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Chemical Peels in Anti-Age Therapy

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ABSTRACT

Against the backdrop of the dynamic expansion of the aesthetic medicine segment, chemical peels retain their status as a fundamental tool in anti-aging therapy. The aim of this study is to systematically summarize the scientific literature, assessing the clinical efficacy, mechanisms of action, and safety profile of chemical peels, with an emphasis on their combination with mesotherapy for the correction of age-associated skin changes. A systematic review and comparative analysis of peer-reviewed clinical studies, meta-analyses, and industry reports indexed in Scopus, Web of Science, and PubMed over recent years was conducted. The results confirm the significant efficacy of alpha hydroxy acids (AHAs) and trichloroacetic acid (TCA) monotherapy in smoothing skin texture, reducing the appearance of wrinkles, and correcting discolorations. A key finding is the demonstrated synergy between peels and mesotherapy: clinical trials have documented a statistically significant superiority of the combined protocols compared to monotherapy in terms of skin hydration, elasticity, and overall skin quality. The comprehensive effect achieved by combining chemical peels and mesotherapy encompasses both epidermal and dermal structures, providing a more pronounced and lasting clinical effect. These data support the hypothesis and highlight the high practical significance of this approach. The presented materials are intended for dermatologists, cosmetologists, and aesthetic medicine specialists focused on optimizing anti-aging protocols.

KEYWORDS

chemical peeling, anti-age therapy, photoaging, skin rejuvenation, trichloroacetic acid, glycolic acid, combination therapy, mesotherapy, neocollagenesis, dermatocosmetology.

Introduction

Modern aesthetic medicine has entered a phase of rapid, nearly exponential expansion. According to industry analytical reports, by 2024 the global market was valued at approximately USD 90 billion, while the projected compound annual growth rate is expected to exceed 10% through 2033 [1]. This momentum is driven by demographic shifts, above all the growing proportion of older adults, together with a pronounced sociocultural preference for minimally invasive interventions that preserve a natural-looking result while imposing only a minimal rehabilitation burden [4]. Against this background, chemical peels (chemoexfoliation) continue to serve as one of the cornerstone technologies of anti-aging therapy, combining proven clinical efficacy, a broad range of indications, and a comparatively low economic barrier to access [2, 3].

Despite the substantial body of evidence confirming the effectiveness of chemical peels as a stand-alone strategy for correcting the signs of photoaging and chronoaging [8], an important methodological gap remains within the current scientific discourse. Specifically, there is still no rigorously systematized assessment of the role of peels within long-term comprehensive rejuvenation programs.

The evidentiary base concerning the synergistic effects and clinical outcomes of combining chemoexfoliation with injectable methods of dermal biostimulation, including mesotherapy, remains especially underdeveloped. In many cases, studies examine these technologies separately, which does not reflect real-world clinical practice, where combined protocols predominate.

The aim of this study is to systematically synthesize data from the scientific literature and to evaluate the clinical efficacy, mechanisms of action, and safety profile of chemical peels, with particular emphasis on their combination with mesotherapy for the correction of age-associated skin changes.

The scientific novelty of the study lies in the targeted synthesis and structuring of evidence concerning the synergistic effect of combining chemical exfoliation with intradermal biostimulation in skin rejuvenation.

The author's hypothesis is formulated as follows: comprehensive treatment regimens, in particular the sequential use of chemical peels and mesotherapy, provide a statistically significant advantage in improving the key biomarkers of skin aging—hydration, elasticity, and microrelief—compared with peel monotherapy and therefore represent a more advanced and clinically effective strategy.

Materials and Methods

The present study was conducted within the framework of a systematic literature review. The analytical strategy included the critical appraisal and integration of empirical data extracted from published clinical trials, meta-analyses, systematic reviews, and authoritative industry reports. A comparative analysis was used to contrast the efficacy and safety profiles of different peeling agents, as well as various therapeutic approaches.

The source base was assembled through a targeted search of the international scientometric databases Scopus, Web of Science (WoS), PubMed/MEDLINE, and the Google Scholar search engine. The key search terms in Russian and English included "chemical peel," "anti-aging therapy," "photoaging," "mesotherapy," "combination therapy," "glycolic acid," and "trichloroacetic acid."

Results and Discussion

Skin aging is multifactorial in nature and is determined by both endogenous mechanisms (chronoaging) and exogenous influences, among which photoaging is dominant. Histologically, this process is associated with thinning of the epidermis and destruction of collagen and elastin fibers in the dermis, which clinically manifests as reduced tissue firmness and elasticity, as well as disturbances in pigmentation (dyschromia) [18]. Chemical peels address these changes through precisely dosed chemical injury at a predetermined depth, thereby initiating regenerative cascades followed by tissue remodeling [7].

The pharmacodynamics and classification principles of peels are determined by the depth of their action. Superficial techniques, including alpha-hydroxy acids and low concentrations of TCA, are confined to the epidermis: they disrupt desmosomal contacts between corneocytes, accelerate their shedding, and thereby lead to evening of skin microrelief and tone, while also enhancing epidermal renewal [9]. Medium-depth peels, such as TCA at 35–50%, reach the papillary dermis, inducing epidermolysis and controlled inflammation, which activates fibroblasts and stimulates neocollagenesis together with remodeling of the dermal matrix; the key mechanism of TCA is keratocoagulation (protein denaturation), visualized by the "frost" phenomenon [12]. Deep peels based on phenol-croton oil formulations extend into the reticular dermis and provide the most pronounced regenerative response; however, their contemporary use is limited by the high incidence of complications, and modern formulations have been modified toward lower concentrations of active components [21].

In anti-aging practice, the following classes of agents are most widely used. Alpha-hydroxy acids (AHAs)—water-soluble acids such as glycolic acid (GA) and lactic acid (LA)—remain among the most effective agents for superficial intervention: they increase epidermal thickness, enhance the synthesis of collagen and hyaluronic acid, improve hydration, and reduce the severity of fine wrinkles [10]. Their effect depends on both the concentration and the pH of the formulation [22]. Beta-hydroxy acids (BHAs), primarily salicylic acid (SA), penetrate the pilosebaceous unit because of their lipophilicity, which makes them preferable for oily skin; within an anti-aging framework, they contribute to dermal thickening and exert anti-inflammatory effects [11]. Trichloroacetic acid (TCA) is a versatile agent with dose-dependent depth of action (10–25% for superficial, 30–50% for medium-depth peeling) [18], and is used

effectively for the correction of pronounced wrinkles, scar-related changes, and manifest photoaging [12].

To systematize the data on the key agents, a comparative summary is presented in Table 1.

Table 1. Comparative characteristics of the main peeling agents in anti-aging therapy (compiled by the author based on [10, 12, 18, 22]).

Agent	Acid Type	Solubility	Depth of Penetration	Primary Mechanism of Action	Key Anti-Aging Indications	Advantages	Limitations
Glycolic acid	AHA	Water-soluble	Superficial	Disruption of desmosomes; stimulation of fibroblasts	Fine wrinkles, dull complexion, loss of tone, mild photoaging	Favorable safety profile; improves hydration	Requires a course of procedures; may cause irritation
Lactic acid	AHA	Water-soluble	Very superficial	Exfoliation; hydration (a component of the natural moisturizing factor, NMF)	Dry, sensitive skin with early signs of aging	Gentle action; pronounced moisturizing effect	Less pronounced stimulatory effect than GA
Salicylic acid	BHA	Lipid-soluble	Superficial (intrafollicular)	Keratolytic, comedolytic, anti-inflammatory	Adult acne, photoaging in oily skin, enlarged pores	Effective for oily, porous skin	May cause dryness; risk of salicylism with extensive application
Trichloroacetic acid	—	Water-soluble	Superficial to medium-depth	Keratocoagulation; potent stimulation of neocollagenesis	Moderate to deep wrinkles, pronounced photoaging, post-acne scars	High efficacy; visible results after 1–2 procedures	Requires a recovery period; higher risk of complications, including post-inflammatory hyperpigmentation (PIH)

The evidence base for chemical peel monotherapy remains substantial and methodologically diverse. Systematic reviews show that trichloroacetic acid (TCA) significantly improves the clinical signs of photodamage, reducing wrinkle severity and manifestations of solar elastosis; low concentrations are optimal for correcting superficial defects, whereas medium-depth applications act as a powerful tool for dermal remodeling [12]. High patient satisfaction with TCA procedures has also been reported, further confirming their clinical significance in real-world practice [25].

Alpha-hydroxy acids (AHAs) demonstrate a comparably pronounced effect on skin quality: they improve

microrelief, reduce superficial wrinkles, and even out skin tone through the induction of collagenogenesis. In one study, 21 days of using AHA-containing products resulted in a 32.5% reduction in wrinkle depth and a 42.9% reduction in roughness [27].

Direct comparisons clarify the clinical differences between agents. In one study, 70% glycolic acid (GA) and 15% TCA both proved effective in photoaging treatment; however, GA produced a faster and more pronounced increase in skin hydration, whereas TCA was associated with more marked erythema [13]. Another study found that the use of 35% GA and 15% TCA in the treatment of melasma—one of the clinical manifestations of photoaging—revealed no statistically significant difference in final efficacy, but a higher frequency of discomfort, including burning and post-peel fissuring, was recorded in the TCA group [28]. Patients treated with GA more often reported improvements in skin radiance and texture [14].

These observations converge on a key practical conclusion: the clinician is inevitably required to balance efficacy against tolerability. Although superficial-to-medium peels often produce comparable objective outcomes, the profile of adverse events and the patient's subjective assessment may differ substantially. Procedures associated with pronounced discomfort and prolonged recovery reduce adherence and willingness to complete the treatment course. For patients seeking maximal remodeling intensity and willing to accept the need for recovery, TCA appears to be a rational choice. For those who seek to minimize social and professional downtime, a course of GA peels is more preferable. This clinical trade-off became one of the drivers behind the development of combination protocols designed to achieve effects approaching those of TCA while preserving the tolerability more typical of AHA-based regimens. Figure 1 illustrates the dynamics of skin improvement associated with both approaches.

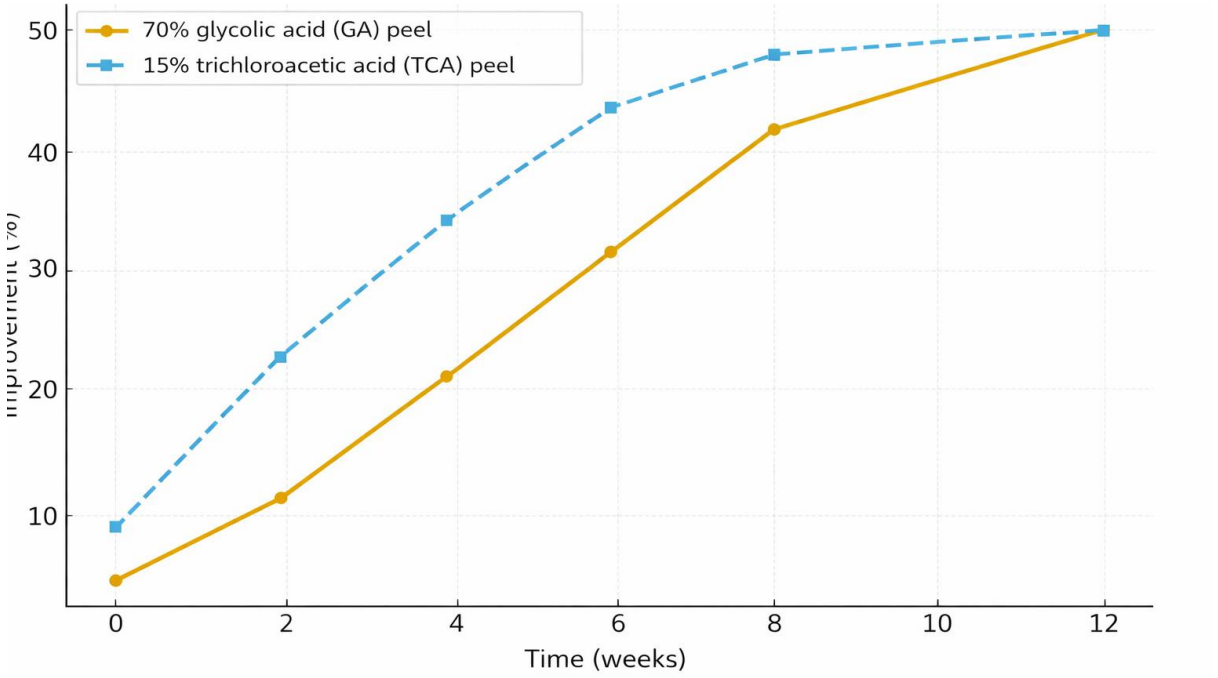

Fig. 1. Dynamics of improvement of objective parameters of skin photoaging (compiled by the author based on [13, 14]).

The core postulate of combination-based techniques is synergy. Mesotherapy and microneedling create microchannels in the skin, substantially increasing transepidermal delivery and, consequently, the pharmacodynamic effect of sequentially applied actives, including peeling acids [15]. At the same time, both technologies act as autonomous inducers of neocollagenesis: peeling through a controlled chemically induced inflammatory response, and mesotherapy through mechanical microtrauma together with the targeted delivery of biostimulating substances. Their combined use produces a cumulative effect of dermal remodeling [24, 26].

The clinical validation of this synergy is compelling. In the study reported in source [15], peeling was compared in 20 women aged 40–65 years: one half of the face received a peel containing 20% azelaic acid plus 40%

vitamin C, whereas the other half received the same peel with a lower concentration of vitamin C (10%) delivered by microneedling mesotherapy [15]. Both approaches proved effective; however, the side treated with combination therapy demonstrated statistically more pronounced gains in skin hydration ($p = 0.002$ for the forehead; $p = 0.001$ for the cheek) and elasticity ($p < 0.05$). Subjective satisfaction in terms of wrinkle smoothing, increased firmness, and improved moisturization was also higher with the combined protocol [15]. Similar conclusions were reported in a series of clinical observations: the combination of 15% TCA with the mesotherapeutic formulation NCTF® 135HA showed superiority over TCA monotherapy in hydration, uniformity of skin texture, and reduction of ptosis [17].

Taken together, these findings reflect a broader shift in paradigm—from superficial "renewal" to genuine rejuvenation. Peeling reshapes the epidermis and the upper dermal layers, whereas mesotherapy delivers bioactive molecules, including hyaluronic acid, vitamins, and amino acids, directly into the dermis, thereby supporting the functional activity of fibroblasts and the extracellular matrix [19, 20]. Their combination provides a multilevel response: peeling optimizes the barrier and enhances penetration, while mesotherapy nourishes and stimulates the deeper dermal structures that determine firmness, hydration, and elasticity. As a result, chemical peeling ceases to be merely an autonomous exfoliative procedure and becomes a catalyst of dermal biorevitalization.

A clinical example may further illustrate this point: the study group consisted of patients older than 30 years with a history of problematic skin who, over the course of one year, underwent a combined therapy program including combined cleansing procedures, peels, and mesotherapy. After remission had been achieved and skin quality had improved, the protocol was shifted to a maintenance anti-aging regimen that has been applied successfully for more than 10 years.

This example illustrates the evolution of treatment strategy in accordance with the patient's changing needs.

Phase 1 (Therapeutic): The use of peels to control inflammation and hyperkeratosis, consistent with their comedolytic and keratolytic effects [11].

Phase 2 (Restructuring and Rejuvenation): The addition of mesotherapy to the peeling protocol for the correction of post-inflammatory changes, including dyschromia and atrophy, and for the initiation of true rejuvenation through stimulation of collagenogenesis and improvement of dermal quality; these effects are supported by clinical data [15].

Phase 3 (Maintenance): The long-term use of the combination (more than 10 years) as maintenance therapy confirms its safety and sustained effectiveness as an anti-aging strategy, underscoring that the objective of modern cosmetology is not a one-time intervention but rather long-term patient management focused on preserving skin health and youthfulness.

Figure 2 visualizes the quantitative superiority of combination therapy in the gain of skin elasticity.

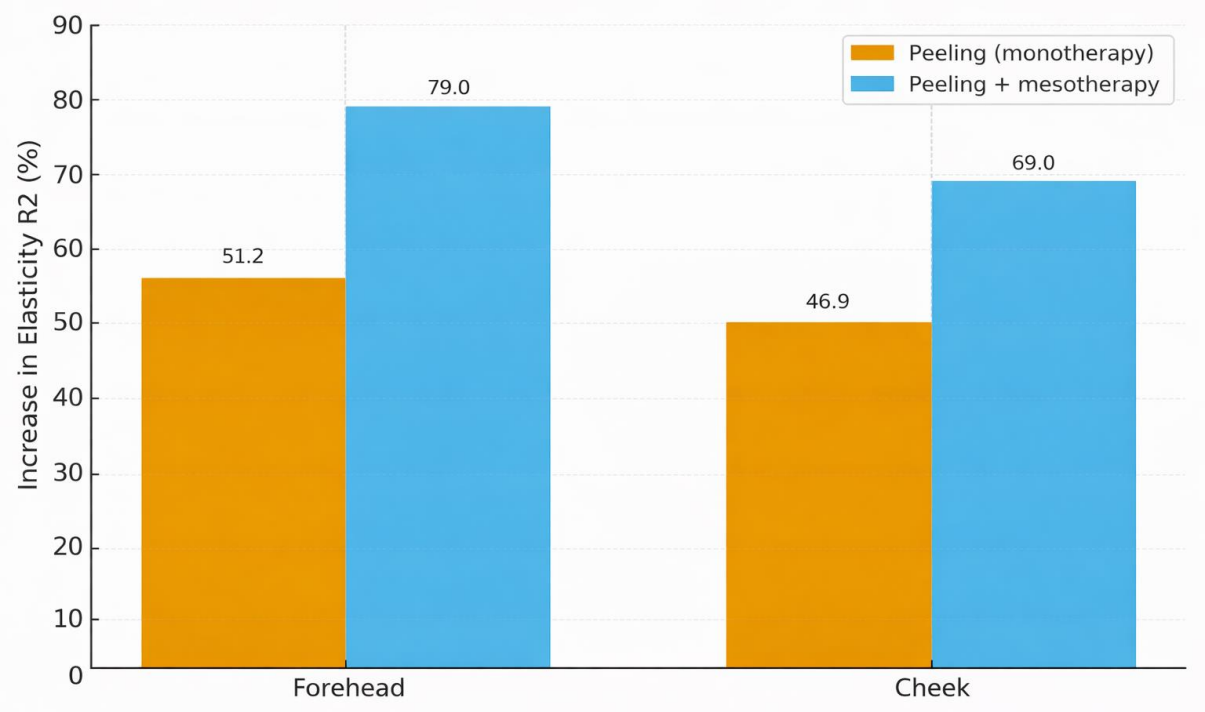

Fig. 2. Comparative improvement in skin elasticity (R2) with mono- and combination therapy (compiled based on the author's data and source [15]).

The safety profile of chemical peels is determined primarily by the depth of the induced tissue injury: the deeper the exposure, the greater the potential frequency and severity of adverse events [5, 16].

Expected reactions (superficial and medium-depth peels): transient erythema, burning sensation, pruritus, edema, as well as fine or large lamellar desquamation, are regarded as physiologic and predictable consequences of the procedure and generally do not require specific correction [25].

The most likely complication is post-inflammatory hyperpigmentation (PIH), particularly in patients with higher Fitzpatrick phototypes [18]. Scarring, secondary bacterial or herpetic infection, and persistent textural abnormalities are also possible, although, with proper technique, they occur relatively infrequently.

The key to risk minimization lies in strict adherence to the standard protocol, which may be most appropriately structured as a stepwise algorithm:

1. Patient selection: individuals with active infectious processes, a predisposition to keloid formation, or unrealistic expectations regarding outcomes should be excluded.
2. Pre-peel preparation ("priming"): the use of topical retinoids or AHAs for 2–4 weeks before the procedure is considered essential in order to equalize penetration of the peeling agent and substantially reduce the likelihood of complications [23].
3. Procedure technique: meticulous degreasing of the skin, uniform application of the formulation, strict control of the endpoint, and timely neutralization where indicated are all of critical importance.
4. Post-peel care: patients should be instructed in advance regarding strict photoprotection (SPF 50+) and the use of gentle cleansing and regenerative skin-care products.

Overall patient satisfaction with the results of chemical peels remains high. Systematic reviews indicate that most patients evaluate the cosmetic effect after a course of TCA peels positively [18]. On one consumer-oriented resource, the "Worth It" rate reaches 87%, which is consistent with clinical observations [15]. The key determinant of satisfaction is the balance between efficacy and tolerability described above. Combination protocols that enhance outcomes without materially prolonging rehabilitation logically increase satisfaction: the patient receives a pronounced effect together with good procedural tolerability.

Conclusion

The systematic analysis conducted confirms that chemical peels retain their status as an effective and pathogenetically substantiated tool in anti-aging therapy. Agents such as trichloroacetic acid and glycolic acid possess a substantial evidence base demonstrating improvement in the key markers of photoaging and chronoaging, including skin texture, wrinkle depth, and the severity of dyschromia. The principal conclusion is consistent with the original hypothesis: the combination of chemical peels with mesotherapy surpasses monotherapy, producing a synergistic effect. Contemporary clinical data show a statistically significant and more pronounced improvement in the fundamental parameters of skin quality, including hydration and elasticity.

The practical significance of these findings lies in the correction of the clinical paradigm itself: peeling should be regarded not as an isolated procedure of superficial renewal, but as an integral component of comprehensive biorevitalization programs. The inclusion of peeling as a stage that prepares the skin and enhances the penetration of active components in mesotherapeutic cocktails ensures a multilevel effect on both epidermal and dermal structures. This approach, supported in part by long-term clinical observation, makes it possible to achieve more personalized, more pronounced, and, critically, more durable anti-aging outcomes, thereby meeting the contemporary patient demand for high efficacy while preserving a natural appearance.

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