publication of this paper.

Received: 25.06.2024. Revised: 10.07.2024. Accepted: 12.07.2024. Published: 15.07.2024.

Innovative Approaches and Comprehensive Strategies in the Treatment of Acne Vulgaris. A Multi-Faceted Review

1. Adrian Maj

Uniwersytecki Szpital Kliniczny im. Fryderyka Chopina w Rzeszowie,

ul. Fryderyka Szopena 2, 35-055 Rzeszów, Poland

<https://orcid.org/0009-0004-8730-1072>

adrian.w.maj@gmail.com

2. Martyna Warno

District Health Centre in Malbork

Ul. 500-lecia 23, 82-200 Malbork

<https://orcid.org/0009-0000-2575-9118>

Martyna.warno@gmail.com

ABSTRACT

Introduction

Acne vulgaris, widely recognized as one of the most prevalent skin disorders, presents numerous diagnostic and therapeutic challenges. It affects not only adolescents during puberty but also adults, constituting a multifaceted phenomenon that influences both the physical condition of the skin and the psychological well-being of individuals. Acne's impact extends to overall well-being and social life. Given the complexity of this condition, a thorough understanding of its etiologies and the pursuit of effective therapeutic methods are essential. This review aims to evaluate fractional laser therapy as a potentially effective and safe treatment for acne vulgaris, emphasizing its potential to improve the quality of life and comfort for individuals suffering from this condition.

Aim of the Study

The objective of this review is to delineate the causes of common acne occurrence and explore solutions in its treatment process. The primary aim is to present fractional laser therapy as an effective treatment modality for acne vulgaris.

Material and Method

This article synthesizes the current state of knowledge regarding acne vulgaris, drawing on various scientific articles.

Conclusions

The path to eliminating skin lesions necessitates a multifaceted and holistic approach, with essential guidance from a dermatologist. Effective acne treatment requires an individualized strategy that considers multiple factors. In practice, a combination of different treatment modalities often yields the best results.

Keywords : common acne, fractional laser, sebum, skin, chemical peels, pores, dermatology, retinol

Introduction

Acne vulgaris is one of the most prevalent skin disorders, affecting both adolescents and adults. Its impact on patients' quality of life, encompassing both physical comfort and psychosocial aspects, has made it a subject of intense scientific research aimed at understanding its mechanisms and developing effective treatment methods. This work focuses on a thorough analysis of the causes of acne vulgaris and explores a modern therapeutic approach, particularly emphasizing the role of fractional laser therapy [1]. In a thoughtful approach to understanding acne vulgaris, it is crucial to consider the multidimensional nature of this skin condition. Genetic, hormonal, environmental, and dietary factors interact in a complex manner, leading to the development of the characteristic skin changes of acne. Understanding these factors is essential not only for identifying the etiology of the disease but

also for constructing effective treatment strategies [2]. In recent years, fractional laser therapy has emerged as a promising method for treating acne vulgaris. It operates by causing precise microscopic damage to skin areas, simultaneously stimulating reparative and regenerative processes. In this context, fractional laser therapy not only addresses existing skin changes but also enhances skin quality by improving elasticity and reducing scars and redness [2,3]. The aim of this work is to review the main causes of acne vulgaris and analyze the effectiveness of fractional laser therapy as an innovative treatment method. By integrating knowledge from dermatology, immunology, and medical technology, this work contributes to understanding this common and impactful skin disorder.

Definition, Symptoms, and Classification of Acne Vulgaris

Acne vulgaris is a chronic skin condition characterized by the presence of blackheads, whiteheads, papules, pustules, and inflammation, primarily affecting the face, back, and chest. This condition commonly occurs in young individuals during adolescence but can also affect adults. Acne vulgaris results from excessive sebum secretion by the sebaceous glands, which, combined with dead skin cells, leads to blockages in hair follicles, facilitating the growth of the bacterium *Propionibacterium acnes*. Genetic, hormonal, environmental factors, and diet may also influence the development of acne vulgaris [3].

The symptoms of acne vulgaris are diverse and can manifest in various forms. Open comedones (blackheads) are areas where sebum and dead skin cells mix and oxidize, forming black spots on the skin surface. Closed comedones (whiteheads) manifest as blockages in the hair follicle that do not reach the skin surface, forming white or yellowish bumps under the skin. Acne may also appear as papules, which are small, hard nodules under the skin that can be painful and cause discomfort. Pustules, characterized by skin eruptions containing pus, may occur, which can be red and painful. Additionally, flat papules resembling small, red skin eruptions can be painful or itchy. Nodular lesions, which appear as larger, painful nodules under the skin, can be filled with pus and represent deeper inflammation of the skin. Lastly, redness and scarring often accompany skin changes and are consequences of acne vulgaris [2,3].

The classification of acne vulgaris encompasses various degrees of severity and types of skin lesions that occur in patients with this condition. Several commonly used classification systems exist, among which the most well-known are the Global Acne Grading System and the Acne Vulgaris Grading System [4]. The Global Acne Grading System assesses the severity of acne based on the number and type of skin lesions and the areas affected by acne. Severity levels may include mild, moderate, and severe, with types of skin lesions considered in the assessment including open and closed comedones, papules, pustules, nodules, and scars. The Acne Vulgaris Grading System evaluates the severity of acne based on the number and type of skin lesions such as comedones, papules, pustules, and scars. The scale ranges from 0 to 4, where 0 indicates no acne and 4 indicates the highest severity [5,6]. This classification considers the areas of skin affected by acne and the presence of any scars. Other classification systems may consider additional factors such as the patient's age, presence of inflammatory conditions, and skin reactions.

The classification of acne vulgaris is crucial for determining the severity of the disease and planning appropriate treatment. It also enables monitoring of therapeutic progress and assessing the effectiveness of treatment methods employed [7,8].

The Pathogenesis of Acne Vulgaris: The Role of Excessive Sebum Production, Follicular Plugs, Proliferation of *Propionibacterium acnes* Bacteria, and Skin Inflammation

The pathogenesis of acne vulgaris involves multiple factors, including excessive sebum secretion, follicular hyperkeratinization, proliferation of *Propionibacterium acnes* bacteria, and skin inflammation [9].

Excessive sebum production is an oily substance produced by the sebaceous glands. It plays a crucial role in maintaining skin hydration and protection. However, excess sebum production can lead to its accumulation in hair follicles, contributing to the development of acne. Excess sebum can mix with dead skin cells and create a plug in the hair follicle, leading to the formation of comedones (blackheads and whiteheads) [10].

Hyperkeratinization refers to the abnormal accumulation of keratinocytes (skin cells) in hair follicles. In acne, this process is often exacerbated, leading to the formation of a plug that blocks the hair follicle opening. This obstruction traps sebum and bacteria in the hair follicle, creating an environment conducive to inflammation and bacterial proliferation [11,12].

Propionibacterium acnes is a bacterium that naturally resides on the skin's surface. However, in the presence of excess sebum and follicular obstruction, *P. acnes* can rapidly proliferate in the hair follicle. As *P. acnes* metabolizes sebum, it produces inflammatory mediators that contribute to the development of acne lesions [13].

The inflammatory response involves the accumulation of sebum, keratinocytes, and bacteria in the hair follicle, triggering an immune response and leading to inflammation. Immune cells release pro-inflammatory cytokines, such as interleukin-1 (IL-1) and tumor necrosis factor-alpha (TNF-alpha), which recruit more immune cells to the site of infection. This inflammatory cascade causes the characteristic redness, swelling, and tenderness associated with acne lesions [14,15].

Overall, the pathogenesis of acne vulgaris is multifactorial and involves a complex interaction between sebum production, follicular hyperkeratinization, bacterial proliferation, and inflammation. Understanding these underlying mechanisms is crucial for developing effective treatments that target acne at its root causes [16].

The Role of Environmental Factors in the Development of Acne Vulgaris

Environmental factors play a significant role in the development of acne vulgaris, although their impact may vary depending on individual genetic predispositions, lifestyle, and complex interactions with other factors [17]. One of the external factors influencing skin issues is air pollution. Particles from atmospheric pollutants, such as pollen, dust, aerosols, and other chemicals, can deposit on the skin, triggering inflammatory reactions and increasing the risk of acne. Additionally, exposure to UV radiation is significant. Excessive exposure to UV rays can lead to skin damage and worsen acne. UV radiation can increase sebum production, contributing to the formation of blackheads and exacerbating acne lesions. Climate can also be a significant factor, with air humidity and variable weather conditions affecting sebum production and worsening the skin condition for some individuals [17,18].

Another crucial factor affecting skin health is an individual's lifestyle. Environmental factors, such as social pressure, work or education-related stress, and changing living conditions, can impact stress levels. Stress, in turn, can influence the production of stress hormones, potentially worsening acne symptoms [19].

Diet and the quality of consumed products also play a vital role. Some studies suggest that diet may impact acne development. Consuming foods with a high glycemic index and potentially irritating substances may worsen acne symptoms [20].

A daily skincare routine and the products used are significant contributors to skin condition. Improper use of cosmetics, especially those high in fat or irritating substances, can contribute to clogged pores and the development of acne. It is essential to highlight that skincare should be tailored to an individual's specific skin type and address their needs [21].

However, it is crucial to note that the impact of environmental factors is complex and varies between individuals. The individual skin response to these factors is one of the elements influencing the occurrence of acne. Therefore, an individualized approach to the diagnosis and treatment of acne, considering both environmental and genetic factors, is essential [22].

Treatment Methods for Acne Vulgaris: Antibacterial and Anti-inflammatory Agents

Various methods are available for treating acne vulgaris, and the choice of appropriate therapy depends on the severity of the condition, the type of skin lesions, individual patient characteristics, and potential triggering factors. One primary method involves the use of antibacterial and anti-inflammatory agents. Preparations containing antibacterial substances (e.g., benzoyl peroxide) or anti-inflammatory substances (e.g., salicylic acid) can be applied topically in the form of gels, creams, or tonics. Treatment methods based on antibacterial and anti-inflammatory agents are often effective in alleviating acne symptoms and reducing the number of skin lesions. However, due to potential side effects and the risk of bacterial resistance, it is important to use them according to the recommendations of a dermatologist and to regularly monitor the condition of the skin [23].

Acne treatment can be carried out both locally, by applying preparations to the skin, and systemically, with oral medications. Topical acne treatments contain various active substances, such as retinoids, azelaic acid, benzoyl peroxide, or salicylic acid. These are applied directly to the affected skin, where they act locally by regulating keratinization processes, reducing sebum production, and diminishing inflammation. They can be used on individual lesions as well as on larger areas of the skin. Gel-based acne treatments often contain the same active ingredients as creams but have a lighter consistency and are absorbed more quickly into the skin. They are particularly recommended for individuals with oily and combination skin, who may experience discomfort after using creams with a more oily consistency [24].

Among topical preparations, several can be distinguished based on their composition. Preparations containing antibiotics, such as clindamycin or erythromycin, can be applied topically to treat acne. These work by inhibiting the growth of *P. acnes* bacteria, reducing the number of bacteria on the skin, and decreasing inflammation. Preparations containing retinoids, such as tretinoin, adapalene, and tazarotene, are effective topical treatments for acne [24,25]. They work by regulating skin keratinization processes, reducing the formation of comedones, preventing the formation of blackheads, and reducing skin inflammation. Azelaic acid, which has antibacterial and anti-inflammatory properties, is another effective ingredient. Preparations containing azelaic acid can be used topically to reduce the number of *Propionibacterium acnes* bacteria and decrease skin inflammation. Additionally, salicylic acid-containing preparations are effective for acne treatment [25,26]. They work by exfoliating dead skin cells, unclogging pores, and preventing the formation of blackheads.

Adjunctive anti-inflammatory medications, such as glucocorticosteroids or non-steroidal anti-inflammatory drugs (NSAIDs), can also be applied topically to reduce skin inflammation and alleviate acne symptoms like redness and swelling. The choice of specific topical treatment depends on individual patient needs and characteristics, as well as the severity of acne. Consulting a dermatologist is always advisable to select an appropriate treatment tailored to the specific case [25,27].

The Use of Antibiotics in the Treatment of Common Acne

Another therapeutic option for acne treatment is the use of antibiotics. While topical treatments with gels or creams containing antibiotics have been mentioned, this is not the only method available. Preparations containing antibiotics, such as clindamycin or erythromycin, are applied topically to acne-affected skin [28]. These antibiotics work by inhibiting the

growth of *Propionibacterium acnes* bacteria, which contribute to inflammation and the formation of acne lesions. These preparations can be applied to individual skin lesions or to larger areas affected by acne.

For moderate to severe acne that does not respond to topical treatment, a doctor may recommend oral antibiotics, such as tetracycline, doxycycline, minocycline, or erythromycin [28,29]. These antibiotics work by inhibiting the growth of *P. acnes* bacteria throughout the body, leading to a reduction in skin inflammation and limiting the occurrence of new acne lesions. Both topical (e.g., clindamycin) and oral (e.g., doxycycline) antibiotics aim to reduce the amount of bacteria and counteract inflammation [29].

Normalization of Hormones as a Necessary Condition in Combating Common Acne

Often, the use of topical treatments proves to be insufficient, making hormonal normalization necessary. Acne can be affected by hormone normalization due to the complex interactions between acne and the body's hormonal system. Normalizing hormones primarily works to reduce inflammation [30]. Acne is frequently associated with skin inflammation, which can be caused by excessive sebum production, pore clogging, bacterial proliferation, and the body's inflammatory response. This inflammatory state may be related to hormonal dysregulation because hormones can affect sebum production and inflammatory processes in the skin. Hormones, especially sex hormones such as testosterone, estrogens, and progesterone, influence the activity of sebaceous glands in the skin. Excessive activity of these glands leads to increased sebum secretion, which in turn can contribute to the formation of comedones, blackheads, and the development of inflammation characteristic of acne. Normalizing hormone levels may help regulate sebum production and reduce the risk of acne occurrence [30,31].

A significant role in the development of acne is played by the regulation of sebum production. Hormones such as testosterone, estrogens, and other sex hormones can influence sebum production by sebaceous glands in the skin. Excessive sebum production can contribute to acne formation. In women, the use of contraceptives may be recommended to regulate hormone levels, particularly when acne is associated with hormonal imbalances. By normalizing hormones, sebum production can be regulated, thereby reducing acne [31,32].

However, it is important to note that hormone normalization does not always lead to an immediate resolution of acne. Many factors influence the development of acne, and hormonal treatment may be just one component of a comprehensive approach to treating this condition. Therefore, it is always important to consult a dermatologist to establish an appropriate treatment plan [32].

Topical and oral retinoids as one of the methods of combating common acne

Topical and oral retinoids can also be used. Retinoids are a group of medications derived from vitamin A, widely used in the treatment of common acne. They can be administered both topically (on the skin) and orally (by mouth). Topical retinoids, such as tretinoin, adapalene, and tazarotene, work by regulating skin keratinization processes. They help unclog skin pores by exfoliating dead skin cells, reducing the formation of blackheads and whiteheads. Additionally, topical retinoids reduce skin inflammation by regulating the immune response, decreasing the number of inflammatory lesions, and reducing redness and swelling. The use of topical retinoids can lead to a significant improvement in the appearance of the skin in individuals with common acne [33]. They can reduce the number of blackheads, prevent the formation of new acne lesions, decrease inflammation, and improve skin texture. However, topical retinoids can cause side effects such as skin irritation, dryness, peeling, redness, and a burning sensation. Additionally, they can sensitize the skin to sunlight, so it is important to

use sunscreen during treatment. Moving on to oral retinoids, such as isotretinoin. They are effective medications used in the treatment of moderate to severe common acne. They work by reducing the size of sebaceous glands, thereby reducing sebum production. Additionally, isotretinoin reduces skin inflammation and decreases the number of *P. acnes* bacteria. Oral retinoids, especially isotretinoin, can lead to long-term remission of acne in many patients. They can significantly reduce the number of acne lesions, prevent the formation of acne scars, and improve the quality of life for patients. Oral retinoids can cause side effects such as dry skin, peeling, sensitivity to sunlight, joint and muscle pain, and they can also cause serious side effects such as liver damage, lipid disorders, or depression. Therefore, treatment with isotretinoin requires close medical supervision. In both cases, both topical and oral retinoids can be effective treatment options for common acne, but their use should be carefully considered and monitored for side effects and tailored to the individual needs and characteristics of the patient [33,34].

Phototherapy as a Modern Method of Treating Acne

Another non-pharmacological method for treating acne vulgaris is phototherapy. This newer treatment approach utilizes various types of light, such as blue light, red light, or combinations of different wavelengths, to reduce the severity of acne and decrease the number of skin lesions. Blue light, for instance, emits wavelengths capable of destroying *Propionibacterium acnes* bacteria, one of the main factors contributing to the development of acne. Acting as an antibacterial agent, blue light limits bacterial proliferation on the skin and reduces inflammation. Red light, on the other hand, possesses anti-inflammatory properties and accelerates the skin healing process [35,36]. By stimulating regenerative processes, red light helps reduce inflammation and the risk of acne scarring.

Some procedures employ combinations of different types of light, such as blue and red light, to achieve a synergistic therapeutic effect. The combination of different wavelengths can more effectively combat bacteria, reduce inflammation, and improve skin condition. Phototherapy is a relatively safe method, causing no serious side effects, although it may be somewhat time-consuming and require regular sessions to achieve desired results. It is often used as a complement to other methods of treating acne vulgaris and can be effective in individuals with mild to moderate forms of acne. However, the effectiveness of the therapy may vary depending on individual patient characteristics and the severity of the condition. Consultation with a dermatologist is recommended to determine an appropriate treatment plan [37].

Advantages and Disadvantages of Using Hyaluronic Acid in Acne Treatment

Effective treatment for acne can also include hyaluronic acid. Hyaluronic acid is a naturally occurring substance in the body that serves many functions, including moisturizing the skin, providing elasticity, and aiding in wound healing. In the context of treating common acne, hyaluronic acid primarily acts as a moisturizer. Since acne often occurs in dry, irritated skin, which may be aggravated by the use of antibacterial and anti-inflammatory medications, hyaluronic acid is effective by attracting and retaining water in the skin, helping to maintain proper hydration and elasticity [38]. Moisturized skin can better address acne problems and reduce irritation and flakiness.

Acne often leads to the formation of wounds, scars, and discoloration on the skin. Hyaluronic acid can accelerate the wound healing process by stimulating the production of collagen and elastin, which are essential for skin repair and regeneration. Improving the healing process can reduce the risk of permanent acne scars and minimize the visibility of existing scars. Additionally, hyaluronic acid may have anti-inflammatory properties that help alleviate the

inflammatory state of acne-prone skin. By reducing inflammation, it can decrease redness, swelling, and tenderness associated with acne lesions and prevent the further spread of inflammation to other areas of the skin.

Although hyaluronic acid does not directly affect sebum production, its moisturizing properties can help maintain balance in the skin. Moisturized skin may be less prone to excessive sebum production, which can contribute to reducing the risk of blackhead and whitehead formation [38,39].

The Impact of Chemical Peels on Acne Treatment

Acne is often associated with excessive skin cell buildup, leading to clogged pores and the formation of blackheads and whiteheads. Chemical peels utilize chemical substances to gently exfoliate the skin, removing dead skin cells and revealing a healthier, more radiant layer of skin. Some chemical agents used in peels, such as salicylic acid, possess soothing and purifying properties that help remove impurities from the skin pores, thus preventing the formation of blackheads, a major concern in common acne. Certain chemical peels contain anti-inflammatory substances, such as mandelic acid or salicylic acid, which can alleviate the inflammatory condition of the skin associated with acne. Reducing inflammation can decrease redness, swelling, and discomfort associated with acne lesions.

Regular use of chemical peels can also improve overall skin texture, reducing the visibility of acne scars and discoloration [40]. By removing dead skin cells and stimulating skin regeneration, chemical peels help smooth and even out skin tone. Moreover, some chemical peels, especially those containing glycolic acid or lactic acid, can stimulate collagen production in the skin. Collagen is essential for maintaining skin elasticity and firmness, so increased production can help improve the structure and appearance of acne-affected skin.

However, it is important to note that while chemical peels can be effective, they may also carry the risk of irritation, particularly for individuals with sensitive skin. Therefore, before commencing chemical peel treatment, consultation with a dermatologist is recommended to choose the appropriate method and chemical substances suitable for individual needs and the patient's skin condition [41].

The Use of CO2 Fractional Laser in the Treatment of Common Acne

The CO2 fractional laser is an advanced tool in aesthetic dermatology that can be an effective solution for the treatment of common acne. This laser operates on the principle of fractional ablation, which involves the controlled removal of microscopic areas of the skin, thereby stimulating regenerative and cellular renewal processes [42]. The CO2 fractional laser emits a laser beam with a wavelength of 10,600 nm, precisely targeting selected areas of the skin and causing microscopic damage (ablation). This induced skin damage stimulates collagen production, a structural protein in the skin responsible for its elasticity, firmness, and smoothness [42].

The skin regeneration process involves the microscopic rebuilding of skin structure, contributing to the reduction of wrinkles, scars, and other skin irregularities. The CO2 fractional laser can effectively target areas affected by acne-related issues such as blackheads, nodules, and redness. The microscopic skin damage induced by the laser aids in the regeneration and overall improvement of acne-prone skin's appearance. Additionally, CO2 fractional laser therapy can help reduce post-acne discoloration and skin redness by stimulating regenerative processes.

Moreover, by stimulating cell renewal, the CO2 fractional laser contributes to overall skin rejuvenation, enhancing its texture, elasticity, and complexion. It is important to emphasize that CO2 fractional laser therapy is an advanced procedure that should be performed by an

experienced dermatologist. In the treatment of acne, the dermatologist adjusts the parameters of the procedure individually, considering the patient's needs and specific skin characteristics. Furthermore, the recovery time after the procedure may vary, and the skin requires special care following CO2 fractional laser treatment [42,43].

Conclusions

The treatment of common acne is a time-consuming and labor-intensive process. The path to eliminating skin lesions requires a multidimensional and holistic approach, with the essential assistance of a dermatologist. Many factors influence the development and severity of acne, such as genetic predispositions, hormonal factors, diet, lifestyle, and stress. Therefore, effective acne treatment necessitates an individualized approach that considers these diverse factors. Therapy should be based on a thorough dermatological diagnosis and take into account the severity of the disease, type of skin lesions, and individual patient needs.

Antibacterial and anti-inflammatory agents, retinoids, hyaluronic acid, phototherapy, and chemical peels are just some of the available therapeutic options. In practice, a combination of different treatment methods is often effective in achieving the best results. It is crucial to make therapeutic decisions consciously, based on current scientific knowledge and best clinical practices. Striving for a comprehensive approach that considers both medical and psychosocial aspects is essential for the effective treatment of common acne.

Simultaneously reducing skin inflammation, regulating sebum production, improving skin healing, and minimizing scar formation and discoloration can significantly enhance the quality of life for patients affected by this condition. However, regardless of the chosen therapeutic method, regular cooperation with a dermatologist and consistent adherence to therapeutic recommendations are crucial for achieving lasting and satisfactory results in the treatment of common acne.

Author's contribution

For full transparency, all submitted manuscripts must include an Author Contribution Statement stating the work of each author. For research articles with multiple authors, a short paragraph must be provided stating their individual contributions.

Conceptualization: Adrian Maj, methodology: Adrian Maj and Martyna Warno, check:, formal analysis: Adrian Maj , investigation:Adrian Maj, resources: Adrian Maj, Martyna Warno , data curation: Martyna Warno; writing- rough preparation: Adrian Maj and Martyna Warno, writing-review and editing: Martyna Warno, supervision: Adrian Maj and Martyna Warno, project administration:Adrian Maj, Martyna Warno; All authors have read and agreed with the published version of the manuscript.

Disclosure

The authors report no conflicts of interest for this work.

References

- [1] Alam M, Omura N, Kaminer MS. Subcision for acne scarring: technique and outcomes in 40 patients. *Dermatol Surg.* 2005 Jun;31(6):310-7. doi: 10.1111/j.1524-4725.2005.31030. PMID: 15962719.
- [2] Haider A, Shaw JC. Treatment of acne vulgaris. *JAMA.* 2004 Jan 21;291(3):307-10. doi: 10.1001/jama.291.3.307. PMID: 14734595.
- [3] Skroza N, Tolino E, Proietti I, Bernardini N, Nicolucci F, Mambrin A, La Viola G, Soccodato V, Zuber S, Balduzzi V, Marchesiello A, Bernardeschi C, Potenza C. Adult Acne

- Versus Adolescent Acne: A Retrospective Study of 1,167 Patients. *J Clin Aesthet Dermatol.* 2018 Sep;11(9):21-25. PMID: 30416597; PMCID: PMC6199756.
- [4] White GM. Recent findings in the epidemiologic evidence, classification, and subtypes of acne vulgaris. *J Am Acad Dermatol.* 1998 Jul;39(1 Suppl):S34-7. doi: 10.1016/s0190-9622(98)70442-6. PMID: 9669146.
- [5] Simonart T. Newer approaches to the treatment of acne vulgaris. *Am J Clin Dermatol.* 2012 Apr 1;13(2):357-64. doi: 10.2165/11598910-000000000-00000. PMID: 22268388.
- [6] Piskin S., Uzunali E. (2006). A review of the use of adapalene for the treatment of acne vulgaris. *Therapeutics and Clinical Risk Management*, 2(2), 251–265.
- [7] Czarnecka-Operacz M., Adamski Z. (2009). Nowoczesne metody leczenia trądziku pospolitego. *Forum Medycyny Rodzinnej*, 3(2), 107-114.
- [8] Thiboutot D, Gollnick H, Bettoli V, et al. New insights into the management of acne: An update from the Global Alliance to Improve Outcomes in Acne Group. *J Am Acad Dermatol.* 2009;60(5 Suppl):S1-S50.
- [9] Kurokawa I, Danby FW, Ju Q, et al. New developments in our understanding of acne pathogenesis and treatment. *Exp Dermatol.* 2009;18(10):821-832.
- [10] Gollnick HP, Bettoli V, Lambert J, et al. A consensus-based practical and daily guide for the treatment of acne patients. *J Eur Acad Dermatol Venereol.* 2016;30(9):1480-1490.
- [11] Platsidaki E, Dessinioti C. Recent advances in understanding *Propionibacterium acnes* (*Cutibacterium acnes*) in acne. *F1000Res.* 2018 Nov 28;7:F1000 Faculty Rev-1953. doi: 10.12688/f1000research.15791.1. PMID: 30564531; PMCID: PMC6281023.
- [12] Wollina U. (2016). Recent advances in the understanding and management of acne vulgaris. *F1000Research*, 5, F1000 Faculty Rev-1632
- [13] Anstead GM, Hartman CS. Topical retinoids in acne vulgaris: Update on efficacy and safety. *Am J Clin Dermatol.* 2011;12(4):217-226.
- [14] Piquero-Martin J, Serra-Baldrich E, Salleras-Redonnet M, Lizan-Garcia M. Combined oral contraceptive effectiveness on female acne: clinical characteristics impact. *Eur J Clin Pharmacol.* 2018 Aug;74(8):1079-1084. doi: 10.1007/s00228-018-2470-9. Epub 2018 Apr 26. PMID: 29696409.
- [15] Dréno B, Poli F. Epidemiology of acne. *Dermatology.* 2003;206(1):7-10. doi: 10.1159/000067802. PMID: 12566808.
- [16] Tan JK, Bhate K. A global perspective on the epidemiology of acne. *Br J Dermatol.* 2015 Jul;172 Suppl 1:3-12. doi: 10.1111/bjd.13462. PMID: 25597339.
- [17] Zouboulis CC. Acne as a chronic systemic disease. *Clin Dermatol.* 2014 Jan-Feb;32(1):389-96. doi: 10.1016/j.clindermatol.2013.06.013. PMID: 24314375.
- [18] Beylot C, Auffret N, Poli F, Claudel JP, Leccia MT, Del Giudice P, Dreno B. *Propionibacterium acnes*: an update on its role in the pathogenesis of acne. *J Eur Acad Dermatol Venereol.* 2014 Jun;28(6):271-8. doi: 10.1111/jdv.12224. Epub 2013 Aug 19. PMID: 23957783.
- [19] Haider A, Shaw JC. Treatment of acne vulgaris. *JAMA.* 2004 Jan 21;291(3):307-10. doi: 10.1001/jama.291.3.307. PMID: 14734595.
- [20] Czarnecka-Operacz M., Adamski Z. (2012). Wpływ czynników endogennych i egzogennych na nasilenie trądziku pospolitego. *Dermatologia Kliniczna*, 14(4), 162-167.
- [21] Nowicka D., Kędzia A., Hryszko M., Karczewski J. (2016). Rola diety w etiopatogenezie trądziku pospolitego. *Dermatologia Kliniczna*, 18(4), 207-210.
- [22] Kaszuba A, Adamski Z. *Leksykon dermatologiczny*. Lublin: Wydawnictwo Czelej, 2011. s.730-731.
- [23] Czarnecka-Operacz M., Adamski Z. (2012). Wpływ czynników endogennych i egzogennych na nasilenie trądziku pospolitego. *Dermatologia Kliniczna*, 14(4), 162-167.

- [24] Krakowski AC, Eichenfield LF, Dohil MA. Management of acne vulgaris: a pediatric dermatologist's perspective. *Semin Cutan Med Surg.* 2008 Sep;27(3):188-94. doi: 10.1016/j.sder.2008.07.004. PMID: 18928821.
- [25] Goulden V, Clark SM, McGeown C, Cunliffe WJ. Treatment of acne with intermittent isotretinoin. *Br J Dermatol.* 1997 May;136(5):690-4. doi: 10.1111/j.1365-2133.1997.tb03745.x. PMID: 9209021.
- [26] Cunliffe WJ, Goulden V. Phototherapy and acne vulgaris. *Br J Dermatol.* 2000 Oct;143(4):725-7. doi: 10.1046/j.1365-2133.2000.03842.x. PMID: 11069466.
- [27] Lehmann HP, Robinson KA, Andrews JS, Holloway V, Goodman SN. Acne therapy: a methodologic review. *J Am Acad Dermatol.* 2002 Jul;47(1):231-40. doi: 10.1067/mjd.2002.124530. PMID: 12077584.
- [28] Simonart T. Newer approaches to the treatment of acne vulgaris. *Am J Clin Dermatol.* 2012 Apr 1;13(2):357-64. doi: 10.2165/11598910-000000000-00000. PMID: 22268388.
- [29] Adamski Z., Kaszuba A., Reich A. (2011). Antybiotyki w leczeniu trądziku pospolitego. *Dermatologia Kliniczna*, 13(3), 143-147.
- [30] Zaremba J., Czarnecka-Operacz M. (2008). Leczenie farmakologiczne trądziku pospolitego. *Dermatologia Kliniczna*, 10(2), 87-91.
- [31] Thiboutot D, Gollnick H, Bettoli V, et al. New insights into the management of acne: An update from the Global Alliance to Improve Outcomes in Acne Group. *J Am Acad Dermatol.* 2009;60(5 Suppl):S1-S50.
- [32] Alexis AF, Callender VD, Baldwin HE, Desai SR, Rendon MI, Taylor SC. Global epidemiology and clinical spectrum of acne vulgaris. *J Drugs Dermatol.* 2011;10(8):742-750.
- [33] Anstead GM, Hartman CS. Topical retinoids in acne vulgaris: Update on efficacy and safety. *Am J Clin Dermatol.* 2011;12(4):217-226.
- [34] Dreno B, Layton A, Zouboulis CC, López-Esteban JL, Zalewska-Janowska A, Bagatin E, Zampeli VA, Yutskovskaya Y, Harper JC, Thiboutot D. Adult female acne: a new paradigm. *J Eur Acad Dermatol Venereol.* 2013 May;27(5):1063-70. doi: 10.1111/j.1468-3083.2012.04610.x. Epub 2012 May 3. PMID: 22554256
- [35] Cunliffe, W. J., & Goulden, V. (2000). Phototherapy and acne vulgaris. *British Journal of Dermatology*, 142(5), 855–856. <https://doi.org/10.1046/j.1365-2133.2000.03433.x>
- [36] Elman, M., & Lebzelter, J. (2004). Light therapy in the treatment of acne vulgaris. *Dermatologic Surgery*, 30(2), 139–146. <https://doi.org/10.1111/j.1524-4725.2004.30033.x>
- [37] Lee, S. Y., You, C. E., & Park, M. Y. (2007). Blue and red light combination LED phototherapy for acne vulgaris in patients with skin phototype IV. *Lasers in Surgery and Medicine*, 39(2), 180–188. <https://doi.org/10.1002/lsm.20428>
- [38] Fabi, S., & Sundaram, H. (2014). The potential of topical and injectable growth factors and cytokines for skin rejuvenation. *Facial Plastic Surgery Clinics of North America*, 22(4), 415–427. <https://doi.org/10.1016/j.fsc.2014.07.009>
- [39] Lee, J. B., Bae, S. H., & Lee, H. S. (2014). Treatment of acne scars with hyaluronic acid: An improved approach. *Journal of the American Academy of Dermatology*, 70(5), e102–e103. <https://doi.org/10.1016/j.jaad.2013.10.057>
- [40] El-Domyati, M., Abd-El-Raheem, T., Abdel-Wahab, H., & Medhat, W. (2016). Efficacy of chemical peeling in treatment of facial acne scars. *The Journal of Cosmetics, Dermatological Sciences and Applications*, 6(3), 115–123. <https://doi.org/10.4236/jcdsa.2016.63015>
- [41] Fabbrocini, G., Annunziata, M. C., D'arco, V., De Vita, V., Lodi, G., Mauriello, M. C., Pastore, F., & Monfrecola, G. (2010). Acne scars: Pathogenesis, classification and treatment. *Dermatology Research and Practice*, 2010, 1–13. <https://doi.org/10.1155/2010/893080>

[42] Sobanko J. F., Alster T. S. (2016). Laser treatment for improvement and minimization of facial scars. *Seminars in Cutaneous Medicine and Surgery*, 35(1), 36–41.

[42] Tierney EP, Hanke CW. Fractionated carbon dioxide laser treatment of photoaging: Prospective study in 45 patients and review of the literature. *Dermatol Surg*. 2011;37(9):1270-1279.