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Acne Vulgaris: Pathogenesis, Clinical Presentation, and Contemporary Treatment Approaches

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Abstract: ***Acne vulgaris is a chronic inflammatory disorder of the pilosebaceous unit and represents one of the most prevalent dermatological conditions worldwide. Although commonly associated with adolescence, acne frequently persists into adulthood and may result in significant physical, psychological, and aesthetic sequelae. The pathogenesis of acne is multifactorial and involves increased sebum production, abnormal follicular keratinization, colonization by Propionibacterium acnes, and complex inflammatory and immune-mediated mechanisms. This review presents a comprehensive overview of acne vulgaris with emphasis on its etiopathogenesis, clinical classification, and contemporary management strategies. The importance of clinical evaluation and severity grading in guiding treatment selection is highlighted. Current topical and systemic therapies, including retinoids, antimicrobial agents, hormonal therapy, and isotretinoin, are discussed with consideration of age, gender, and skin type. The role of procedural and aesthetic interventions as adjuncts to medical management is also explored, focusing on appropriate patient selection, timing, and safety. Special attention is given to acne management in pigmented skin types, particularly within the Indian population, where post-inflammatory hyperpigmentation and scarring are common concerns. Preventive strategies, maintenance therapy, and patient education are emphasized as essential components of long-term disease control. A comprehensive and individualized approach integrating medical and aesthetic therapies is essential for achieving sustained clinical improvement and enhancing patient quality of life.***

Keywords: Acne vulgaris, Pilosebaceous unit, *Propionibacterium acnes*, Acne management, Aesthetic treatment, Post-inflammatory hyperpigmentation

1. Introduction

Acne vulgaris is a common chronic inflammatory disorder of the pilosebaceous unit, characterized by the presence of comedones, papules, pustules, nodules, and in severe cases, cysts, and scarring. It affects areas of the skin rich in sebaceous glands, including the face, chest, shoulders, and back. Although acne is traditionally associated with adolescence, it frequently persists into adulthood and may newly present later in life, particularly among females.

The pathogenesis of acne is multifactorial and involves complex interactions between increased sebum production, abnormal follicular keratinization, colonization by *Propionibacterium acnes* and activation of inflammatory and immune pathways. These processes culminate in the formation of both non-inflammatory and inflammatory acne lesions. Current evidence suggests that inflammation may precede visible lesion formation, highlighting acne as an inflammatory disease rather than a purely infectious or cosmetic condition

Beyond its cutaneous manifestations, acne exerts a significant psychosocial burden. Patients frequently experience reduced self-esteem, anxiety, and diminished quality of life, particularly when lesions involve the face or result in scarring. Consequently, early diagnosis and appropriate therapeutic intervention are essential to minimize long-term sequelae.

From an aesthetic medicine perspective, acne management extends beyond lesion clearance to include maintenance therapy, prevention of post-inflammatory pigmentation, and management of acne-related scarring. An integrated understanding of acne biology and clinical treatment modalities is therefore crucial for clinicians and aesthetic practitioners alike. This review aims to provide a comprehensive overview of acne vulgaris, focusing on its pathogenesis, clinical presentation, and contemporary treatment approaches based on current scientific understanding.

2. Epidemiology of Acne

Acne affects 80-**-90% of adolescents** at some point during puberty. The onset of acne closely correlates with pubertal hormonal changes that stimulate sebaceous gland activity. Increased androgen production during this phase leads to sebaceous gland hypertrophy and enhanced sebum secretion, creating an environment conducive to acne development

Gender-related differences are evident in the epidemiology of acne. During adolescence, acne tends to be **more severe and persistent in males**, due to higher androgen levels and greater sebaceous activity. In contrast, **females demonstrate a higher prevalence of acne persistence into adulthood**, particularly in the third and fourth decades of life. Adult female acne often presents with a chronic, relapsing course and may be influenced by hormonal fluctuations associated with the menstrual cycle, pregnancy, and endocrine disorders.

Although acne is commonly perceived as a transient adolescent condition, **a substantial proportion of individuals continue to experience acne beyond the age of 25 years**. Adult-onset acne, defined as acne appearing for the first time after adolescence, is increasingly recognized, especially among women. Factors such as stress, cosmetic use, hormonal imbalance, and lifestyle modifications are believed to contribute to this trend.

The anatomical distribution of acne lesions mirrors the density and activity of sebaceous glands. Acne affects seborrheic areas such as the face, chest, shoulders, and upper back. The forehead, nose, and chin---collectively referred to as the "T-zone"---exhibit the highest sebaceous gland density and sebum output, explaining the high prevalence of lesions in these regions. Ethnic and racial variations in acne prevalence and severity have also been documented. While the overall incidence may be comparable across populations, differences are observed in lesion type, inflammatory response, and post-acne sequelae such as post-inflammatory hyperpigmentation and scarring. These variations are particularly relevant in darker skin types, where inflammatory lesions may lead to prolonged pigmentation, emphasizing the importance of early and appropriate management.

3. Etiopathogenesis of Acne

Acne vulgaris is a multifactorial inflammatory disorder involving the pilosebaceous unit. Its development is governed by the interaction of structural, hormonal, microbial, and immunological factors. Rather than arising from a single cause, acne represents a cascade of events that result in follicular obstruction, inflammation, and lesion formation. Contemporary understanding recognizes acne as an inflammatory disease from its earliest stages, even before clinical lesions become visible.
The principal pathogenic mechanisms include abnormalities of the pilosebaceous unit, increased sebum production, follicular hyperkeratinization, colonization by *Cutibacterium acnes*, and activation of inflammatory and immune responses.

3.1 Anatomy of the Pilosebaceous Unit

The pilosebaceous unit consists of the hair follicle, sebaceous gland, sebaceous duct, and arrector pili muscle. These units are distributed throughout the skin, except on the palms and soles, and are most densely concentrated on the face, chest, and upper back---areas commonly affected by acne.

Sebaceous glands are holocrine glands that release sebum through complete disintegration of sebocytes. The sebaceous duct opens into the follicular canal, allowing sebum to reach the skin surface. Structural variations in follicle size, duct diameter, and gland activity significantly influence susceptibility to acne. Smaller follicular openings and high sebaceous activity, particularly in facial regions, create increased resistance to sebum flow, predisposing the follicle to blockage and lesion formation.

3.2 Sebum Secretion and Androgen Influence

Sebum production plays a central role in acne pathogenesis. Sebaceous gland activity increases markedly during puberty under the influence of androgens, particularly testosterone and dihydrotestosterone. These hormones stimulate sebocyte proliferation and lipid synthesis, resulting in increased sebum output.
Sebum is a complex lipid mixture composed primarily of triglycerides, free fatty acids, wax esters, squalene, and cholesterol derivatives. In acne-prone individuals, both the quantity and composition of sebum are altered. Excessive sebum provides a favourable environment for microbial proliferation and contributes to follicular obstruction.

While elevated androgen levels can exacerbate acne, hormonal influence alone does not fully explain disease severity. Many individuals with normal androgen levels develop acne, suggesting that local androgen metabolism, sebaceous gland sensitivity, and downstream inflammatory responses are equally important .

3.3 Follicular Hyperkeratinization and Comedone Formation

The earliest pathological event in acne is abnormal follicular keratinization. Under normal conditions, keratinocytes lining the follicular canal undergo orderly differentiation and desquamation. In acne, this process is disrupted, leading to retention of keratinocytes and formation of a keratinous plug within the follicle.

This retained material combines with sebum to form a microcomedo, the precursor lesion of all acne types. Microcomedones are clinically invisible but serve as the foundation for both non-inflammatory and inflammatory acne lesions. As the follicle becomes increasingly distended, it may present as an open comedone (blackhead) or closed comedone (whitehead).

The dark appearance of open comedones is due to oxidation of melanin and lipids rather than external contamination. Follicular hyperkeratinization is therefore a critical initiating factor in acne pathogenesis and a primary therapeutic target.

3.4 Role of *Propionibacterium acnes* (P. acnes)

Propionibacterium acnes is a Gram-positive, anaerobic bacterium that forms part of the normal skin microbiota. It colonizes the pilosebaceous unit after the onset of puberty, when increased sebum production creates a lipid-rich environment favourable for bacterial growth. Although *P. acnes* is a commensal organism, it plays a crucial role in the pathogenesis of acne by contributing to follicular inflammation.

The bacterium produces lipolytic enzymes that hydrolyze sebum triglycerides into free fatty acids. These free fatty acids alter the follicular microenvironment, increase follicular wall permeability, and act as irritants that promote inflammation. In addition, *P. acnes* releases proteases, hyaluronidases, and chemotactic factors that further contribute to tissue damage and inflammatory responses.

Importantly, acne is not a result of simple bacterial infection. The pathogenic role of *P. acnes* lies primarily in its ability to activate the host immune system. Components of the bacterial cell wall interact with pattern recognition receptors, particularly toll-like receptors, on keratinocytes and immune cells. This interaction leads to the release of pro-inflammatory cytokines and chemokines, resulting in recruitment of inflammatory cells to the follicle.

Clinical severity of acne does not directly correlate with the quantity of *P. acnes* present within the follicle. Instead,

disease expression depends on the individual's inflammatory response to the organism. This explains why similar levels of bacterial colonization may result in mild acne in some individuals and severe inflammatory lesions in others.

Understanding the immunomodulatory role of *P. acnes* has important therapeutic implications. It supports the rationale for using treatments that target inflammation and follicular microenvironment, in addition to antimicrobial agents, in the comprehensive management of acne.

4. Clinical Classification of Acne

Acne vulgaris presents with a wide spectrum of clinical manifestations ranging from mild non-inflammatory lesions to severe inflammatory and nodulocystic disease. Clinical classification of acne is essential for determining disease severity, guiding therapeutic decisions, and predicting prognosis. Acne lesions are broadly classified based on the presence or absence of inflammation and the depth of follicular involvement.

4.1 Non-Inflammatory Acne

Non-inflammatory acne is characterized by the presence of comedones without surrounding erythema or tenderness. These lesions result primarily from follicular hyperkeratinisation and sebum retention rather than overt inflammation.

(a) Open Comedones (Blackheads)
Open comedones occur when the follicular orifice is dilated, allowing partial extrusion of the keratin--sebum plug. The dark coloration is caused by oxidation of melanin and lipids at the surface, not by dirt or bacterial infection. Open comedones are commonly seen on the nose, forehead, and chin.

(b) Closed Comedones (Whiteheads)
Closed comedones form when the follicular opening remains narrow, trapping keratinous material beneath the skin surface. They appear as small, skin-colored or whitish papules and often serve as precursor lesions for inflammatory acne. Closed comedones are more prone to rupture, leading to inflammatory responses.

4.2 Inflammatory Acne

Inflammatory acne develops when follicular contents provoke an immune response, resulting in erythema, swelling, and tenderness. These lesions indicate progression of disease severity and increased risk of post-inflammatory sequelae.

(a) Papules
Papules are small, raised, erythematous lesions caused by inflammation of the follicular wall. They are usually tender and signify early inflammatory acne.

(b) Pustules
Pustules represent a further stage of inflammation and are characterized by a visible collection of purulent material within the lesion. Despite their appearance, pustules are sterile and reflect immune-mediated inflammation rather than active infection.

4.3 Severe Forms of Acne

Severe acne involves deeper follicular inflammation and destruction of surrounding tissue. These forms are associated with a higher risk of permanent scarring and psychological distress.

(a) Nodules
Nodules are large, firm, painful lesions located deep within the dermis. They result from extensive inflammation and follicular rupture, leading to involvement of surrounding connective tissue.

(b) Cysts
Cystic lesions are fluctuant, pus-filled cavities formed by intense inflammatory reactions. They often persist for prolonged periods and heal with scarring. Nodulocystic acne typically requires systemic therapy for effective management.

5. Clinical Evaluation and Diagnosis

Accurate clinical evaluation and diagnosis of acne vulgaris are fundamental for effective disease management and prevention of long-term sequelae. Although acne is primarily diagnosed on clinical grounds, a structured and comprehensive assessment enables differentiation from acneiform disorders, identification of aggravating factors, and formulation of individualized treatment strategies. In the context of aesthetic medicine, evaluation also extends to cosmetic practices, skin type assessment, and patient expectations.

5.1 Clinical History

A thorough clinical history should include age of onset, duration of disease, lesion progression, and previous treatments undertaken. Early-onset acne often indicates a strong genetic or hormonal predisposition, while adult-onset acne warrants closer evaluation of hormonal, cosmetic, and lifestyle factors.

Aggravating factors such as premenstrual flares, stress, dietary habits, cosmetic usage, occupational exposure, and inappropriate skin-care practices should be documented. In female patients, a history of menstrual irregularities, hirsutism, or infertility may suggest an underlying endocrine component.

Equally important is the assessment of prior treatment history, including over-the-counter products, prescription medications, aesthetic procedures, and patient compliance. In aesthetic settings, a history of frequent chemical peels, unregulated topical steroid use, or aggressive exfoliation is particularly relevant, as these practices may worsen acne or compromise the skin barrier.

5.2 Clinical Examination

Clinical examination involves evaluation of lesion morphology, severity, distribution, and presence of

complications. Acne lesions are classified into non-inflammatory and inflammatory types, and their anatomical distribution is carefully assessed. Facial acne commonly involves the forehead, cheeks, nose, and chin, whereas truncal acne affects the chest, shoulders, and upper back.

The presence of nodules, cysts, post-inflammatory hyperpigmentation, erythema, or scarring indicates more severe disease and influences therapeutic planning. In adult females, acne localized to the mandibular region and chin may suggest hormonal influence.

From an aesthetic perspective, assessment of skin type, oiliness, sensitivity, and barrier integrity is essential. These parameters guide selection of topical agents, procedural treatments, and cosmeceuticals, particularly in patients prone to irritation or pigmentation.

5.3 Acne Grading and Severity Assessment

Grading acne severity is crucial for standardizing diagnosis, monitoring treatment response, and conducting clinical research. Several grading systems are employed in clinical practice, commonly categorizing acne into mild, moderate, and severe forms based on lesion type, number, and distribution.

- **Mild acne**: Comedonal lesions with few inflammatory papules or pustules
- **Moderate acne**: Increased number of inflammatory lesions with limited nodules
- **Severe acne**: Extensive inflammatory lesions, nodules, cysts, and risk of scarring

Objective grading aids clinicians in selecting appropriate therapeutic modalities, ranging from topical agents for mild disease to systemic and procedural interventions for severe acne

5.6 Differential Diagnosis

Several dermatological conditions may mimic acne and must be excluded during evaluation. Acneiform eruptions typically lack comedones and may result from medications such as corticosteroids or anabolic steroids. Rosacea, perioral dermatitis, folliculitis, and seborrheic dermatitis should also be considered.

Correct diagnosis is essential, as these conditions require different therapeutic approaches. Misdiagnosis may lead to inappropriate treatment and disease exacerbation.

5.7 Hormonal and Laboratory Evaluation

Routine laboratory investigations are not indicated for all acne patients. However, hormonal evaluation is recommended in selected cases, particularly in adult females with late-onset acne, sudden severe acne, treatment resistance, or signs of hyperandrogenism.

Assessment of androgen levels may aid in identifying endocrine abnormalities and allows targeted hormonal therapy, improving long-term disease control.

5.8 Role of Aesthetic Consultation in Acne Evaluation

In modern clinical practice, aesthetic consultation plays an important adjunctive role in acne management. Patients frequently seek aesthetic interventions for faster lesion resolution, prevention of pigmentation, and improvement of skin texture.

During aesthetic evaluation, clinicians must assess procedural suitability, timing, and safety. Active inflammatory acne may contraindicate certain procedures, while inappropriate interventions can aggravate inflammation or increase post-inflammatory pigmentation. Patient counselling regarding realistic expectations and the need for combination therapy is essential for optimal outcomes.

5.9 Cosmetic Misuse and Acne Exacerbation

Cosmetic misuse is a significant but often overlooked contributor to acne, particularly in urban and aesthetic-practice settings. The use of comedogenic products, heavy makeup, occlusive sunscreens, and inappropriate topical steroids can precipitate or worsen acne lesions.

Steroid-modified acne, resulting from prolonged unsupervised use of topical corticosteroids, presents with monomorphic papules and pustules and is increasingly observed. Detailed evaluation of cosmetic and skincare products used by the patient is therefore essential to identify and eliminate triggering factors.

5.10 Acne Evaluation in Indian Skin Types

Indian skin, typically classified under Fitzpatrick skin types IV and V, exhibits distinct clinical considerations in acne evaluation. These skin types are more prone to post-inflammatory hyperpigmentation and pigmentary sequelae, even following mild inflammatory lesions [6].

Early recognition of pigmentation risk, cautious selection of topical agents, and avoidance of overly aggressive procedures are crucial. Acne evaluation in Indian patients should emphasize prevention of sequelae in addition to lesion clearance, aligning treatment goals with both medical and aesthetic priorities.

5.11 Psychological Assessment and Quality of Life

Acne significantly affects psychological well-being, particularly when lesions involve visible areas or result in scarring. Emotional distress, anxiety, and reduced self-esteem are common and may influence treatment adherence [5].

Assessment of psychosocial impact should be integrated into routine evaluation. Addressing patient concerns and providing appropriate counselling enhances therapeutic compliance and overall treatment success.

6. Topical Therapies in Acne

Topical therapy remains the cornerstone of acne management, particularly in mild to moderate disease. These agents act directly on key pathogenic mechanisms such as follicular

hyperkeratinisation, microbial proliferation, inflammation, and excess sebum production. In addition to prescription medications, cosmeceutical products play an increasingly important adjunctive role, especially in aesthetic practice and long-term maintenance therapy [1].

Appropriate selection, combination, and patient education regarding topical therapies are essential to maximize efficacy while minimizing adverse effects, particularly in pigmented and sensitive skin types commonly seen in the Indian population.

6.1 Topical Retinoids

Topical retinoids are first-line agents in acne therapy due to their ability to normalize follicular keratinization, prevent microcomedo formation, and exert anti-inflammatory effects. Commonly used retinoids include tretinoin, adapalene, and tazarotene.

Retinoids are effective in treating both non-inflammatory and inflammatory acne and form the backbone of long-term maintenance therapy. They also enhance penetration and efficacy of other topical agents, making them ideal for combination regimens.

However, retinoid-induced irritation---manifesting as erythema, dryness, peeling, and burning---is a frequent cause of poor adherence, especially in Indian skin types prone to sensitivity and post-inflammatory pigmentation.

6.2 Retinoid Tolerability Strategies (Clinical & Aesthetic Focus)

Improving retinoid tolerability is essential for sustained treatment success. Strategies include:

- Initiating therapy with **lower concentrations** and gradually increasing strength
- **Alternate-night application** during the initial weeks
- Short-contact therapy in sensitive individuals
- Use of **barrier-repair moisturizers** containing ceramides, hyaluronic acid, or niacinamide
- Avoiding simultaneous application with irritating agents during early treatment

In aesthetic practice, retinoids should be temporarily discontinued prior to procedures such as chemical peels or energy-based treatments to reduce the risk of irritation and pigmentation.

6.3 Benzoyl Peroxide

Benzoyl peroxide is a potent antimicrobial agent effective against *Propionibacterium acnes*. It also exhibits mild keratolytic and anti-inflammatory properties. Unlike antibiotics, benzoyl peroxide does not induce bacterial resistance.

It is commonly used as monotherapy in mild acne or in combination with topical antibiotics or retinoids in moderate acne. Lower concentrations are preferred in Indian skin to minimize irritation.

Patient counselling regarding dryness, irritation, and fabric bleaching is essential to improve compliance.

6.4 Topical Antibiotics

Topical antibiotics such as clindamycin and erythromycin reduce inflammatory lesions by suppressing *P. acnes* and inflammatory mediators. Due to increasing antibiotic resistance, these agents should never be used as monotherapy.

Combination with benzoyl peroxide is strongly recommended to enhance efficacy and prevent resistance. Long-term unsupervised use, commonly seen in cosmetic misuse, should be actively discouraged.

6.5 Keratolytic and Adjunctive Agents

Keratolytic agents such as salicylic acid promote exfoliation and reduce follicular blockage. Salicylic acid is lipophilic and penetrates sebaceous follicles effectively, making it useful in comedonal acne.

Azelaic acid deserves special emphasis in Indian skin due to its **triple benefit-** antimicrobial, anti-inflammatory, and depigmenting actions. It is particularly effective in patients with post-inflammatory hyperpigmentation and sensitive skin, where retinoids may not be well tolerated.

6.6 Role of Cosmeceuticals in Acne Management

Cosmeceuticals play an important supportive role in acne management by improving skin barrier function, reducing irritation, and enhancing treatment adherence. Non-comedogenic cleansers, oil-control formulations, and barrier-repair moisturizers are essential components of an effective acne regimen.

Active cosmeceutical ingredients such as niacinamide, zinc, green tea extract, and botanical anti-inflammatories help reduce erythema, sebum production, and irritation. These products are particularly valuable in Indian patients, where aggressive therapy may trigger pigmentation.

Cosmeceuticals should be used as adjuncts, not substitutes, for evidence-based medical treatment.

6.7 Indian Formulation Considerations

In the Indian context, formulation choice significantly impacts treatment outcomes. Gel-based, non-occlusive formulations are better tolerated in humid climates and oily skin types. Alcohol-heavy formulations and fragranced products should be avoided due to their irritant potential.
Fixed-dose combinations commonly available in India should be prescribed judiciously to avoid misuse and steroid contamination, which can lead to steroid-modified acne.

6.8 Combination Topical Therapy

Combination therapy addresses multiple pathogenic factors simultaneously and is more effective than monotherapy. Common combinations include retinoids with benzoyl peroxide or topical antibiotics.

Fixed-dose combinations simplify regimens, improve adherence, and enhance clinical outcomes when prescribed rationally and monitored appropriately.

6.9 Role of Topical Therapy in Aesthetic Practice

In aesthetic medicine, topical therapy serves both therapeutic and preventive roles. It is essential for stabilizing active acne prior to procedures, maintaining results post-intervention, and minimizing complications such as pigmentation and scarring.

Individualized topical regimens based on skin type, sensitivity, and procedural history are crucial for safe and effective outcomes.

7. Systemic Therapies in Acne

Systemic therapy is indicated in patients with moderate to severe acne, extensive inflammatory lesions, nodulocystic acne, truncal involvement, or disease refractory to topical treatment. Systemic agents target deeper pathogenic mechanisms such as inflammation, microbial proliferation, hormonal imbalance, and excessive sebaceous gland activity. Careful patient selection, monitoring, and duration control are essential to maximize benefits while minimizing adverse effects.

In aesthetic practice, systemic therapies are often combined with topical and procedural interventions to achieve faster lesion control and prevent long-term sequelae such as scarring and pigmentation.

7.1 Oral Antibiotics

Oral antibiotics are commonly prescribed for moderate to severe inflammatory acne. Their primary role is to reduce *Propionibacterium acnes* proliferation and suppress inflammatory responses within the pilosebaceous unit.

Commonly used oral antibiotics include tetracyclines and macrolides. These agents exert anti-inflammatory effects in addition to antimicrobial action. Oral antibiotics are particularly effective in patients with widespread papulopustular lesions and truncal acne.

However, prolonged, or indiscriminate use can lead to antibiotic resistance and alteration of normal microbiota. Therefore, oral antibiotics should always be combined with appropriate topical agents, such as benzoyl peroxide or retinoids, and used for limited durations. Monotherapy and long-term maintenance with antibiotics should be avoided

7.2 Age-Based Considerations for Oral Antibiotics

In adolescents and young adults, oral antibiotics are commonly used for inflammatory acne but require careful monitoring for compliance and adverse effects. In adult patients, particularly females, antibiotics should be reassessed early if response is inadequate, as hormonal factors may play a more significant role.

In paediatric patients, systemic antibiotics are used cautiously and only when clearly indicated.

7.3 Hormonal Therapy

Hormonal therapy plays an important role in the management of acne in selected female patients, particularly those with signs of androgen excess or hormonally driven disease. Hormonal modulation reduces sebaceous gland activity and improves inflammatory lesions.

Candidates for hormonal therapy include adult women with persistent acne, premenstrual flares, acne localized to the lower face, or associated features such as irregular menstrual cycles or hirsutism. Hormonal therapy is not indicated in male patients and requires careful patient counselling.

Hormonal agents are often used in combination with topical therapies to achieve sustained disease control and reduce relapse rates.

7.4 Oral Isotretinoin

Oral isotretinoin is the most effective systemic therapy for severe acne. It acts by reducing sebaceous gland size and activity, normalizing follicular keratinization, suppressing *P. acnes*, and exerting anti-inflammatory effects [1].

Indications for isotretinoin include severe nodulocystic acne, acne resistant to conventional therapy, acne associated with scarring, and acne causing significant psychological distress. Early intervention with isotretinoin may prevent permanent scarring and long-term morbidity.

Despite its efficacy, isotretinoin requires strict monitoring due to its potential adverse effects. Common side effects include mucocutaneous dryness, cheilitis, and photosensitivity. In Indian patients, careful dose titration and supportive skincare are essential to minimize irritation and pigmentation risk.

7.5 Age and Gender Considerations for Isotretinoin

In adolescents, isotretinoin is prescribed with caution, ensuring appropriate counselling regarding expectations and adherence. In adult patients, particularly women of reproductive age, strict contraceptive measures and informed consent are mandatory.

Lower-dose and intermittent regimens are increasingly used to improve tolerability while maintaining efficacy, especially in patients with sensitive skin or moderate disease.

7.6 Systemic Therapy in Indian Clinical Practice

In the Indian context, systemic therapy selection must consider climatic conditions, skin type, dietary habits, and patient adherence. Indian patients are more prone to post-inflammatory hyperpigmentation, making early control of inflammation particularly important.

Overuse of antibiotics and unsupervised isotretinoin therapy remain concerns. Therefore, clinician-guided treatment protocols and patient education are essential to ensure safety and long-term success.

7.7 Integration of Systemic Therapy with Aesthetic Treatments

Systemic therapies are frequently combined with topical agents and aesthetic procedures to enhance outcomes. Active inflammatory acne should be stabilized with medical therapy before initiating procedures such as chemical peels or energy-based treatments.

Isotretinoin-treated patients require careful procedural planning due to increased skin sensitivity. Coordination between medical and aesthetic management ensures effective treatment while minimizing complications.

7.8 Comparative Overview of Systemic Therapies in Acne

Systemic therapies used in acne management differ significantly in their indications, mechanisms of action, duration of use, and safety profiles. Oral antibiotics are primarily indicated for moderate to severe inflammatory acne, particularly in patients with widespread papulopustular lesions or truncal involvement. Their main advantage lies in rapid reduction of inflammation; however, they are intended for short-term use only due to concerns regarding antibiotic resistance. Long-term maintenance with oral antibiotics is not recommended, and they should always be combined with appropriate topical agents to enhance efficacy and limit resistance development.

Hormonal therapy is uniquely beneficial in selected female patients with hormonally influenced acne. Unlike antibiotics, hormonal agents address the underlying endocrine contribution by reducing androgen-mediated sebaceous gland activity. These therapies are particularly useful in adult women with persistent acne, premenstrual exacerbations, or associated signs of hyperandrogenism. Hormonal therapy offers the advantage of long-term disease control but requires careful patient selection, counselling, and monitoring. It is contraindicated in male patients and not suitable for all females.

Oral isotretinoin represents the most comprehensive systemic treatment option, as it targets all major pathogenic factors of acne. It is indicated in severe, nodulocystic, scarring, or treatment-resistant acne. Unlike antibiotics and hormonal agents, isotretinoin has the potential to induce prolonged remission and, in some cases, permanent resolution of acne. However, its use is limited by potential adverse effects and strict monitoring requirements, particularly in women of reproductive age. Dose individualization and supportive skincare are essential to improve tolerability, especially in Indian skin types prone to dryness and pigmentation.

From a clinical and aesthetic perspective, selection of systemic therapy should be guided by acne severity, patient age, gender, hormonal status, psychological impact, and previous treatment response. Antibiotics are best suited for short-term inflammatory control, hormonal therapy for endocrine-driven disease in females, and isotretinoin for severe or refractory acne. Understanding these distinctions allows clinicians to optimize treatment outcomes while minimizing risks and long-term complications

7.9 Transition from Medical to Procedural Management

Effective acne management requires a stepwise and integrated approach in which medical therapy forms the foundation, while procedural and aesthetic interventions serve as adjuncts to enhance outcomes and address residual concerns. Systemic and topical therapies are essential for controlling active inflammation, reducing lesion count, and stabilizing the disease process. Once inflammatory activity is adequately controlled, procedural treatments can be safely introduced to accelerate resolution, prevent post-inflammatory sequelae, and improve overall skin quality.

Initiating aesthetic procedures in the presence of uncontrolled inflammatory acne may worsen inflammation, increase the risk of post-inflammatory hyperpigmentation, and compromise treatment outcomes. Therefore, appropriate timing and patient selection are critical. Stabilization with medical therapy allows clinicians to tailor procedural interventions based on residual lesions, pigmentation, scarring, and skin type.

From an aesthetic medicine perspective, this integrated model emphasizes acne as a chronic condition requiring long-term management rather than episodic treatment. The transition from pharmacological control to procedural optimization represents a continuum of care aimed at achieving sustained clinical improvement and enhanced patient satisfaction

8. Procedural and Aesthetic Treatments in Acne

Procedural and aesthetic treatments serve as important adjuncts in the comprehensive management of acne. While pharmacological therapy remains the primary modality for controlling active disease, aesthetic procedures enhance treatment outcomes by accelerating lesion resolution, reducing inflammation, preventing post-inflammatory sequelae, and improving overall skin texture and tone. These interventions are particularly valuable in patients with treatment-resistant acne, residual lesions, pigmentation, or early scarring.

Appropriate patient selection, timing, and procedural choice are critical to ensure safety and efficacy, especially in pigmented skin types commonly seen in the Indian population.

8.1 Role of Procedures in Active Acne

In patients with mild to moderate inflammatory acne, certain procedures may be safely incorporated alongside medical therapy to enhance clinical response. These procedures act by reducing follicular blockage, controlling inflammation, and improving penetration of topical agents.

However, aggressive procedures should be avoided in the presence of severe active inflammation or nodulocystic acne, as they may exacerbate disease activity and increase the risk of post-inflammatory hyperpigmentation and scarring. Stabilization with topical or systemic therapy is therefore a prerequisite before initiating most aesthetic interventions.

8.2 Chemical Peels

Chemical peels are among the most used aesthetic procedures in acne management. Superficial peels utilizing agents such as alpha-hydroxy acids, beta-hydroxy acids, and combination formulations promote exfoliation, reduce follicular obstruction, and improve comedonal acne [2].

Salicylic acid peels are particularly effective in acne-prone skin due to their lipophilic nature and ability to penetrate sebaceous follicles. In addition to lesion reduction, chemical peels help improve post-inflammatory hyperpigmentation and uneven skin tone, which are common concerns in Indian patients [2].

Peel selection, concentration, and frequency should be individualized based on acne severity, skin sensitivity, and pigmentation risk. Overuse or improper technique may result in irritation, barrier damage, and pigmentary complications.

8.3 Light-Based and Energy-Based Therapies

Light-based therapies have emerged as useful adjuncts in acne treatment due to their anti-inflammatory and antimicrobial effects. These modalities reduce *Propionibacterium acnes* activity and modulate sebaceous gland function.

Energy-based treatments are most effective in inflammatory acne and are often combined with topical or systemic therapy. While well tolerated, cautious parameter selection is required in darker skin types to minimize the risk of dyschromia.

Light-based therapies should be considered supportive rather than standalone treatments and are best utilized as part of a multimodal acne management plan.

8.4 Comedone Extraction and Supportive Procedures

Manual comedone extraction may be beneficial in selected patients with comedonal acne. When performed correctly under aseptic conditions, it can reduce lesion burden and improve treatment response.

Supportive procedures such as gentle exfoliation and controlled exfoliative therapies may assist in maintaining follicular patency. However, unsupervised, or aggressive mechanical manipulation should be discouraged, as it can aggravate inflammation and contribute to scarring.

8.5 Procedural Considerations in Indian Skin Types

Indian skin types (Fitzpatrick IV--V) require special consideration due to increased susceptibility to post-inflammatory hyperpigmentation and prolonged erythema. Procedural interventions should prioritize safety, gradual progression, and minimal irritation.

Lower concentrations, longer intervals between sessions, and adequate pre- and post-procedure skincare are essential. Sun protection and pigment-control strategies should be integrated into all procedural treatment plans to minimize adverse outcomes.

8.6 Integration of Procedures with Medical Therapy

Procedural treatments should be integrated with ongoing medical therapy rather than replacing it. Topical and systemic agents help maintain disease control, while procedures address residual lesions and aesthetic concerns.

Patients receiving systemic therapies, particularly isotretinoin, require careful procedural planning due to altered skin sensitivity. Coordination between medical and aesthetic management ensures continuity of care and optimal outcomes.

8.7 Patient Counselling and Expectations

Effective patient counselling is a critical component of procedural acne management. Patients should be informed that aesthetic procedures are adjunctive measures and that multiple sessions may be required to achieve visible improvement.

Setting realistic expectations regarding outcomes, duration, and maintenance therapy improves patient satisfaction and adherence. Education regarding post-procedure care is particularly important in preventing complications and pigmentation.

9. Special Considerations in Acne Management

Acne vulgaris presents with considerable clinical heterogeneity, influenced by patient age, gender, hormonal status, skin type, and associated comorbidities. Management strategies must therefore be individualized according to clinical presentation rather than adopting a uniform therapeutic approach. Recognition of special acne subtypes and patient-specific factors is essential for achieving optimal clinical and aesthetic outcomes while minimizing adverse effects and long-term sequelae.

(a) Acne in Adolescents

Adolescent acne represents the most common clinical presentation and is closely linked to pubertal hormonal changes. Increased androgen activity during this period stimulates sebaceous gland function, leading to excessive sebum production and follicular occlusion. Clinically, adolescent acne commonly presents as comedonal or mixed comedonal--inflammatory lesions involving the face and trunk.

Management in adolescents should prioritize early intervention to prevent progression and scarring. Topical retinoids and benzoyl peroxide form the foundation of therapy, with systemic antibiotics reserved for moderate to severe inflammatory disease. Patient education regarding treatment adherence, avoidance of aggressive skin practices, and realistic expectations is particularly important, as non-compliance and cosmetic misuse are common in this age group.

(b) Adult Female Acne

Adult female acne is increasingly recognized and often presents as a chronic, relapsing condition. Clinically, it is characterized by inflammatory papules and nodules affecting

the lower face, jawline, and chin. Hormonal fluctuations related to menstrual cycles, pregnancy, polycystic ovarian syndrome, and stress play a significant role in disease persistence.

Management of adult female acne requires a comprehensive evaluation of hormonal influences and lifestyle factors. While topical therapies remain essential, many patients benefit from hormonal modulation and long-term maintenance regimens. Emphasis should be placed on minimizing irritation and pigmentation, as adult skin tends to be more sensitive and prone to post-inflammatory changes.

(c) Acne in Sensitive and Reactive Skin

Patients with sensitive or reactive skin often experience exaggerated irritation in response to standard acne therapies. This subgroup frequently presents with erythema, burning, and barrier dysfunction, which may exacerbate inflammatory lesions and compromise adherence.

Management in such cases requires careful agent selection, gradual introduction of active treatments, and consistent use of barrier-supportive cosmeceuticals. Low-strength retinoids, azelaic acid, and anti-inflammatory ingredients are preferred. Avoidance of harsh cleansers, frequent exfoliation, and inappropriate cosmetic products is essential to prevent treatment-induced flares.

(d) Acne in Pigmented and Ethnic Skin

In pigmented skin types, including the Indian population, acne is often accompanied by prominent post-inflammatory hyperpigmentation, even following mild inflammatory lesions. Pigmentary sequelae may persist longer than active acne and significantly impact quality of life.

Management strategies should prioritize early inflammation control, gentle therapeutic approaches, and integration of depigmenting agents. Procedural interventions must be selected cautiously, with emphasis on safety and gradual improvement to reduce the risk of dyschromia.

(e) Truncal Acne

Truncal acne commonly involves the chest, shoulders, and upper back and is often more inflammatory and treatment-resistant than facial acne. Due to thicker skin and increased sebaceous gland density, topical penetration may be reduced, necessitating systemic therapy in moderate to severe cases.

Management should combine appropriate topical agents with systemic treatments when indicated. Patient education regarding cleansing practices, clothing choices, and sweat management is essential to support treatment efficacy.

(f) Acne Associated with Psychological Distress

The psychological impact of acne is significant and often underestimated. Visible lesions, prolonged disease course, and pigmentary or scarring sequelae can contribute to anxiety, social withdrawal, and reduced self-esteem.

Recognition of psychological distress should form an integral part of acne evaluation. Early, effective treatment and empathetic patient counselling improve adherence and overall treatment outcomes. In selected cases, referral for psychological support may be beneficial.

(g) Maintenance Therapy and Relapse Prevention

Acne is a chronic condition with a tendency for relapse following treatment discontinuation. Maintenance therapy plays a critical role in sustaining clinical improvement and preventing recurrence.

Long-term use of non-irritating topical agents, appropriate cosmeceuticals, and lifestyle modifications form the basis of maintenance care. Patient education regarding the chronic nature of acne and the need for continued therapy enhances long-term success.

10. Complications and Sequelae of Acne

Acne vulgaris, particularly when severe, prolonged, or inadequately treated, can lead to a range of complications that extend beyond active lesions. These sequelae may persist long after resolution of inflammation and often have significant cosmetic and psychological implications. Early recognition and appropriate management are essential to minimize long-term morbidity.

(a) Post-Inflammatory Hyperpigmentation

Post-inflammatory hyperpigmentation is one of the most common sequelae of acne, especially in individuals with pigmented skin types. It results from increased melanin production or abnormal melanin distribution following cutaneous inflammation. Clinically, it presents as flat brown, black, or greyish macules at sites of resolved acne lesions [3].

In Indian skin, even mild inflammatory acne can lead to pronounced and persistent pigmentation. Factors such as delayed treatment, excessive inflammation, mechanical manipulation, and inappropriate procedures increase the risk. Management focuses on early control of inflammation, use of gentle topical therapies, sun protection, and gradual introduction of depigmenting agents. Aggressive interventions may worsen pigmentation and should be avoided [4].

(b) Erythema and Post-Inflammatory Redness

Persistent erythema may occur following resolution of inflammatory acne lesions, particularly in fair to medium skin tones. It results from prolonged vasodilation and inflammatory changes in the dermis. Although erythema often resolves spontaneously, it may persist for months and contribute to patient dissatisfaction.

Appropriate anti-inflammatory treatment, barrier-supportive skincare, and avoidance of irritants help reduce post-inflammatory redness. In aesthetic practice, procedural interventions should be timed carefully to prevent exacerbation.

(c) Acne Scarring

Acne scarring represents a permanent sequela resulting from deep inflammation and destruction of dermal structures. The risk of scarring is higher in nodulocystic acne, delayed treatment, and repeated manipulation of lesions. Scars are

broadly classified as atrophic or hypertrophic based on tissue response.

Atrophic scars, including ice-pick, boxcar, and rolling scars, are more commonly observed and result from collagen loss during the healing process. Hypertrophic scars and keloids result from excessive collagen deposition and are more frequently seen on the chest and shoulders, particularly in genetically predisposed individuals.

Prevention remains the most effective strategy, emphasizing early and adequate treatment of inflammatory acne. Management of established scars often requires combination procedural approaches, underscoring the importance of timely intervention.

(d) Psychological and Emotional Impact

The psychological burden of acne and its sequelae is substantial. Visible lesions, pigmentation, and scarring can significantly affect self-esteem, social interactions, and overall quality of life. Adolescents and young adults are particularly vulnerable to emotional distress, anxiety, and social withdrawal [5].

Recognition of psychological impact is a critical component of acne management. Effective communication, reassurance, and realistic expectation setting improve treatment adherence and patient satisfaction. In selected cases, psychological counselling may be warranted as part of a holistic management approach.

(e) Impact on Quality of Life and Social Functioning

Acne-related complications often influence personal, academic, and professional life. Patients may avoid social situations, experience reduced confidence, and report diminished productivity. Persistent sequelae such as pigmentation and scarring often outlast active disease and require prolonged management.

Understanding the broader impact of acne complications highlights the need for early, comprehensive, and sustained treatment strategies that address both medical and aesthetic concerns.

10.1 Preventive Strategies in Acne and Its Sequelae

Prevention plays a pivotal role in minimizing the complications and long-term sequelae of acne vulgaris. Early identification of acne and timely initiation of appropriate therapy are the most effective measures for preventing pigmentary changes, scarring, and psychological distress. Delayed or inadequate treatment allows prolonged inflammation, which increases the risk of permanent skin damage.

Patient education is central to preventive care. Individuals should be counselled regarding the chronic and relapsing nature of acne, the importance of treatment adherence, and realistic expectations regarding outcomes. Avoidance of mechanical manipulation such as squeezing or picking of lesions is essential, as these practices significantly increase the risk of scarring and post-inflammatory hyperpigmentation.

Rational skincare practices also contribute to prevention. Use of gentle, non-comedogenic cleansers, appropriate moisturizers, and sunscreen helps maintain barrier integrity and reduces treatment-related irritation. In pigmented skin types, consistent photoprotection is particularly important to prevent worsening of acne-induced pigmentation.

From an aesthetic medicine perspective, prevention includes careful selection and timing of procedures. Stabilization of active acne prior to aesthetic interventions, avoidance of aggressive techniques, and adherence to proper pre- and post-procedure care reduce the risk of adverse outcomes. Long-term maintenance therapy using well-tolerated topical agents further helps prevent relapse and progression.

Overall, a preventive approach that integrates medical treatment, skincare guidance, and patient education is essential for reducing the burden of acne and its sequelae and for improving long-term clinical and aesthetic outcomes

11. Conclusion

Acne vulgaris is a complex, chronic inflammatory disorder of the pilosebaceous unit that extends far beyond a transient cosmetic concern. Its multifactorial pathogenesis, variable clinical presentation, and potential for long-term sequelae necessitate a comprehensive and individualized approach to management. Understanding the interplay between sebaceous gland activity, follicular keratinization, microbial colonization, and inflammatory pathways forms the scientific foundation for rational therapeutic decision-making.

Effective acne management requires early diagnosis, appropriate severity-based treatment selection, and sustained maintenance therapy. Topical agents remain the cornerstone for mild to moderate disease, while systemic therapies play a critical role in controlling severe, widespread, or treatment-resistant acne. Procedural and aesthetic interventions, when appropriately timed and judiciously selected, further enhance treatment outcomes by addressing residual lesions, pigmentation, and early scarring.

Special consideration must be given to patient-specific factors such as age, gender, hormonal status, skin sensitivity, and ethnic background. In Indian and other pigmented skin types, the heightened risk of post-inflammatory hyperpigmentation and scarring underscores the importance of gentle yet effective treatment strategies, cautious procedural planning, and emphasis on prevention. Adult female acne, adolescent acne, truncal involvement, and acne in sensitive skin each demand tailored therapeutic approaches rather than a uniform treatment model.

Beyond physical manifestations, the psychosocial impact of acne is substantial and often underrecognized. Emotional distress, reduced self-esteem, and impaired quality of life highlight the need for empathetic patient communication and holistic care. Incorporating patient education, realistic expectation setting, and adherence counselling into routine clinical practice significantly improves long-term outcomes.

From an aesthetic medicine perspective, acne management represents a continuum of care rather than an isolated

intervention. Integrating medical therapy with supportive skincare, cosmeceuticals, and evidence-based procedures allows clinicians and aesthetic practitioners to not only control active disease but also prevent complications and enhance overall skin health.

In conclusion, acne vulgaris should be approached as a chronic inflammatory condition requiring early intervention, individualized treatment, and long-term maintenance. A multidisciplinary, patient-centred strategy that combines scientific understanding with clinical expertise and aesthetic sensibility offers the greatest potential for sustained disease control and improved quality of life. Continued research and evolving therapeutic modalities will further refine acne management, reinforcing the importance of evidence-based practice in both dermatological and aesthetic settings.

References

[1] Reynolds RV, Yeung H, Cheng CE, Cook-Bolden F, Desai SR, Drub KM, Freeman EE, Keri JE, Stein Gold LF, Tan JKL, Tollefson MM, Weiss JS, Wu PA, Zaenglein AL, Han JM, Barbieri JS. Guidelines of care for the management of acne vulgaris. J Am Accad Dermatol. 2024;90(5):1006.e1–1006.e30.
[2] Handog EB, Datuin MS, Singson IA. Chemical peels for acne and acne scars in Asians: evidence-based review. J Cutané Aesthet Surg. 2012 ;5(4) :239–246.
[3] Kaufman BP, Aman T, Alexis AF. Post inflammatory hyperpigmentation: epidemiology, clinical presentation, pathogenesis, and treatment. Am J Clin Dermatol. 2018;19(4):489–503.
[4] Adalatkhah H, Sadeghi Bazargani H. The association between melasma and post inflammatory hyperpigmentation in acne patients. Iran Red Crescent Med J. 2013;15(5):400–403.
[5] Hazarika N, Archana M. The psychosocial impact of acne vulgaris. Indian J Dermatol. 2016;61(5):515–520.
[6] Thomas J, Parthasarathi A, et al. Consensus on management of acne-induced post-inflammatory hyperpigmentation: an Indian perspective. Int J Res Dermatol. 2021;7(1). doi:10.18203/issn.2455-4529.IntJResDermatol20205923

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