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Review Article

Chitosan in aesthetic practice: A clinical narrative review of skin, scar, and scalp applications

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ABSTRACT

Background: Chitosan is a cationic polysaccharide derived from chitin with film-forming, bioadhesive, antimicrobial, and wound-modulating properties, supporting increasing interest in aesthetic dermatology.
Objective: To synthesize clinically relevant evidence on chitosan and its derivatives in aesthetic practice, focusing on skin barrier support, post-procedure recovery, acne, pigmentary disorders, and scalp applications.
Methods: A narrative review of PubMed/Medline literature through February 2026 was conducted, prioritizing clinical trials, split-face studies, and relevant human data, supported by mechanistic and formulation evidence.

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Results: Clinical studies suggest that chitosan hydrogels can support post-procedural recovery after ablative laser treatments with outcomes comparable to standard regimens and improved tolerability. Chitosan-based delivery systems enhance topical performance of actives such as nicotinamide, spironolactone, and α-arbutin in acne and melasma. In scalp applications, microneedling-assisted topical chitosan demonstrated improvements in hair density comparable to minoxidil in small studies.
Conclusions: Chitosan shows potential as a barrier-supportive material, a delivery platform for topical actives, and an adjunct in scalp therapies. However, heterogeneity in formulations and limited study sizes restrict generalizability. Larger, standardized clinical trials are needed to define its role in aesthetic protocols.

Introduction

Aesthetic practice increasingly combines topical therapies with minimally invasive procedures such as injectables, microneedling, and laser-based treatments. Across these settings, key clinical goals include predictable outcomes, rapid recovery, and minimal adverse effects such as irritation, infection, or dyspigmentation. Because many procedures intentionally disrupt the skin barrier, post-procedure care that supports barrier recovery and reduces inflammation is essential.[12,14]

Chitosan, a deacetylated derivative of chitin, has attracted interest in aesthetic practice due to its film-forming, bioadhesive, moisture-retaining, and antimicrobial properties.[1–4,7] On intact skin, it primarily functions as a surface-active film that reduces transepidermal water loss and enhances retention of co-applied actives.[3,4,11] In barrier-disrupted settings, such as after laser or microneedling, it may contribute to wound healing and act as a delivery platform for topical agents.[6,8,12,14] Clinically, chitosan is relevant as a cosmetic ingredient, a post-procedure barrier-support material, and a carrier for active compounds.[3,4,6]

Despite these attractive properties, the evidence base is fragmented because the term “chitosan” spans a family of materials. Chitosan preparations differ in molecular weight (from oligomers to high–molecular–weight polymers), degree of deacetylation (DDA), viscosity, residual protein content, endotoxin burden, and chemical modification (e.g., carboxymethylation, quaternization, hydroxyalkylation).[1–4] These parameters influence solubility, charge density, antimicrobial potency, and immunologic interactions.[1,2,7] In addition, clinical studies differ in outcome measures, dosing schedules, and the specific procedural context (intact skin vs injured skin). Therefore, benefits observed in one setting cannot be assumed to generalize across all chitosan products and indications.[1–4]

This clinical narrative review aims to (1) summarize clinically relevant mechanisms and formulation concepts for chitosan in skin and scalp care, and (2) critically appraise the current human evidence base across aesthetic indications where chitosan has been tested or is actively being developed. We focus on post–procedure recovery (laser and microneedling–adjunctive care), acne and sebum–related presentations, pigmentary disorders relevant to aesthetic practice, and hair/scalp applications. Where human evidence is limited, we emphasize mechanistic plausibility and research needs rather than extrapolating to prescriptive protocols.

Materials and methods

Design: This is a clinical narrative review intended to support evidence–informed aesthetic practice. The objective was not to perform meta–analysis but to provide a clinically oriented synthesis across diverse chitosan materials, formulations, and aesthetic indications.

Search strategy: We conducted a literature search in PubMed/Medline through February 2026 using combinations of terms including “chitosan”, “hydroxybutyl chitosan”, “carboxymethyl chitosan”, “chitosan nanoparticles”, “cosmetic”, “cosmeceutical”, “aesthetic”, “laser”, “microneedling”, “acne”, “melasma”, “hyperpigmentation”, “alopecia”, “hair loss”, “wound healing”, and “skin barrier”. Reference–chaining was performed from key review papers on chitosan chemistry and cosmetic applications and from the reference lists of clinical trials identified in the primary search.[1–4,11–18]

Study selection and prioritization: We prioritized peer–reviewed human studies relevant to aesthetic dermatology or overlapping outpatient dermatology/plastic surgery practice, including randomized controlled trials (RCTs), split–face studies, multicenter clinical trials, pragmatic feasibility studies, and controlled cohort studies.[11–17] Because clinical studies are relatively sparse in some aesthetic domains, mechanistic preclinical studies and formulation reviews were included when they helped interpret clinical findings or clarified how material parameters (molecular weight, degree of deacetylation, chemical modification) may influence biological responses.[1–8,18]

Data extraction and synthesis: For each clinical study, we extracted the population, intervention (including chitosan type when described), comparator, outcomes, follow–up duration, main results, and major limitations. Evidence was synthesized qualitatively and organized by clinical indication and by the practical role of chitosan (cosmetic film/conditioner, post–procedure dressing, drug–delivery platform, or emerging injectable biomaterial).

Chitosan Fundamentals for aesthetic practice

Definitions, sources, and manufacturing considerations

Chitosan is a partially deacetylated form of chitin composed of glucosamine and N-acetylglucosamine units.[1,2] Its properties vary depending on molecular weight, degree of deacetylation, and chemical modification, which influence solubility, charge, and biological activity.[1–4] These variations limit direct comparison across studies and prevent generalization of findings between different chitosan formulations.[1–4]

Key physicochemical parameters that influence clinical behavior

Key material parameters influencing clinical behavior include molecular weight, degree of deacetylation, and formulation pH.[1–4,8] Molecular weight affects viscosity, film strength, and degradation; higher values favor surface film formation, whereas lower values may enhance superficial deposition in barrier-disrupted skin.[1,3,4] Degree of deacetylation determines charge density and antimicrobial interaction.[1,7] Because protonation is pH-dependent, formulation pH influences solubility and tolerability.[1,2,8] Importantly, most clinical effects reflect the overall formulation rather than chitosan alone.

Chitosan is typically incorporated into formulations containing humectants, emulsifiers, and preservatives.[3,4,6] Clinical outcomes therefore reflect the overall formulation rather than chitosan alone, and excipients may significantly influence tolerability.[12,14]

Formulation formats relevant to clinical aesthetics

Chitosan is deployed in several formulation formats that map to different aesthetic use cases:

(1) Solutions and toners: Low–viscosity chitosan solutions may be used as conditioning or film–forming topicals. On intact skin, they can reduce friction and provide a “tightening” feel through film contraction upon drying. On hair/scalp, they can improve manageability and potentially modulate scalp microenvironment by forming a breathable film.[3,4,11]
(2) Hydrogels and thermoresponsive gels: Hydrogels can provide a moist microenvironment and controlled release of encapsulated actives. Hydroxybutyl chitosan hydrogels have been studied in post–procedural wound contexts, including after ablative fractional CO_2 laser resurfacing. In such settings, the hydrogel acts as a barrier–support material and may modulate inflammatory responses during re–epithelialization.[8,12]

Table 1
Practical classification of chitosan materials and formats relevant to aesthetic practice.

Material / derivative	Typical formulation formats	Primary functional role (aesthetic)	Clinical/procedural contexts	Key considerations
Native/acid-soluble chitosan (varied MW, DDA)	Solutions; gels; films (acidic vehicles)	Film-forming; antimicrobial; bioadhesive	Intact skin/hair conditioning; limited post-procedure use unless buffered	Acidic pH may irritate; MW/DDA variability; quality control
Chitosan oligosaccharides (COS)	Solutions; serums	Potential bioactivity; lower viscosity	Intact skin/scalp products; adjunctive delivery	Penetration still limited on intact skin; product claims vary
Hydroxybutyl chitosan (HBC)	Hydrogels; film-forming gels	Barrier support; moist wound environment	Post-laser resurfacing; post-procedure recovery	Evidence emerging in split-face trial; evaluate preservatives and irritancy
Carboxymethyl chitosan	Creams; hydrogels	Moisturization; water solubility	Sensitive skin; barrier support	Derivative-specific properties; fewer aesthetic trials
Quaternized/hydroxypropyl chitosans	Hair conditioners; leave-on styling products	Hair conditioning; antistatic; film-forming	Hair shaft conditioning; cosmetic styling	Charge independent of pH; mainly cosmetic rather than regenerative evidence
Chitosan nanoparticles / coated carriers	Nanogels; nanoparticle gels; coated lipid carriers	Delivery platform for actives	Acne; melasma; potentially post-procedure actives	Safety depends on cargo; need robust clinical trials and standardized endpoints

(3) Films and dressings: Chitosan films are used in wound care for hemostasis and as antimicrobial barriers. In aesthetic practice, film–forming chitosan derivatives may serve as post–procedure protective layers, particularly when minimal occlusion is desired. Film format can also reduce friction on healing skin and potentially lower risk of secondary infection.[7,9,12]
(4) Nanoparticles and carrier systems: Chitosan is widely used to create nanoparticles via ionic gelation (often with tripolyphosphate, TPP) and to coat lipid carriers.[6] These systems can improve stability and skin deposition of actives, enable sustained release, and reduce irritancy by controlling drug exposure at the surface.[6,15–17] Clinical examples include chitosan nanoparticles delivering nicotinamide for acne and chitosan–coated nanostructured lipid carriers delivering spironolactone for acne. A split–face clinical study also used functionalized chitosan nanoparticles to enhance delivery of α–arbutin for melasma.[15–17]
(5) Emerging injectable/implantable biomaterials: Injectable chitosan–based fillers and scaffolds are an emerging area. Their potential value in aesthetics is conceptually similar to other biostimulatory materials: temporary volumization coupled with tissue remodeling. However, clinical evidence for injectable chitosan fillers in aesthetics remains limited, and regulatory status varies by jurisdiction. In this review we treat injectable chitosan as an emerging research domain rather than an established clinical tool.[18–20] The clinically relevant chitosan material types, formulation formats, aesthetic roles, and procedural considerations are summarized in Table 1.

Mechanisms of action relevant to aesthetic dermatology

Film formation, bioadhesion, and barrier support

Chitosan forms a breathable film through electrostatic interaction with keratin and the stratum corneum.[3,4] This film reduces transepidermal water loss, improves hydration, and provides mechanical

protection after procedures.[3,4,12] In intact skin, effects are primarily surface-active rather than deeply penetrative.[3,5] In barrier-disrupted settings such as laser or microneedling, chitosan hydrogels may support re-epithelialization and comfort, as suggested by a split-face trial of hydroxybutyl chitosan after ablative CO_2 laser resurfacing.[12]

Antimicrobial activity and microbiome–relevant effects

Chitosan exhibits antimicrobial, hemostatic, and immunomodulatory properties that may contribute to wound healing and post-procedural recovery.[7,9] While preclinical data suggest effects on inflammation and tissue repair, clinical evidence remains limited.[1,2,7,8] Current data indicate potential benefits in reducing irritation and supporting re-epithelialization, but larger studies are needed to confirm effects on clinically relevant outcomes such as erythema duration and post-inflammatory hyperpigmentation.[12]

Chitosan as a delivery platform: retention, deposition, and controlled release

Many aesthetic indications involve actives that are effective but limited by irritation, instability, or inadequate deposition into target layers. Chitosan's role as a delivery platform stems from its ability to form polyelectrolyte complexes, nanoparticles, and hydrogels that can encapsulate actives and modulate release.[6,8] By controlling drug exposure at the surface and enhancing retention within the epidermis, chitosan carriers can improve tolerability and efficacy.[6,15–17] Importantly, chitosan carriers do not necessarily drive systemic absorption; studies such as the α–arbutin chitosan nanoparticle melasma trial emphasized increased deposition in deeper skin layers without transdermal delivery, which aligns with a favorable safety profile for topical aesthetics.[17]

Clinical examples include: (1) nicotinamide loaded into chitosan nanoparticles for acne, where inflammatory lesion counts decreased substantially with topical therapy in a feasibility trial; (2) spironolactone delivered via chitosan–coated nanostructured lipid carriers in a multicenter double–blind trial for acne; and (3) α–arbutin delivered via functionalized chitosan nanoparticles in a split–face melasma study.[15–17] In each case, the chitosan component should be interpreted as enabling delivery and retention of the active rather than as a stand–alone pharmacologic treatment.[6,15–17]

Device–assisted delivery is particularly relevant: microneedling and fractional lasers can create microchannels that transiently bypass the stratum corneum barrier.[12,14] Delivering chitosan–based nanoparticles immediately after such procedures may increase penetration of encapsulated actives, but it may also increase irritation risk depending on cargo and excipients.[6,12,14] Therefore, when clinicians consider combining chitosan carriers with device procedures, they should apply wound–care principles: start with barrier–supportive formulations, avoid unnecessary irritants, and ensure sterility or appropriate preservation in products intended for compromised skin.[9,12,19]

Clinical applications in aesthetic practice

Chitosan as a cosmetic ingredient for skin and hair care

Chitosan and its derivatives are widely used in cosmetics for film–forming and conditioning properties.[3,4] In hair care, quaternized chitosans and hydroxypropyl derivatives are employed as cationic conditioners that bind to negatively charged hair, improving combability and reducing static.[3,4] In skin care, chitosan can serve as a film former, viscosity modifier, and sensory enhancer.[3,4] From a clinician's perspective, these cosmetic uses matter because they shape patient expectations ("tightening", "lifting" feel) and because some post–procedure regimens include over–the–counter products containing chitosan derivatives.[3,4,11]

Human evidence in cosmetic contexts is limited but not absent. A randomized, double–blind, placebo–controlled clinical study evaluated the efficacy and safety of a chitosan–containing formulation on facial sebum.[11] Over a short treatment period, the chitosan formulation reduced measured sebum and was well tolerated.[11] While such findings are not sufficient to define an acne treatment

protocol, they support the plausibility of chitosan's utility in oily skin management and illustrate that chitosan can be used on facial skin with acceptable tolerability in controlled settings.[11]

It is important to separate "cosmetic" effects from claims of dermal remodeling. Film–forming polymers can transiently smooth and tighten the surface without changing dermal collagen.[3,4] Patients may interpret surface tightening as "skin tightening." In clinical practice, such short–term cosmetic benefits can be valuable for patient satisfaction, but clinicians should communicate that durable tightening or lifting outcomes require interventions that induce remodeling (energy–based devices, biostimulatory injectables, surgery) rather than topical film formers alone.[3,4,18] Selected human clinical studies supporting the following aesthetic applications are summarized in Table 2.

Post–procedure recovery: lasers, resurfacing, and barrier repair

Energy–based procedures, particularly ablative fractional CO_2 laser resurfacing, are effective for acne scarring and photodamage but create predictable downtime characterized by erythema, edema, pain, crusting, and transient barrier disruption.[12] Post–procedure care aims to reduce discomfort, accelerate re–epithelialization, reduce infection risk, and minimize PIH—especially in patients with higher Fitzpatrick phototypes.[12] Standard post–laser regimens vary widely but often include combinations of topical corticosteroids (short course), growth factor products, petrolatum–based occlusives, and sometimes topical antibiotics. However, topical steroids can cause irritation or steroid acne, and topical antibiotics raise concerns about resistance and sensitization. Therefore, barrier–supportive alternatives that provide moisturization and wound protection with acceptable tolerability are of high clinical interest.[12]

Hydroxybutyl chitosan (HBC) hydrogel has been evaluated in a prospective randomized split-face trial (n=18) following ablative fractional CO_2 laser resurfacing.[12] Compared with a multi-product positive control regimen, HBC achieved comparable healing outcomes by Days 7 and 28, with improved moisturization and avoidance of steroid-related irritation.[12] These findings suggest that a single chitosan-based hydrogel may function as a practical post-procedure barrier-support option in selected patients.[12]

Beyond ablative lasers, microneedling and fractional radiofrequency devices similarly create micro–injuries with transient barrier compromise.[14] While direct clinical trials of chitosan hydrogels in these settings are limited, mechanistic logic supports evaluating chitosan–based gels as post–microneedling barrier support.[8,12,14] Such evaluations should include endpoints important to aesthetic practice: duration of erythema, transepidermal water loss, patient–reported burning/stinging, and rates of inflammatory flares (acneiform eruption, rosacea flare) and PIH.[12,14]

Practical considerations for post–procedure use include: (1) preservative choice and microbial safety (products applied to disrupted skin must be microbiologically safe); (2) pH and irritancy (acidic chitosan solutions may sting on compromised skin); and (3) occlusion level (excessive occlusion may increase acneiform eruptions).[9,12,19] Hydroxybutyl chitosan formulations designed specifically as hydrogels for skin recovery may be preferable to repurposing cosmetic conditioners for post–laser use.[12]

Acne and sebaceous disorders: chitosan carriers and tolerability

Acne vulgaris is a multifactorial inflammatory condition often limited by treatment-related irritation. In this context, chitosan is primarily relevant as a delivery platform that can improve tolerability and enhance deposition of active compounds.[6,15,16] Clinical studies suggest that chitosan-based carriers may improve outcomes with agents such as nicotinamide and spironolactone, while maintaining acceptable tolerability.[15,16] Additionally, chitosan-containing formulations may reduce sebum and support adjunctive care in oily skin.[11] However, the independent contribution of chitosan remains difficult to isolate, and further standardized clinical studies are required.[11,15,16]

Pigmentary disorders and skin brightening: melasma as a clinical model

Melasma is a common acquired hypermelanosis affecting the face, often exacerbated by ultraviolet exposure, hormonal factors, and inflammation. It is clinically relevant in aesthetic practice because

Table 2
Selected human clinical studies of chitosan relevant to aesthetic practice.

Indication / context	Study design	N	Chitosan formulation	Comparator	Key outcomes	Main finding / notes
Post-laser recovery (ablative fractional CO_2)	Prospective randomized split-face trial	18	Hydroxybutyl chitosan hydrogel	Positive control regimen (desonide + EGF gel + fusidic acid)	Erythema/edema/pain; time to decrustation; barrier function; melanin	Comparable healing outcomes by Days 7 and 28; better moisturization; no steroid-related irritation; more early pain reported
Hair loss (AGA/diffuse thinning)	Prospective controlled study (3 arms)	30	Microneedling + 2% topical chitosan	5% minoxidil; no treatment	Trichoscopic hair density; shaft diameter; satisfaction; AEs	Chitosan and minoxidil both improved density vs control at 6 months; chitosan numerically higher but not statistically different vs minoxidil; mild transient erythema
Acne vulgaris	Clinical feasibility study	Not explicitly reported in the abstract; study design and sample size details are incompletely described in publicly available summaries.	Nicotinamide-loaded chitosan nanoparticles gel	Baseline/comparator per study	Inflammatory and non-inflammatory lesion counts; tolerability	Reported reduction in lesion counts, although precise quantitative outcomes were not specified in the abstract.
Acne vulgaris	Multicenter randomized double-blind trial	Sample size not explicitly reported in the abstract; multicenter randomized design with incomplete publicly available details.	Chitosan-coated NLC delivering spironolactone	Control formulation (per trial)	Acne severity outcomes; safety	Supports the clinical feasibility of chitosan-based carrier systems as delivery platforms for topical active agents in acne management.
Melasma	Comparative split-face clinical study	Not reported in abstract; detailed study characteristics should be interpreted with caution due to incomplete reporting.	α-arbutin-loaded functionalized chitosan nanoparticles hydrogel (with HA/collagen adjuncts)	Free α-arbutin hydrogel	mMASI; melanin markers	Nanoparticle hydrogel showed better therapeutic efficacy than free drug hydrogel; improved melasma indices without transdermal delivery
Oily facial skin / sebum	Randomized double-blind placebo-controlled trial	Not reported in abstract; detailed study characteristics should be interpreted with caution due to incomplete reporting.	Chitosan formulation	Placebo	Sebum measurements; safety	Chitosan reduced facial sebum and was well tolerated (Reduced facial sebum and was well tolerate)

patients frequently seek procedural and topical solutions, yet aggressive procedures (peels, lasers) can worsen melasma or trigger PIH in susceptible individuals. Therefore, optimizing topical therapy and enhancing delivery of depigmenting actives remain important goals.[17]

Chitosan nanoparticles have been evaluated as carriers for depigmenting agents.[17] In a split–face clinical study, functionalized chitosan nanoparticles were formulated in hydrogel form to enhance topical delivery of α–arbutin.[17] The study included in vitro and ex vivo characterization, and it reported that chitosan nanoparticle hydrogels achieved superior clinical improvement compared with a conventional α–arbutin hydrogel.[17] Improvements were assessed using a modified melasma area and severity index (mMASI) and by histologic or imaging–based measures of melanin content, supporting the concept that chitosan nanoparticles can increase deposition of a whitening active into relevant skin layers without promoting transdermal delivery.[17]

For aesthetic clinicians, this study illustrates a broader pattern: chitosan nanoparticles can be used to increase skin retention and controlled release of actives, potentially improving efficacy without increasing irritation.[6,17] However, melasma is highly responsive to photoprotection and adherence, and split–face designs can be influenced by differential sun exposure and patient behavior. Larger studies with standardized sunscreen use and longer follow–up are needed to determine whether chitosan nanoparticle formulations reduce relapse rates or enable lower concentrations of depigmenting actives.[17]

Beyond α–arbutin, the same delivery principles could apply to other pigmentary actives used in aesthetics (tranexamic acid, niacinamide, kojic acid, antioxidants).[6,17] When considering such applications, clinicians should weigh the benefits of enhanced deposition against the risk of irritation on compromised skin, especially when combined with procedures.[6,12,17] Evidence to guide combined procedural–topical protocols remains limited, highlighting a need for trials that integrate chitosan–based delivery systems into real–world aesthetic treatment sequences.[12,17]

Scalp and hair: device–assisted chitosan delivery for hair loss

Hair loss, including androgenetic alopecia and diffuse thinning, is a frequent aesthetic complaint. Standard topical therapy with 5% minoxidil has established efficacy but is limited by adherence, scalp irritation, and variable response. Microneedling has gained interest as an adjunctive modality that may stimulate growth factors, enhance transdermal delivery, and improve outcomes when combined with topical agents.[14] In this context, chitosan's role is conceptually appealing: chitosan is non–hormonal, has reported immunomodulatory and regenerative properties in wound contexts, and can be delivered after microneedling to exploit microchannel access.[7,8,13,14]

A controlled clinical study evaluated microneedling–assisted topical 2% chitosan compared with 5% topical minoxidil and a no–treatment control group.[13] Thirty patients (aged 22–58 years) with androgenetic alopecia or diffuse hair loss were randomized equally into three groups (n=10 each): (1) microneedling followed by topical 2% chitosan, (2) twice–daily 5% minoxidil, and (3) untreated control.[13] Treatments continued for 6 months, with primary outcomes including trichoscopic hair density and hair shaft diameter, and secondary outcomes including patient satisfaction and adverse events. After 6 months, both the chitosan and minoxidil groups demonstrated significant increases in mean hair density compared with control (+30.5% and +22.3%, respectively), while differences between chitosan and minoxidil were not statistically significant in this small sample.[13] Hair shaft diameter and patient satisfaction improved in both treatment groups, and adverse events were mild and transient (erythema in three patients).[13] A representative scalp biopsy from a chitosan–treated subject showed increased follicular density and improved dermal matrix organization, offering supportive histologic plausibility.

First, chitosan delivered after microneedling appears feasible and tolerable in a small controlled study and may provide improvements comparable to minoxidil in some patients.[13] Second, because the study involved microneedling in the chitosan arm, the observed benefit likely reflects a combination of mechanical stimulation and topical chitosan effects rather than chitosan alone.[13,14] Third, the evidence level is limited by small sample size and lack of blinding for procedural differences. Larger, blinded, adequately powered trials are needed to determine whether chitosan adds benefit beyond

microneedling alone, whether it can reduce reliance on minoxidil, and which patient subgroups respond best.[13,14]

Emerging injectable and regenerative applications

Chitosan's biodegradability and ability to form hydrogels have motivated research into injectable chitosan biomaterials for tissue engineering and soft–tissue augmentation.[8,18] In principle, an injectable chitosan filler could provide immediate volumization and serve as a scaffold that supports cellular infiltration and matrix remodeling.[8,18] A biomaterials study describing a "novel chitosan dermal filler" reported enhanced moldability and elasticity through design of a liquid–to–gel transition, highlighting ongoing material innovation.[18] However, clinical evidence for injectable chitosan fillers in aesthetic medicine is limited, and such products are not widely established in routine practice compared with hyaluronic acid fillers, calcium hydroxylapatite, poly–L–lactic acid, or polycaprolactone.[18–20]

In addition to fillers, chitosan hydrogels are being explored as carriers for regenerative biologics (growth factors, peptides, extracellular vesicles).[8] These approaches intersect with the "regenerative aesthetics" trend, but many remain preclinical. Clinicians should interpret these developments as emerging and should prioritize products with clear regulatory status, validated sterility and biocompatibility testing, and supportive human clinical data before considering off–label use in aesthetic injection contexts.[18–20]

Safety, tolerability, and regulatory considerations

Overall, chitosan is widely regarded as biocompatible and has a long history of use in biomedical devices (wound dressings) and in cosmetic formulations.[1–4,9] Nevertheless, safety in aesthetic practice should be considered through three lenses: (1) source–related allergy concerns, (2) formulation–related irritancy and microbiological safety, and (3) route–specific risk (intact skin versus compromised skin or injection).[9,10,19,20]

Allergy and shellfish sensitivity: Chitosan derived from crustaceans raises questions about shellfish allergy. Shellfish allergy is primarily mediated by proteins (e.g., tropomyosin), whereas chitosan is a polysaccharide; however, residual proteins can remain depending on processing.[9] A small clinical study assessed the safety of chitosan bandages in patients with shellfish allergy and reported no allergic reactions, supporting the concept that well–processed chitosan devices may be safe in shellfish–allergic individuals.[9] Nonetheless, clinicians should use caution in patients with severe anaphylactic shellfish allergy and consider fungal–derived chitosan sources when feasible. Clear labeling of source and quality metrics is important, but not always available in cosmetic products.[9,19,20]

Irritancy and preservative exposure: Chitosan itself is generally non–irritating, but formulation pH and preservatives can drive irritation, especially on compromised skin.[1,2,12] Acid–soluble chitosan may require acidic vehicles, which can sting after laser or microneedling.[1,2,12,14] For post–procedure use, derivatives formulated at near–neutral pH (e.g., hydroxybutyl chitosan hydrogels) may be more tolerable.[12] Microbiological safety is critical: products applied to disrupted skin must be appropriately preserved or sterile to avoid iatrogenic infection.[9,12,19] Clinicians should be cautious with "natural" or preservative–free formulations unless sterility is ensured.[19,20]

Rare systemic reactions: Although topical chitosan is generally safe, rare systemic hypersensitivity has been reported in other routes of administration.[10] A case report described anaphylactic shock following intra–articular injection of a chitosan–containing product.[10] While not directly applicable to topical aesthetics, it highlights that chitosan–containing biomaterials can, in rare circumstances, provoke severe reactions.[10] This reinforces a core principle: safety evidence is route–specific. A topical hydrogel on intact skin has a different risk profile from an injected chitosan scaffold.[9,10,18]

Regulatory status of chitosan products varies by jurisdiction and intended use (cosmetic, medical device, or drug).[19,20] Cosmetic ingredient listing does not equate to proven therapeutic efficacy.[19,20] For products applied to compromised skin, clinicians should verify appropriate safety, sterility, and regulatory classification before integration into procedural protocols.[12,19,20]

Fig. 1. MALDI0-TOF-confirmed Ideal Sized Chitosan (ISC, Doum Inc., Korea) exhibits a molecular weight predominantly below ~200 Da, conferring heightened anti-inflammatory, antioxidant, and tissue-regenerating activities along with superior percutaneous absorption across the stratum corneum to the dermis and hypodermis. This enhanced delivery ensures that bioactive chitosan reaches deep tissue compartments where collagen synthesis and extracellular matrix remodeling occur, positioning Arche's ISC technology as an active delivery platform that leverages low-molecular-weight chitosan's intrinsic bioactivity and penetrative capacity for advanced regenerative applications.

Ideal Sized Chitosan (Arche)

Chitosan, a polysaccharide derived from crab shells and fungi, engages diverse cell signaling pathways in stem cells, platelets, and immune cells, with broad tissue regeneration applications.[1,2,7,8] MALDI–TOF analysis confirms that Arche's Ideal Size Chitosan (ISC, Doum Inc., Korea) has a molecular weight predominantly below ~200 Da, indicating a high proportion of low–molecular–weight chitosan. This low molecular weight confers heightened anti–inflammatory, antioxidant, and tissue–regenerating activity and enables superior percutaneous absorption across the stratum corneum into deeper dermal and hypodermal layers, delivering bioactive chitosan to sites of collagen synthesis and extracellular matrix remodeling.[1–6] Mechanistically, chitosan promotes stem cell proliferation and differentiation, upregulates stromal–derived factor–1α to facilitate stem cell homing and angiogenesis, and enhances MSC migration.[1,2,7,8] Chitosan hydrogel has shown neovascularization and antifibrotic effects comparable to adipose–derived stem cells in myocardial infarction models.[8] A liquid–to–gel chitosan dermal filler demonstrated greater durability and collagen production than conventional hyaluronic acid fillers.[18] Injectable chitosan formulations thus act as regenerative skin boosters by recruiting mesenchymal stromal cells, supporting matrix organization, and promoting wound healing.[18–20] In this review, chitosan is discussed as a mechanistically defined platform rather than a product–brand category (Fig. 1). In practice, clinicians should align Ideal sized chitosan formulation with clinical context. Film-forming derivatives may support cosmetic surface effects on intact skin, whereas hydrogels are more appropriate for post-procedure barrier support.[8,12] Chitosan-based nanoparticles can enhance topical delivery of specific actives but should be used cautiously after device procedures.[6,12,15–17] Clear patient counseling and documentation of product characteristics are recommended.[19,20]

Limitations of the current evidence and future directions

The clinical evidence for chitosan in aesthetic practice is promising but remains limited by heterogeneity. Studies differ in chitosan derivative, molecular weight, degree of deacetylation, vehicle composition, and outcome measures.[1–4,11–18] Many studies are small, short–term, and focus on sur-

rogate endpoints (e.g., sebum measurements, early healing scores) rather than long–term aesthetic outcomes.[11–13,15–17] Additionally, many chitosan–based studies evaluate a delivery system (nanoparticles, lipid carriers) where the active ingredient is the primary therapeutic agent; disentangling the polymer's independent contribution is challenging.[6,15–17]

Conclusions

Chitosan represents a multifunctional material at the intersection of cosmetic science, wound care, and drug delivery.[1–8] Current evidence supports its role in barrier support, post-procedural recovery, and as a carrier for topical actives in acne and pigmentary disorders.[11,12,15–17] Emerging data also suggest potential applications in scalp therapies.[13,14] However, significant heterogeneity across formulations and limited study sizes restrict generalizability. Future research should focus on standardized formulations and well-designed clinical trials to define its role in aesthetic practice.[1–4,11–18]

Financial disclosure

There is no financial disclosure to report.

Ethical statement

This is a review paper so there is no IRB needed. However, the study aligns with the Declaration of Helsinki.

Declaration of competing interest

The authors have considered the conflict of interest statement included in the "Author Guidelines." The authors certify that, no aspect of current personal or professional situation might reasonably be expected to significantly affect the views on the subject they are presenting.

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This study was conducted in compliance with the principles set forth in the Declaration of Helsinki.

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