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Scalpel, Toxin, and Performance Pressure: Metabolic, Psychiatric, and Psychosocial Aspects of Aesthetic Medicine in Competitive and Physique Athletes

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Abstract

Background: The convergence of aesthetic medicine and competitive sport has emerged as a domain of growing clinical concern. Image-driven sponsorship, social-media exposure, and the imperative of peak visual presentation may shape demand for minimally invasive procedures among both endurance- and skill-oriented athletes and physique-oriented competitors such as bodybuilders and fitness athletes.

Aim: To synthesise current evidence on metabolic, pharmacokinetic, psychiatric, and psychosocial determinants of aesthetic medicine outcomes in this population and to outline practical recommendations for screening and intervention.

Material and Methods: A narrative review of peer-reviewed literature was undertaken across PubMed, Scopus, and Web of Science, prioritising in vivo studies, systematic reviews, meta-analyses, and guidelines issued by psychiatric and dermatological societies.

Results: Available data suggest that elevated basal metabolic rate, exercise-induced oxidative stress, and tissue hyperperfusion may shorten the effective duration of crosslinked hyaluronic acid fillers and of botulinum neurotoxin in highly active individuals. Concomitant use of anabolic-androgenic steroids, diuretics, and growth-related peptides may modify wound healing, haemostasis, and filler behaviour. Body dysmorphic disorder, muscle dysmorphia, and disordered eating appear over-represented in physique-oriented sport and may underlie compulsive treatment-seeking.

Conclusions: Clinicians treating athletes are encouraged to integrate validated psychometric screening into routine assessment, to anticipate altered pharmacokinetics, and to develop clear psychiatric referral pathways. Prospective trials evaluating filler and neurotoxin durability under sustained physiological stress are warranted.

Keywords: aesthetic medicine; athletes; body dysmorphic disorder; muscle dysmorphia; anabolic-androgenic steroids; hyaluronic acid; botulinum toxin

1. Introduction

1.1. Framing the Problem: The Evolving Public Image of the Competitive Athlete

Over the past two decades, aesthetic medicine has shifted from a peripheral, predominantly cosmetic enterprise to a multidisciplinary clinical domain situated at the interface of dermatology, plastic surgery, endocrinology, rehabilitation and mental health [1]. Within this broader expansion, athletes — and in particular elite competitors whose visibility is amplified

by sponsorship contracts, broadcast media and image-centric social platforms — have emerged as a distinct, increasingly conspicuous segment of the aesthetic patient population. Motivations for minimally invasive procedures have long been recognised as multifactorial, encompassing the desire for a more youthful appearance, the wish to enhance self-confidence and emotional well-being, and the perception that aesthetic interventions can contribute to professional success or career advancement [2]. In the case of professional athletes, those motivations are layered upon a working life in which physical presentation is directly monetised through endorsement deals, federation imagery, and broadcast exposure, so that appearance may be experienced not only as a private concern but as an occupational asset.

The arrival of appearance-focused social media — most prominently Instagram, TikTok and Snapchat — appears to have intensified this dynamic. Recent work in aesthetic medicine clinics has documented the phenomenon of so-called "Snapchat dysmorphia", in which patients present requesting interventions designed to make them resemble digitally filtered versions of their own selfies, an emerging construct that has been reported to correlate with symptoms of body dysmorphic disorder (BDD) in women seeking aesthetic procedures [3]. Although this phenomenon has been described chiefly in lay-clinic populations, athletes — whose personal brands typically depend on continuous online self-presentation — may plausibly be exposed to similar pressures, and the convergence of media-driven ideals with the demands of competitive sport warrants closer scrutiny.

Concurrently, the literature on body image among physically active populations suggests a more nuanced picture than the older stereotype of the "healthy athletic body". Although sports participation is generally associated with more favourable body image and higher body appreciation than in non-athlete controls [4,5], evidence indicates that elite-level competition, weight-sensitive disciplines and aesthetic sports may attenuate or reverse this protective effect [4,6]. A recent umbrella review noted that elite athletes appear to be at elevated risk for the full spectrum of disordered eating, even where body dissatisfaction is, in absolute terms, lower than in sedentary controls [7]. This apparent paradox — diminished general body dissatisfaction coupled with elevated sport-specific dissatisfaction and disordered eating — is highly relevant to the aesthetic practitioner, since it suggests that the population presenting for treatment may not appear, on superficial assessment, to be psychologically vulnerable.

1.2. Competitive Athletes versus Physique Athletes: Defining the Target Groups

The umbrella term "athlete" conceals considerable heterogeneity, and this work draws a working distinction between two broad categories whose motivations for aesthetic intervention differ in important respects. The first group comprises **competitive athletes** in the conventional sense — endurance, ball, combat, racquet and team-sport competitors — whose primary aesthetic concerns tend to mirror those of the wider population (peri-orbital lines, hyperhidrosis, scarring), often layered onto specific occupational concerns related to broadcast visibility. The second group comprises **physique-oriented athletes**, including bodybuilders, fitness, bikini and physique competitors, whose sport is defined by the judged appearance of the body itself. In this latter group, muscular hypertrophy, low body-fat percentage and proportion are not by-products of training but the explicit competitive outcome.

Empirical work indicates that these groups differ both in body image profile and in the trajectory of appearance-related concerns. Studies of male bodybuilders, both competitive and non-competitive, have shown that they wish to be both leaner and more muscular than they are, with an almost linear gradient between competitive bodybuilders, non-competitive bodybuilders and non-training controls in the desired body composition [4]. The same body of evidence indicates that female athletes generally report greater body image dissatisfaction than their male counterparts, and that athletes engaged in leanness-focused disciplines tend to report higher dissatisfaction than those in non-leanness sports [4,5]. Adolescent female athletes in particular may carry disproportionate risk for body image disturbance and disordered eating [6].

Within physique-oriented sport, muscle dysmorphia (MD), originally framed as "reverse anorexia" and currently classified as a specifier of BDD in the DSM-5-TR and ICD-11, occupies a central position [8,9]. Individuals affected by MD are preoccupied with the conviction that they are insufficiently muscular, even when objectively hypertrophied, and may organise much of their daily activity — weightlifting, restrictive dieting, supplement use and, in some cases, anabolic-androgenic steroid (AAS) use — around the pursuit of muscularity [8]. A scoping review of personality correlates of MD has highlighted vulnerable narcissism, neuroticism and perfectionism as recurrent traits, while emphasising that the competitive

environment of elite sport may interact with such personality-based vulnerabilities to shape both onset and clinical expression [9]. Importantly, AAS use, although prohibited by the World Anti-Doping Agency, has been estimated to occur in 1–3% of the US general adult population, with substantially higher rates reported in gym-based and bodybuilding subcultures [10]. The dermatological, hepatic, cardiovascular and psychiatric sequelae of AAS use are well documented, and their bearing on the safety of aesthetic procedures — discussed in detail in later sections — is a recurring clinical concern.

It is against this background that the aesthetic practitioner is increasingly asked to treat athletes whose physiology, pharmacology and psychological profile may diverge meaningfully from those of the average patient. A controlled single-blind clinical trial has reported, for instance, that high levels of physical activity may shorten the aesthetic durability of botulinum toxin type A (BoNT-A) injected into the upper face, with measurable differences appearing as early as one to two months after treatment [11]. Such findings imply that the dose–response and duration parameters established in sedentary cohorts may not transfer directly to athletic populations, and they introduce questions that the existing evidence base addresses only fragmentarily.

1.3. Aim of the Study and Research Questions

Against this evolving clinical landscape, the present narrative review pursues three interrelated aims. First, it seeks to synthesise the available evidence on the physiological and pharmacokinetic peculiarities of aesthetic interventions in athletes, with particular attention to crosslinked hyaluronic acid (HA) fillers and BoNT-A and to medical indications such as hyperhidrosis and masseter hypertrophy. Second, it aims to outline the principal interactions between sport-related pharmacology — chiefly AAS, diuretics and growth-related peptides — and aesthetic procedures, with respect to wound healing, haemostasis and filler behaviour. Third, it considers the psychiatric and psychosocial dimensions of treatment in this population, focusing on BDD, MD, disordered eating, reward-system dynamics, and the clinical tools available for screening and referral.

Specifically, the review is structured around the following questions: (i) To what extent does the physiology of the trained body modify the duration and behaviour of injectable aesthetic

agents? (ii) What pharmacological interactions between sport-related agents and aesthetic procedures carry the greatest clinical risk? (iii) How prevalent and how clinically significant are BDD, MD and related conditions among competitive and physique athletes seeking aesthetic care? (iv) Which screening instruments and referral algorithms can practitioners reasonably integrate into routine practice? In approaching these questions, the review remains explicitly cautious: the evidence base is uneven, and in several domains — notably the long-term durability of fillers under sustained athletic stress — robust prospective data are scarce.

2. Methodology of the Review

The present work is a narrative review intended to integrate physiological, pharmacological, psychiatric and psychosocial evidence concerning the use of aesthetic medicine in competitive and physique-oriented athletes. A narrative format was selected deliberately, in view of the marked heterogeneity of the relevant literature — which spans cellular pharmacokinetics, sports medicine, psychiatry, dermatology and clinical psychology — and the corresponding difficulty of harmonising findings within a single quantitative synthesis. Where individual primary studies, systematic reviews or meta-analyses were available, they have been preferentially cited; where direct evidence in athletic populations was lacking, inferences from adjacent clinical populations are drawn explicitly and identified as such.

2.1. Inclusion and Exclusion Criteria

Articles were considered eligible if they met one or more of the following criteria: (i) peer-reviewed original investigations addressing the physiology, pharmacokinetics, or clinical outcomes of injectable aesthetic agents — including crosslinked hyaluronic acid (HA) fillers, botulinum neurotoxin type A (BoNT-A), hyaluronidase, biostimulators (poly-L-lactic acid, calcium hydroxylapatite) and emerging hybrid devices — in adult human participants or, where indispensable, in well-characterised animal or in vitro models with explicit translational relevance; (ii) systematic reviews and meta-analyses examining body image, disordered eating, body dysmorphic disorder (BDD), muscle dysmorphia (MD) and related psychiatric morbidity in athletic, physique-oriented or general aesthetic-medicine populations; (iii) consensus statements, position papers and clinical guidelines issued by recognised psychiatric,

dermatological, plastic-surgical or aesthetic-medicine societies; and (iv) primary studies addressing the dermatological, endocrine, haematological or hepatic effects of anabolic-androgenic steroids (AAS), diuretics, growth hormone (GH) and insulin-like growth factor 1 (IGF-1) in the context of athletic populations or with direct bearing on wound healing, haemostasis and integumentary integrity.

Preference was given to in vivo investigations in human subjects, to diagnostic frameworks anchored in the DSM-5-TR and ICD-11 [12], and to studies employing validated psychometric instruments — including, but not limited to, the BDD Yale-Brown Obsessive Compulsive Scale (BDD-YBOCS), the BDD Questionnaire (BDDQ), the BDDQ Dermatology Version (BDDQ-DV) and the Cosmetic Procedure Screening Questionnaire (COPS) [13]. Sources of comparable methodological standing (for example, consensus guidelines on the prevention and management of HA filler-induced vascular occlusion) [14] were also retained, since they reflect the operational standards of contemporary aesthetic practice.

Exclusion criteria were defined a priori in order to maintain the clinical and methodological focus of the review. Excluded materials comprised: single case reports without sufficient mechanistic or clinical depth; conference abstracts not subsequently published in peer-reviewed form; commercial promotional literature; sources where the full text could not be obtained; opinion pieces lacking systematic argumentation; and primary studies whose participants did not engage in any regular structured physical activity, unless used solely as background or as comparator groups. Where conflicting evidence was identified, both perspectives were retained and discussed, in line with the descriptive function of a narrative review.

No formal pre-registration was undertaken, in accordance with the conventions of narrative — rather than systematic — synthesis; this limitation is acknowledged. Risk-of-bias appraisal was conducted informally at the level of individual citations, with greater weight given to studies using validated outcome measures, adequate sample sizes, prospective designs and transparent reporting of conflicts of interest. Findings that depended chiefly on small, retrospective, or methodologically weaker cohorts have been flagged accordingly in the text.

2.2. Keywords and Search Strings

Electronic searches were performed across three databases — PubMed/MEDLINE, Scopus, and Web of Science — covering literature from database inception to the early months of 2026. Additional sources were retrieved through hand-searching of the reference lists of included articles ("snowballing"), through review of relevant clinical guidelines, and through targeted searches of journals dedicated to aesthetic medicine, dermatologic surgery, sports medicine, and psychiatry. The search strategy combined three thematic blocks, joined by Boolean operators.

The first block, addressing the **aesthetic-medicine intervention**, comprised the following terms (combined with OR): "hyaluronic acid filler", "dermal filler", "crosslinked hyaluronic acid", "botulinum toxin", "botulinum neurotoxin", "onabotulinumtoxinA", "abobotulinumtoxinA", "incobotulinumtoxinA", "hyaluronidase", "calcium hydroxylapatite", "poly-L-lactic acid", "biostimulator", "minimally invasive aesthetic procedure", "soft tissue augmentation", and "neuromodulator".

The second block, addressing the **target population and physiological context**, comprised: "athlete*", "elite athlete*", "competitive sport*", "endurance training", "resistance training", "bodybuilder*", "physique competitor*", "fitness athlete*", "weightlifter*", "physical activity", "exercise", "muscle hypertrophy", "masseter hypertrophy", "bruxism", "hyperhidrosis", and "wound healing".

The third block, addressing **pharmacological exposures and psychiatric comorbidity**, comprised: "anabolic-androgenic steroid*", "AAS", "testosterone", "nandrolone", "stanozolol", "diuretic*", "growth hormone", "GH", "IGF-1", "insulin-like growth factor", "peptide*", "body dysmorphic disorder", "BDD", "muscle dysmorphia", "bigorexia", "disordered eating", "eating disorder*", "body image", "Snapchat dysmorphia", "cognitive behavioural therapy", "schema therapy", and "BDD-YBOCS".

Cross-thematic queries were constructed by combining one term from each block with AND — for instance, ("botulinum toxin" AND ("athlete*" OR "physical activity") AND "duration");

("hyaluronic acid filler" AND "metabolism" AND ("exercise" OR "athlete*")); ("anabolic-androgenic steroid*" AND ("wound healing" OR "keloid" OR "fibroblast")); and ("body dysmorphic disorder" AND ("athlete*" OR "bodybuilder*") AND "screening"). Filters were applied where appropriate to restrict results to studies in human participants, to articles available in English (with Polish-language sources retained where they contributed methodological or epidemiological value), and to peer-reviewed full-text publications.

Titles and abstracts were screened against the inclusion criteria; potentially relevant articles were retrieved in full text. Decisions regarding inclusion of equivocal items were guided by relevance to the four research questions stated in Section 2.3, by methodological quality and by the recency of evidence, with priority given to publications from the past ten years, augmented by foundational older works where they represented the canonical reference for a given concept (for example, the original conceptualisation of MD or the introduction of validated BDD screening instruments). Where systematic reviews and meta-analyses subsumed earlier primary studies, the umbrella sources were preferred to avoid duplication.

3. Physiological and Pharmacokinetic Aspects (Tissue Mechanisms)

This chapter examines how the trained body — defined by elevated basal metabolic rate, recurrent oxidative loading, capillary angiogenesis and chronic mechanical demand on selected muscle groups — may modify the pharmacokinetics and tissue behaviour of the agents most commonly injected in aesthetic practice. Three injectable modalities are considered: crosslinked hyaluronic acid (HA) fillers, botulinum neurotoxin type A (BoNT-A), and, within the discussion of BoNT-A, two medical indications particularly relevant to athletic populations (primary focal hyperhidrosis and masseter hypertrophy associated with bruxism). The discussion proceeds from mechanism to clinical implication, with explicit caution where direct evidence in athletes is absent.

3.1. Hyaluronic Acid and Tissue Hypermetabolism

Hyaluronic acid is a linear, unbranched glycosaminoglycan composed of repeating disaccharide units of D-glucuronic acid and N-acetyl-D-glucosamine connected by β-1,4 and β-1,3

glycosidic bonds [15]. Over half of the body's HA content resides in the skin, where it serves as a principal extracellular-matrix constituent responsible for hydration, viscoelasticity and mechanical integrity of the dermis [15]. Endogenous cutaneous HA exhibits a strikingly dynamic turnover: the half-life of native dermal HA has been reported at approximately one day, reflecting a tightly regulated balance between synthesis by hyaluronan synthases (HAS1–HAS3) and degradation through hyaluronidase activity together with the HYBID/KIAA1199/CEMIP axis [16]. Approximately one-third of the total cutaneous HA pool is reported to undergo daily renewal under normal physiological conditions [15].

The injectable HA-based fillers used in aesthetic practice differ from endogenous HA in that they are chemically crosslinked — most commonly with 1,4-butanediol diglycidyl ether — which prolongs their tissue residence time and confers the rheological properties required for volume restoration [17]. Magnetic resonance imaging studies indicate that crosslinked HA fillers may persist in vivo for far longer than the conventionally assumed 3–12 months: in a recent cohort of 33 patients, residual HA was detectable in the mid-face for 2 to 15 years after the last reported injection, with no patient demonstrating complete resolution at the 2-year time point [18]. Factors most consistently associated with extended longevity include HA concentration, the chemistry and degree of crosslinking, rheological behaviour of the gel, and anatomical placement within deep, low-mobility fat compartments [17,18].

Spontaneous degradation of crosslinked HA proceeds through two principal pathways: enzymatic cleavage of the β-1,4-glycosidic linkage by endogenous hyaluronidases, and oxidative depolymerisation by reactive oxygen species (ROS) [17]. Both pathways merit particular consideration in athletic populations. Sustained aerobic activity, prolonged endurance exertion and eccentric resistance training are recognised to raise basal metabolic rate and to generate substantial ROS fluxes within working muscle and adjacent tissues. Although cutaneous ROS exposure during recovery from exercise has not been quantified directly in athletes, in vitro studies of crosslinked HA exposed to H_2O_2/Cu^{2+} ROS-generating systems have shown a measurable decline in the storage modulus G' within minutes of incubation, with gels of higher complex viscosity proving comparatively more resistant [17]. By extension, the recurrent exposure of dermal compartments to exercise-induced oxidative stress may plausibly

accelerate the depolymerisation of injected HA polymers, although prospective in vivo evidence in athletes is presently lacking.

Tissue perfusion is the second variable likely to differ in trained individuals. Regular training is associated with capillary angiogenesis and elevated baseline microvascular perfusion, both within working muscles and within overlying integument. Higher perfusion plausibly enhances the delivery of endogenous hyaluronidases to the filler depot and accelerates clearance of degradation products [17]. Hyaluronidase isoforms differ by compartment: HYBID and HYAL2 predominate within dermal fibroblasts, whereas epidermal keratinocytes secrete HYAL1 extracellularly, with optimal activity at the weakly acidic pH (4.6–4.8) characteristic of the stratum corneum and upper viable layers [16]. Temperature-dependent kinetics also bear on this picture: elevated tissue temperatures, of the kind reached during sustained exertion, may both accelerate enzymatic HA degradation and destabilise hyaluronan synthase activity, with one in vitro experiment showing a fall in HA molecular weight from 753 kDa to 36 kDa after 24 h of high-temperature, low-pH exposure [15].

Clinically, these mechanisms converge on an emerging — although not yet quantitatively validated — hypothesis: that the effective half-life ($t_{1/2}$) of crosslinked HA filler may be shorter in highly active competitive and physique athletes than in sedentary or moderately active controls. No prospective, controlled study has, to our knowledge, directly tested this hypothesis with imaging endpoints in athletic cohorts, and the inference is therefore offered with caution. The clinical implications nevertheless include the possibility of accelerated loss of volume restoration, more frequent retreatment intervals, and the need for explicit pre-treatment counselling. Adverse events common to HA filler use — ecchymosis, oedema, granuloma formation, the Tyndall effect and, rarely, vascular occlusion with skin necrosis [19] — also deserve emphasis in patients whose training involves repeated facial trauma (combat sports), markedly increased intracranial pressure (Valsalva-laden lifting) or prolonged sun and heat exposure (endurance athletes).

3.2. Botulinum Neurotoxin in Physically Active Patients

BoNT-A is a 150 kDa di-chain protein composed of a 100 kDa heavy chain — responsible for receptor binding and endocytic internalisation via synaptic vesicle protein 2 (SV2) isoforms — and a 50 kDa light chain that, once translocated across the endosomal membrane, exerts zinc-dependent endopeptidase activity against SNAP-25, a constituent of the SNARE complex required for acetylcholine-vesicle fusion at the neuromuscular junction [20,21]. Cleavage of SNAP-25 prevents the docking and exocytosis of acetylcholine-containing vesicles, producing reversible flaccid paralysis of the targeted muscle [21]. In standard aesthetic practice — directed most often at the frontalis, corrugator supercilii and procerus muscles — the paralytic and consequent wrinkle-attenuating effect typically becomes apparent within 24 hours to two weeks of injection and lasts approximately three to six months, depending on dose, formulation and patient characteristics [21,22].

The restoration of neuromuscular transmission is mediated by axonal sprouting from the original motor neuron, the formation of new functional terminals at adjacent endplate regions, and eventual reabsorption of those sprouts as the parent terminal recovers SNAP-25 function [20]. Several physiological variables that govern this recovery are themselves modulated by training. Repetitive motor-unit recruitment, characteristic of both resistance and endurance training, has been shown in animal models to stimulate neural plasticity within the spinal cord and to facilitate functional reorganisation of motor output — processes mechanistically akin to those that underlie neuromuscular reinnervation [11]. Plasma and intramuscular concentrations of certain myokines that promote nerve sprouting and reinnervation have also been reported to rise after exercise, irrespective of exercise modality [11]. The cumulative implication is that the neuromuscular environment of a highly active patient may be biased towards accelerated functional recovery after pharmacological denervation.

Direct clinical evidence supporting this inference was provided by a controlled single-blind trial in 60 women stratified into low, moderate and high physical-activity groups, all of whom received a single standardised BoNT-A injection (12 U into the frontalis, 7 U into each corrugator supercilii, and 4 U into the procerus) [11]. At the 1-, 2- and 3-month follow-up time points, the low-activity group showed significantly greater reductions in surface

electromyographic activity of the frontalis, corrugator and procerus muscles than the moderate- and high-activity groups ($p < 0.001$), and the severity of forehead and glabellar lines on the Merz scale improved significantly more — and for longer — in the low-activity arm [11]. Patient satisfaction with treatment, measured on the FACE-Q "Appearance of Lines Between Eyebrows" subscale, was correspondingly maintained for longer in the low-activity group, whereas in the high-activity group the satisfaction score returned towards baseline by 2–3 months [11]. These findings lend empirical support to the long-standing clinical impression that the so-called "break-through" of BoNT-A activity tends to occur earlier in athletes than in sedentary patients.

Additional mechanistic considerations apply in physique-oriented athletes, who frequently demonstrate facial muscular hypertrophy and a high baseline density of motor-unit recruitment. Although the kinetics of BoNT-A binding to SV2 are not, on first principles, altered by hypertrophy [20], the increased number of available motor endplates per unit muscle volume may necessitate higher unit doses to achieve comparable functional attenuation. Practitioners working with this population may therefore reasonably anticipate both larger required doses and shorter inter-session intervals, while remaining attentive to the immunogenic complications that may attend repeated, high-cumulative-dose exposure [22].

3.3. Aesthetic Medicine for Medical Indications in Athletes

Beyond strictly cosmetic indications, BoNT-A is increasingly used in athletes for two principal medical conditions whose pathophysiology is intertwined with athletic activity itself: primary focal hyperhidrosis and masseter hypertrophy associated with bruxism.

Primary focal hyperhidrosis. Hyperhidrosis denotes sweating in excess of thermoregulatory requirements and is most often expressed in axillary, palmar, plantar or craniofacial distributions [23]. Primary focal hyperhidrosis is reported to affect up to ~2.8% of the general adult population and to impair quality of life to a degree comparable with severe acne or psoriasis [23,24]. In athletes the condition may interfere not only with personal and social functioning but with sport-specific tasks — secure grip on a racquet or weight, stability of helmet and eyewear, and skin maceration within tightly fitted gear. Mechanistically, primary

focal hyperhidrosis is thought to reflect dysregulated sympathetic cholinergic innervation of otherwise normal eccrine sweat glands [24]. Intradermal BoNT-A injection blocks presynaptic acetylcholine release at the eccrine cholinergic terminal — the same SNAP-25-dependent mechanism that mediates its neuromuscular action [23]. In the pivotal randomised, double-blind placebo-controlled trials underpinning regulatory approval, onabotulinumtoxinA significantly reduced axillary sweat production within one week of injection and maintained effect for ≥6 months, with corresponding improvements on the Hyperhidrosis Disease Severity Scale, the Short Form-12 physical and mental component scores, and the Hyperhidrosis Impact Questionnaire [24]. Adverse events in these trials were predominantly transient and local [24]. Whether the same dose–response relationship holds in athletes — with elevated baseline sweat rates and ongoing eccrine adaptation to repeated thermal stress — remains an open question that, to our knowledge, has not been systematically addressed.

Bruxism and masseter hypertrophy. Bruxism — repetitive masticatory muscle activity involving tooth clenching, grinding or forceful mandibular movement — has reported prevalence rates of approximately 8–31% for sleep bruxism and 22–31% for awake bruxism in adults [25]. Strength athletes and powerlifters are a population in which bruxism-like behaviour is particularly conspicuous: repeated maximal isometric clenching during heavy lifts, parafunctional bracing of the jaw under high intrathoracic pressure, and stress-related daytime clenching may all contribute to chronic overloading of the masticatory apparatus. Masseter hypertrophy is a recognised consequence — and an independent aesthetic complaint — characterised by a soft swelling near the mandibular angle, a squared lower-facial contour and, in many cases, regional pain or temporomandibular dysfunction [26]. Conservative interventions (occlusal splints, behavioural modification, physiotherapy) remain first-line, but BoNT-A injection of the masseter is now broadly regarded as the standard non-surgical management when conservative measures fail [25,26]. The mechanism is again SNAP-25 cleavage and resulting acetylcholine blockade at the masseter neuromuscular junction, with consequent reduction in contractile force, muscle volume and clenching intensity [26]. Reported aesthetic outcomes include narrowing of the lower-third facial contour and softening of the mandibular angle, with parallel improvements in pain and parafunctional behaviour [26]. International consensus on dosing has not been definitively established, although ranges of approximately 20–40 U per side are commonly reported; in physique-oriented athletes with

marked masseter hypertrophy higher unit doses may be required, with the caveat that retreatment intervals may be shorter than in sedentary patients in light of the durability data discussed above [11,26].

Taken together, the three subsections of this chapter outline a coherent if incomplete picture. In athletes, both filler longevity and neuromodulator durability may be modified by sustained physiological perturbations — elevated basal metabolic rate, oxidative stress, tissue hyperperfusion, increased motor-unit turnover and chronic mechanical loading — that have not been the focus of the registration trials underlying current clinical practice. The next chapter turns to the second axis of difference between athletic and non-athletic patients: the pharmacological exposures that are common in physique-oriented sport but unusual in the general aesthetic-medicine population.

4. Doping, Sport Pharmacology, and Aesthetic Medicine

The pharmacological profile of physique-oriented athletes differs in important respects from that of the general aesthetic patient. Anabolic-androgenic steroids (AAS), diuretics used for the "drying" phase of contest preparation, and growth-related peptides — including recombinant human growth hormone (rhGH), insulin-like growth factor 1 (IGF-1) analogues, and a heterogeneous group of "peptide bioregulators" — are widely, if often surreptitiously, used at concentrations that exceed any therapeutic indication. Each of these agents may affect the tissue substrates on which aesthetic procedures depend: dermal fibroblast biology, collagen turnover, coagulation, fluid-electrolyte balance and, in the case of biostimulator fillers, the very pathways that determine the collagen-forming response. This chapter outlines the principal interactions, with explicit caution about the limited dedicated evidence in athletic populations.

4.1. Anabolic-Androgenic Steroids (AAS)

AAS are synthetic analogues of testosterone that exert their biological action primarily through binding to the cytoplasmic androgen receptor (AR), with subsequent translocation of the ligand–receptor complex to the nucleus and binding to androgen response elements on target gene promoters [27]. In addition to genomic signalling, non-genomic pathways — including

G-protein-coupled membrane interactions and rapid calcium fluxes — have also been described [10,27]. Beyond muscle, ARs are expressed in skin, hair follicles, sebaceous glands, the liver, kidneys, and the haematopoietic, immune and central nervous systems [27], so the pharmacological reach of AAS extends far beyond the intended hypertrophic effect.

From a dermatological standpoint, the most conspicuous manifestation of AAS exposure is acne, reported in up to ~43% of users, with severe acne fulminans documented chiefly in male bodybuilders [28]. The proposed mechanism involves enlargement of sebaceous glands, increased sebum production, and proliferation of *Cutibacterium acnes* in an androgen-enriched follicular environment, with both sebocytes and follicular keratinocytes expressing functional ARs [28]. Other recognised cutaneous changes include striae distensae, hirsutism, alopecia and injection-site furuncles, the last of which may interfere directly with the technical execution of aesthetic procedures in the head, neck and upper trunk [28]. Importantly, acne fulminans may be precipitated by isotretinoin used in the context of ongoing AAS exposure, a clinically relevant interaction in patients who arrive for dermatological care while continuing covert AAS use [28].

The implications for invasive aesthetic procedures and laser therapies arise from AAS effects on the connective tissue. Although direct cutaneous studies in athletes are scarce, indirect inferences can be drawn from the tendon literature. AAS exposure has been associated with disrupted collagen synthesis and crosslinking, decreased matrix metalloproteinase-2 activity, paratenon thickening and reduced viscoelastic compliance, with a corresponding rise in rupture risk under mechanical load [29]. Analogous fibroblast-level perturbations in the dermis may plausibly translate into altered wound healing kinetics, although prospective skin-specific data in AAS users remain limited. In athletes specifically, keloid formation has been highlighted as a clinically meaningful complication: repeated microtrauma, increased skin tension over hypertrophied musculature, surgical interventions for sports injuries, and exuberant fibroblastic activity may combine to predispose physique athletes to pathological scarring after invasive aesthetic procedures, ablative laser treatments and minor surgical revisions [30]. The relevant signalling pathways — TGF-β/Smad, MAPK, PI3K/AKT/mTOR and JAK/STAT — are themselves modulated by hormonal milieu, mechanotransduction and inflammatory tone, all of which may be perturbed in AAS users [30].

The wound-healing literature offers further mechanistic insight. Hormones modulate every phase of skin repair — haemostasis, inflammation, proliferation and remodelling — through actions on keratinocyte migration, fibroblast proliferation, collagen deposition and angiogenesis [31]. Androgens such as testosterone have been reported to facilitate keratinocyte and fibroblast proliferation and to promote angiogenesis under physiological conditions [31]; however, in settings of chronic inflammation, supra-physiological exposure or psychological stress, androgens may prolong the inflammatory phase via increased interleukin-6 and tumour necrosis factor-α expression, thereby impairing rather than supporting repair [31]. Nutritional and anabolic substrate availability also bear directly on outcome: wound healing imposes a hyper-metabolic, catabolic state in which lean body mass and protein-energy balance determine the capacity for tissue regeneration [32]. The combination of restrictive contest-preparation diets and aggressive AAS cycles may therefore generate a paradoxical state of pharmacological anabolism superimposed on substrate scarcity and chronic inflammation — conditions that, on balance, may not favour optimal healing after invasive aesthetic procedures.

A separate axis of risk in AAS users relates to haematology and haemostasis. AAS have been consistently reported to stimulate erythropoiesis and to raise haematocrit, with polycythaemia and hyperviscosity well documented at supraphysiological doses [10,27]. They may also induce changes in platelet aggregation and in plasma lipid profile, and have been associated with cardiovascular events including myocardial infarction and venous thromboembolism in young athletes [10]. From the standpoint of injectable aesthetic procedures, an elevated haematocrit and altered platelet behaviour may translate into a higher incidence of ecchymosis, prolonged post-injection bruising, painful haematoma formation, and — in unfortunate cases — extension of vascular complications such as filler-induced occlusion. For these reasons, a careful, non-judgmental history of AAS exposure and, where appropriate, a baseline full blood count prior to injectable treatment may be advisable in physique-oriented athletes, with proceedings adjusted accordingly.

Finally, female AAS users represent a population in which the interaction between sport pharmacology and aesthetic medicine carries particular nuance. The prevalence of AAS use in women, although lower than in men, has been rising and is driven primarily by the pursuit of

an aesthetically lean and muscular phenotype [33]. Reported sequelae include voice deepening, clitoromegaly, menstrual irregularities, virilisation, hirsutism and androgenic alopecia (the so-called SAHA syndrome) — many of which themselves prompt aesthetic medicine consultation [33]. Importantly, the very motivations that drive AAS use in women may also drive treatment-seeking behaviour for aesthetic procedures, and clinicians should consider this trajectory in their assessment and counselling.

4.2. Diuretics and Modifiers of Water and Electrolyte Balance

Diuretics — including loop, thiazide and potassium-sparing agents, and, less commonly, osmotic agents — are widely used during the final phase of contest preparation in physique sport to maximise muscular definition through transient extracellular fluid contraction. They are listed as prohibited substances by anti-doping authorities both for their masking properties and for their direct effects on body composition. Although dedicated experimental data on the interaction between diuretic-induced volume contraction and injectable aesthetic agents are essentially absent, several mechanistic considerations bear on clinical practice.

HA is a strongly hydrophilic glycosaminoglycan whose tissue volume reflects the equilibrium between intrinsic osmotic activity, water binding by its polyanionic backbone and the local osmolarity of the extracellular fluid [15]. Under conditions of acute extracellular fluid contraction — as may follow aggressive pre-competition diuretic use, combined with carbohydrate and sodium manipulation — the hydration state of an existing crosslinked HA depot may shift, with reported anecdotal correlates including transient visible deflation of filler-augmented sites and, after rehydration, sudden swelling or "blooming" of previously stable depots. Such fluctuations are not, to our knowledge, supported by prospective imaging studies in athletes, but they are mechanistically consistent with the established osmotic behaviour of HA gels [15,17]. AAS use compounds the picture: AAS may themselves induce sodium and water retention, and combined AAS–diuretic cycling can generate repeated, abrupt swings in extracellular fluid composition that no aesthetic timetable can comfortably accommodate [10,33].

Practically, these considerations argue for at least three precautions: avoidance of large-volume HA filler placement in close temporal proximity to declared or suspected competition cycles; explicit pre-procedural enquiry into recent fluid-manipulation strategies; and patient counselling regarding the possibility of unpredictable filler behaviour. A further consideration is that intense, repetitive diuretic use may induce electrolyte derangements (hypokalaemia, hyponatraemia, alkalosis) and renal compromise, conditions that complicate the safe management of vasoactive emergencies such as filler-induced vascular occlusion, where hyaluronidase infiltration and supportive measures should ideally be deployed in a haemodynamically stable patient.

4.3. Peptides and Growth Hormones (GH/IGF-1) and their Interactions with Biostimulators

The use of recombinant growth hormone (rhGH), IGF-1 and IGF-1 analogues, and a wider class of synthetic peptides marketed for "tissue repair" or "anti-ageing" purposes, has become increasingly common in physique-oriented populations. These agents share, broadly, anabolic and proliferative activity, and they bear directly on the biology that underpins biostimulator-based aesthetic interventions such as poly-L-lactic acid (PLLA), calcium hydroxylapatite (CaHA) and certain hybrid HA–chitosan or HA–high-molecular-weight devices [17].

rhGH has been shown clinically and experimentally to enhance collagen deposition, accelerate keratinocyte proliferation, augment IGF-1 production by the liver, and stimulate angiogenesis through activation of the ERK signalling pathway and increased expression of EGF, TGF-β and VEGF [31]. IGF-1 itself has been characterised as an important chemotactic and mitogenic stimulus for keratinocytes and fibroblasts, with documented effects on wound bed contraction, hyaluronan synthesis and overall tissue regeneration [34]. From a mechanistic standpoint, these agents would be expected to potentiate the fibroblastic response that biostimulator fillers are designed to elicit. The clinically relevant concern, however, is that this potentiation may be unpredictable and asymmetric. PLLA microparticles undergo hydrolytic degradation that generates lactic-acid oligomers; the resulting fibroblast activation and neocollagenesis depend in part on the local cytokine milieu [17]. CaHA microspheres act as a scaffold for collagen deposition mediated by fibroblasts and osteoclastic enzymes, with the magnitude of collagen

response again dependent on the responsiveness of the local fibroblast population [17]. Superimposing systemic rhGH or IGF-1 exposure on either platform may therefore generate exaggerated, prolonged or anatomically uneven fibroblastic responses, with theoretical risks ranging from over-correction and visible nodule formation to delayed-onset granulomatous reactions.

A related concern arises with hybrid devices that combine crosslinked HA with secondary regenerative components (for example, lactose-modified chitosan or other polysaccharides), the durability and biological behaviour of which may also be modified in a high-IGF-1 environment [17]. Although direct interaction data are presently lacking, prudence supports the recommendation that practitioners enquire specifically about peptide and GH use prior to administering biostimulator fillers, and that they consider deferring such treatments until at least several weeks after the cessation of the relevant cycles.

Taken together, the pharmacological exposures characteristic of physique-oriented athletes — chronic high-dose AAS, intermittent aggressive diuretic use and the increasing background presence of rhGH/IGF-1 and peptide bioregulators — define a clinical context in which standard treatment protocols may not transfer reliably from sedentary patients. The chapter that follows examines the second major dimension of difference in this population: the psychiatric and psychosocial substrate on which the demand for aesthetic intervention frequently rests.

5. Psychopathology and Body Image: Psychiatric Assessment of the Athlete-Patient

The physiological and pharmacological considerations outlined in the preceding chapters describe one dimension of the clinical encounter with the athlete-patient; the psychiatric and psychosocial substrate constitutes the second. Body dysmorphic disorder (BDD), muscle dysmorphia (MD) and disordered eating form a spectrum of appearance-focused psychopathology with elevated representation in aesthetic-medicine settings and in physique-oriented sport. Their recognition, however, is uneven; clinicians without dedicated training in mental-health screening may not detect them even at the point of consultation. This chapter integrates contemporary diagnostic, epidemiological and neurobiological evidence to inform the practitioner's assessment of the athlete-patient who presents for aesthetic intervention.

5.1. Body Dysmorphic Disorder (BDD) in Athletes

Definition and diagnostic framework

BDD is currently conceptualised within both the DSM-5-TR and the ICD-11 as an obsessive–compulsive-spectrum disorder characterised by a persistent preoccupation with one or more perceived defects in physical appearance that are not observable or appear only slight to others, together with repetitive behaviours (mirror checking, grooming, skin picking, reassurance seeking) or mental acts (appearance comparison) executed in response to that preoccupation [12,35]. The preoccupation must cause clinically significant distress or functional impairment, and must not be better explained by an eating disorder when the concern is restricted to body weight and shape [12]. The disorder typically has its onset before 18 years of age and is associated with a substantial — approximately three- to four-fold — increase in the risk of suicidal ideation and attempts compared with unaffected matched individuals [35].

Prevalence in general and aesthetic populations

Estimates of BDD prevalence vary widely with the instrument used, the diagnostic threshold applied, and the population sampled. In community-based samples from high-income countries the weighted prevalence has been estimated at approximately 2% [35], although more recent meta-analyses incorporating cosmetic and dermatological cohorts have reported markedly higher pooled figures — on the order of 17% in heterogeneous community and clinical samples — and considerable regional variability [36]. Across clinical settings, prevalence rises substantially: a recent meta-analysis of 65 studies and more than 17,000 patients in aesthetic and reconstructive plastic-surgery settings reported an overall pooled prevalence of approximately 18.6%, with higher rates documented in some Latin American and Middle Eastern cohorts [37]. In dermatology clinics the prevalence has been estimated at around 11–16%, in general cosmetic-surgery settings at around 13–24%, and in cosmetic dermatology at up to 20% [35,36,37]. These figures are likely to substantially exceed those in the general population, even allowing for instrument-related inflation. The clinical recognition of BDD in routine aesthetic practice nevertheless remains suboptimal: practitioners without dedicated training have been reported to identify only a small fraction of cases at consultation, and a

number of clinical features — frequent mirror checking, constant comparison with others, requests for technically improbable results, expectation that a cosmetic procedure will resolve broader life problems, and demanding behaviour toward the surgeon or staff — have been proposed as practical clues [38].

Dedicated data on BDD prevalence among athletes specifically are limited; most evidence is inferred from the broader literatures on body image and disordered eating in elite and physique sport [3,6,7]. Available indirect evidence is nevertheless suggestive: elite athletes appear at elevated risk for the spectrum of disordered eating and for appearance-focused preoccupations, with physique-oriented and aesthetic disciplines representing the highest-risk subgroups [6,7]. The growing recognition of so-called Snapchat dysmorphia in image-centric aesthetic clinics adds a further plausible mechanism for the development of BDD-like symptomatology among athletes whose personal brand depends on continuous social-media self-presentation [3].

Neurobiological and cognitive underpinnings

The pathophysiology of BDD has not been fully delineated, but converging evidence from neuroimaging, eye-tracking and neurocognitive studies points to disturbances at the interface of visual perception and emotional processing [35]. Structural and functional differences from healthy controls have been described in regions involved in visual and emotional processing, including elements of the occipitotemporal and fronto-limbic networks; though the findings are not yet sufficient to establish a definitive pathophysiological model, the pattern is consistent with both an over-reliance on detail-based ("local") visual processing of one's own face and an over-allocation of attentional and emotional salience to perceived flaws [35]. Functional MRI work has reported altered activity in fronto-striatal circuits and elevated amygdala reactivity to facial stimuli in individuals with BDD, with corresponding behavioural correlates of misinterpretation of neutral faces as hostile or disgusted and impairments in identity matching across emotional expressions [35]. Such mechanisms may, on a daily basis, render the patient with BDD acutely sensitive to perceived judgement from others — particularly relevant in athletes whose performances are explicitly judged.

Cognitive-behavioural models of BDD offer a complementary level of explanation. Veale's model situates the disorder in the experience of the self as an aesthetic object: an external trigger (a mirror, a photograph, a reflection) activates self-focused attention on a distorted internal image, which is then negatively appraised, generating rumination, low mood and the deployment of safety behaviours (camouflage, avoidance, repeated checking) that paradoxically maintain the preoccupation [39]. Excessive self-focused attention has been shown empirically to amplify the perception of minor imperfections [39], and the model has direct clinical implications: aesthetic procedures that "fix" a perceived flaw without addressing the underlying attentional bias may temporarily reduce, but more often relocate, the focus of distress to a new feature [38,39].

5.2. Muscle Dysmorphia (Bigorexia) and Eating Disorders

Conceptual framework

MD was first delineated by Pope and colleagues in 1997 as a subtype of BDD whose central preoccupation is the conviction of being insufficiently muscular or lean, even in the presence of an objectively hypertrophied physique [40]. Originally termed "reverse anorexia nervosa", the syndrome is characterised by hours of daily preoccupation with muscularity, compulsive weightlifting, restrictive high-protein dieting, body checking behaviours, avoidance of bodily exposure (except in competitive contexts), camouflage with baggy clothing and, in a substantial proportion of cases, the use of anabolic-androgenic steroids and other appearance- and performance-enhancing drugs [40]. MD is currently classified as a specifier of BDD in the DSM-5-TR and the ICD-11 [8,9]. Prevalence among male recreational and competitive bodybuilders has been estimated at approximately 10–53% depending on instrument and threshold, with culturally driven pressures toward muscularity and a documented gender-related preponderance in men [8,40].

Personality, perfectionism and disordered eating

The intersection of MD and broader appearance-focused pathology is increasingly recognised. A recent meta-analysis pooling 34 studies and over 13,000 participants reported a moderate and

statistically significant cross-sectional association between BDD symptoms and perfectionism ($r \approx 0.32$), with comparable estimates for the MD subtype ($r \approx 0.34$) [41]. Both perfectionistic concerns (fear of mistakes, self-criticism) and perfectionistic strivings (setting and pursuing high standards) appeared relevant, though concerns showed the more consistent association [41]. These findings align with the personality literature on MD, in which vulnerable narcissism, neuroticism and perfectionism recur as predictors of symptom severity [9].

Disordered eating is the third element of this clinical triad. Athletes are reported to demonstrate prevalence rates of eating disorders considerably higher than non-athlete controls — with figures ranging from 14% to 45% — and the risk is concentrated in aesthetic disciplines, weight-class sports, endurance sports and physique-oriented sport [42]. Specific phenomena recognised in athletes include Relative Energy Deficiency in Sport (REDs), the Female Athlete Triad, and orthorexia, the last of which is characterised by an obsessive focus on dietary "purity" [42]. Sub-clinical disordered eating ("disordered eating" without full diagnostic threshold) is also widespread and may, in many cases, be normalised within the cultural environment of the sport [42]. Within physique-oriented populations, MD frequently co-occurs with bulimic-type behaviours, restrictive cutting cycles before competition, and the use of diuretics and stimulants — a pattern that may evade detection on standard screening designed for thinness-oriented eating disorders [40,42].

The vicious cycle: aesthetic correction as compensation

When MD, perfectionism and disordered eating converge, aesthetic medicine procedures may become functionally embedded in a compensatory behavioural sequence. The patient who fears the imminent loss of competitive form — between contests, in the transition to a higher weight class, or after retirement from active sport — may experience minor age- or fatigue-related changes in appearance as catastrophic. Aesthetic interventions (BoNT-A for the upper face, HA fillers in the mid-face, masseter reduction, body contouring, scar revisions) may then be sought not as ageing-related corrections but as attempts to re-establish the perceived identity of the competitive athlete. In this context, technically successful procedures may produce only transient psychological relief and may be followed, within weeks to months, by a renewed focus on a different anatomical site. The mechanism, well described in the BDD literature [38,39],

applies with particular force in this population, in which the boundary between training-related body monitoring and clinically significant body checking may be especially difficult to draw.

5.3. Reward Mechanisms and Treatment-Seeking Addiction (The "Fix-it" Syndrome)

Reward, habituation and addiction frameworks

A complementary conceptual framework for the recurrence of treatment-seeking behaviour invokes reward-system dynamics. The proposed "Addiction to Body Image" model situates MD within the framework of behavioural addictions, defining the addictive activity not as exercise per se but as the *maintenance of body image* via a suite of behaviours — bodybuilding, dieting, supplement and drug use, purchasing of training accessories and, by extension, repeated aesthetic procedures [43]. The model maps onto established addiction components: salience (preoccupation with body-image maintenance to the exclusion of other roles), mood modification (endorphin and dopamine release after training or after a successful procedure), tolerance (the need for progressively larger or more frequent interventions), withdrawal-like dysphoria when behaviours are interrupted, conflict (interpersonal and occupational), and relapse [43]. Although the addiction reframing of MD remains an opinion-level proposal rather than a consensus position, it offers a clinically useful heuristic: post-procedure dopaminergic reward appears, in susceptible individuals, to habituate rapidly, generating a need for renewed interventions to recapture the initial experience of relief.

Treatment dissatisfaction in BDD and the "Fix-it" trajectory

The empirical literature on satisfaction after aesthetic intervention in patients with BDD is consistent with this dynamic. A recent systematic review of psychological disorder and patient satisfaction in aesthetic surgery analysed 13 studies and reported that, although the relationship is not uniform across instruments, the majority of investigations identified a negative association between moderate-to-severe preoperative psychological symptoms — particularly BDD, depression and anxiety — and postoperative satisfaction [44]. Earlier work indicates that the proportion of BDD patients who report symptom worsening or new appearance-related concerns after aesthetic procedures is substantial, with rates in some series exceeding 80%

[12,37,38]. Importantly, "satisfaction" in these patients tends not to be stable: an initially favourable response in the first weeks may give way to renewed dissatisfaction within months, frequently with displacement of the concern to a different anatomical feature [38,39].

This dynamic — sometimes described informally as the "Fix-it" syndrome — describes the patient who returns repeatedly for additional interventions in the conviction that a final, decisive correction will resolve the underlying distress, despite an objective record of accumulated procedures that have not done so. The mechanism is not, in essence, technical but cognitive: as long as the unaddressed cognitive schema of defectiveness or shame is operative, no aesthetic intervention can deliver lasting symptomatic relief [39]. In athletes whose competitive identity depends on a particular phenotype, and whose access to image-centric social platforms is essentially continuous, the conditions favouring this trajectory are unusually concentrated. Postoperative satisfaction is also moderated by the alignment between expectations and outcomes, the presence of preoperative depression or anxiety, and the level of preoperative psychological screening — variables that are seldom systematically addressed in routine aesthetic practice [44].

6. Screening and Psychotherapeutic Tools in the Clinician's Office

The conceptual ground covered in the preceding chapter — BDD, MD, disordered eating and reward-driven treatment-seeking — translates, in routine aesthetic practice, into a small number of recurring clinical dilemmas. How does the practitioner recognise the patient whose ostensibly modest aesthetic request is in fact the surface expression of unrecognised psychopathology? Which assessment tools transfer practicably from research to a 30-minute consultation? How and when can the clinician usefully draw on elements of cognitive-behavioural therapy (CBT) or schema therapy? And when is the only ethically defensible response a clear refusal of treatment and a structured psychiatric referral? This chapter offers a working framework, addressed to the aesthetic practitioner rather than to the psychotherapist.

6.1. Red Flags in the Medical History

Why screening matters: clinical and medicolegal stakes

Operating on a patient with untreated BDD is associated with elevated risk of postoperative dissatisfaction, symptom worsening, emergence of new appearance-related concerns and, in a small but well-documented minority of cases, hostility or even litigation directed at the practitioner [12,37,38]. The Australian Health Practitioner Regulation Agency response in 2023 — mandating validated preoperative psychological screening for elective cosmetic surgery — represents the most explicit regulatory acknowledgement of this risk to date [45]. A recent national survey of Australian aesthetic plastic surgeons, conducted one year after implementation, nevertheless reported a striking gap between the prevalence of BDD documented in the literature and the rates of referral and diagnosis observed in practice: 84% of surveyed surgeons referred fewer than 5% of patients for psychological assessment, and 70% reported no cases of BDD diagnosed in the preceding year [45]. Mean surgeon-rated confidence in the accuracy and usefulness of the available screening tools was 3.2/10 on both metrics, and only 30% indicated they would continue to use screening if it were not mandatory [45]. These figures indicate that, even where regulatory mandate exists, implementation depends critically on instrument validity, practitioner training and a structured pathway for follow-up assessment.

Validated screening tools and their use

Several validated instruments are available to the aesthetic practitioner. The most widely used include the Body Dysmorphic Disorder Questionnaire (BDDQ), its Dermatology Version (BDDQ-DV) and the Cosmetic Procedure Screening Questionnaire (COPS) [13]. The BDDQ-DV — originally developed by Phillips and colleagues — was specifically modified to the dermatologic and aesthetic context, with a Likert-scale rating of distress and functional impairment replacing the weight-related items of the parent instrument; it has demonstrated high sensitivity and specificity in dermatological surgery cohorts and has recently been validated in a Polish-language version, with Cronbach's α of 0.92 and excellent test–retest reliability [46]. The BDD-YBOCS (Yale–Brown Obsessive Compulsive Scale modified for BDD), the Dysmorphic Concern Questionnaire (DCQ) and the BDDQ–Aesthetic Surgery

(BDDQ-AS) constitute alternative instruments with different validation profiles [13]. One pragmatic refinement is the multiphasic, "cryptic" screening protocol, in which patients are screened with a brief, ostensibly generic prescreening form followed by a more extensive secondary questionnaire only in those who flag positive on the first; in a multicentre evaluation of 734 sequential aesthetic patients, 4.2% progressed to the secondary screening and 29% of those subsequently screened positive for BDD, with refusal of treatment offered to the majority of positive cases [47]. The "cryptic" structure aims to mitigate the social-desirability bias that may otherwise lead BDD patients to under-report symptoms.

Athlete-specific red flags

Beyond the standard clinical clues — frequent mirror checking, constant comparison with others, requests for technically improbable outcomes, displacement of distress to a new feature after prior procedures, demanding behaviour toward staff [38] — a number of red flags are of particular relevance in the athlete-patient. These include: a stated motivation framed in terms of judging panels, social-media exposure or sponsorship pressure rather than personal preference; a pattern of intense pre-competition treatment requests followed by post-competition expressions of regret; reports of compulsive weighing, body monitoring or daily measurement of specific body parts; evidence of restrictive cutting or bulking cycles incompatible with healthy nutrition; concurrent or recent use of AAS, diuretics or peptides, declared or suspected; and a personal history of binge–restrict eating or training-related injury. The presence of MD-specific behaviours — wearing baggy clothing despite obvious muscularity, avoidance of beaches or changing rooms, daily preoccupation with size or symmetry, and an objective fat-free mass index that exceeds plausibly achievable physiological limits — should raise particular suspicion [40,43]. Patient surveys have also indicated that, although awareness of BDD is rising in the lay population, patients themselves often regard their aesthetic concerns as legitimate and rarely volunteer psychiatric history during a cosmetic consultation; clinicians may need to enquire actively and non-judgmentally rather than expecting spontaneous disclosure [48].

6.2. Cognitive-Behavioural Therapy and Schema Therapy: Tools for the Aesthetic Clinician

The aesthetic practitioner is not a psychotherapist, and the discussion below is not intended to substitute for formal psychological intervention. Nevertheless, an understanding of the conceptual framework, and a working facility with a small number of techniques, can substantially improve consultation quality and the calibration of patient expectations.

Evidence base for CBT in BDD

Cognitive-behavioural therapy adapted for BDD — incorporating cognitive restructuring, exposure with response prevention, and behavioural experiments — has accumulated the strongest evidence base for the disorder. A systematic review and meta-analysis of seven randomised controlled trials (n = 299) reported that CBT was superior to waitlist or credible psychological placebo in reducing BDD symptom severity (standardised mean difference $\delta = -1.22$, 95% CI −1.66 to −0.79), with parallel improvements in depressive symptoms ($\delta = -0.49$) and insight ($\delta = -0.56$), and maintenance of effect at 2–4 months follow-up [49]. The conceptual basis for CBT in BDD is the cognitive model in which excessive self-focused attention on a distorted internal image, negative appraisal, rumination and the deployment of safety behaviours together maintain symptoms; targeting any element of this loop can shift the system [39]. Pharmacotherapy with selective serotonin reuptake inhibitors has independent evidence of efficacy and is often used in combination [49].

Practical cognitive techniques in the aesthetic consultation

A small repertoire of cognitive-behavioural techniques can usefully inform the practitioner's communication. The most relevant in the aesthetic context is the identification and gentle questioning of cognitive distortions [50]. Common distortions in physique athletes include "mind reading" (the conviction that judges, opponents or social-media followers are noticing or evaluating a specific perceived flaw); "all-or-nothing" thinking ("if my forehead lines are visible, my career is over"); "fortune telling" (the prediction that without a specific intervention, contractual or competitive consequences will follow); "magnification" of minor asymmetries;

and "personalisation" (the assumption that observers' behaviour reflects judgement of one's appearance). The clinician can productively bring such interpretations into open discussion — not with the aim of providing therapy in the office, but in order to test whether the patient's stated motivation is shared with the rest of their life or restricted to the procedure itself, and whether expectations are accordingly realistic. CBT for BDD specifically targets these attention and interpretive biases and impaired visual processing, encouraging holistic rather than detail-focused perception [50]. Where the patient is unable to engage with this kind of probing, or responds with reassurance-seeking, hostility or further escalation of demands, the consultation has yielded important diagnostic information regardless of whether a procedure is ultimately performed.

Schema therapy and the recognition of maladaptive schemas

A complementary framework, particularly relevant to chronic and treatment-resistant presentations, is schema therapy, which integrates cognitive-behavioural, interpersonal, experiential and psychodynamic techniques to address the early maladaptive schemas presumed to underlie long-standing emotional and relational difficulties [51]. Schema therapy posits a set of universal core emotional needs — safety, stability, nurturance, autonomy, competence, identity, freedom of expression, spontaneity and realistic limits — and proposes that early maladaptive schemas arise when these needs are systematically unmet in childhood [51]. Coping with such schemas tends to occur through surrender, avoidance or overcompensation; the latter is of particular relevance in physique-oriented sport, where overcompensatory pursuit of muscularity, control over food intake and visible mastery of the body may serve to offset earlier experiences of weakness, ridicule or rejection [9,51].

Two schema domains recur in clinical descriptions of physique athletes and treatment-resistant aesthetic patients. The first is the **Defectiveness/Shame** schema, in which the individual carries a fundamental sense of being internally flawed, defective or unworthy of love, and seeks external bodily perfection as compensation. The second is the **Unrelenting Standards** schema, in which the individual feels driven to meet internalised standards of performance and appearance so high that they leave little room for relaxation, satisfaction or stable self-acceptance. Both schemas have been linked, in the broader BDD and MD literature, to high

perfectionism, vulnerable narcissism, and the chronic dissatisfaction that follows even technically successful aesthetic interventions [9,51]. Recognising these patterns does not equip the aesthetic clinician to treat them; it does, however, equip them to distinguish patients whose distress is likely to be resolved by a discrete procedure from those for whom no procedure, however well executed, can substitute for the underlying psychotherapeutic work.

6.3. Intervention Algorithm: When to Refuse and When to Refer

The translation of these screening and conceptual frameworks into a practical algorithm requires only a small number of decision points. A reasonable structure for routine aesthetic practice is the following.

Stage 1 — Universal screening. All new patients should complete a validated brief instrument (for example, BDDQ-DV or COPS) at the initial consultation, supplemented by an open enquiry into prior aesthetic procedures, satisfaction with previous outcomes, and the specific events or environments (competition, broadcast appearance, social-media exposure) that motivated the present request [13,47]. The "cryptic" two-step protocol, in which the initial form is presented as part of a general intake rather than a psychiatric screen, may improve disclosure [47].

Stage 2 — Risk stratification. Patients flagged positive by initial screening, or those demonstrating any of the athlete-specific red flags described above, progress to a more detailed assessment. The clinician should explicitly evaluate (i) the discrepancy between objective and perceived deficit; (ii) the degree of functional and emotional impairment attributable to the appearance concern; (iii) the presence of repetitive behaviours (mirror checking, comparison, reassurance seeking); (iv) the history of prior cosmetic procedures and their outcomes; (v) the realism of expectations and motivations; and (vi) any concurrent psychiatric symptoms (depression, anxiety, suicidal ideation, disordered eating, AAS use). Empirical evidence indicates that moderate-to-severe preoperative psychological symptoms — particularly BDD — are associated with significantly worse postoperative satisfaction, supporting a cautious threshold for proceeding [44].

Stage 3 — Intervention or referral. Where assessment indicates a clinically meaningful suspicion of BDD, MD, an eating disorder, severe depression, suicidal ideation, AAS-induced mood disorder, or unrealistic expectations resistant to discussion, aesthetic intervention should be deferred and the patient referred to a clinician trained in evidence-based psychological treatment for these conditions. CBT remains the first-line psychological treatment for BDD, with selective serotonin reuptake inhibitors as the primary pharmacotherapy; a recent meta-analysis and trial-sequential analysis of randomised controlled trials of psychological interventions for BDD reported moderate-to-large effects of CBT, with maintenance at follow-up, although the authors emphasised the heterogeneity of trial quality and the need for larger, controlled studies [52]. Where comorbid disordered eating or AAS use is identified, multidisciplinary referral (psychiatry, eating-disorder services, endocrinology, sports medicine) is preferred. Where the patient declines referral, the practitioner is nevertheless on stronger ethical and medicolegal ground for declining to proceed: declining treatment in the presence of unaddressed psychopathology is consistent with both contemporary regulatory expectations [45] and a substantial empirical literature on outcomes [37,44].

Stage 4 — Selective treatment with explicit monitoring. In patients with mild appearance concerns, intact insight, realistic expectations and absence of red flags, conservative aesthetic intervention may be appropriate. Postoperative follow-up should incorporate repeat administration of validated outcome measures, an explicit re-evaluation of satisfaction at defined time points (for example, 6 weeks, 3 months, 12 months), and a clearly documented plan for psychiatric re-referral if dissatisfaction emerges or if symptoms transfer to a new anatomical site [44]. Patient education is also relevant at this stage: surveys of aesthetic patients in Polish plastic-surgery and aesthetic-medicine clinics have indicated that, while public awareness of BDD is growing, patients frequently perceive practitioners as insufficiently engaged with mental-health aspects of care, and view a more active role in education and referral as both legitimate and desirable [48].

The absolute indications for refusing aesthetic intervention thus reduce to a short list: an objective deficit that is clinically negligible in the face of severe distress; explicit or implicit suicidal ideation; active eating disorder or AAS-induced mood disturbance; manifest cognitive distortion that does not yield to brief discussion; demanding, hostile or "doctor-shopping"

behaviour; a documented history of dissatisfaction with multiple prior procedures with displacement of the concern; and any patient request that the practitioner does not believe can be ethically and technically satisfied. In such circumstances, the clinician's duty is not to attempt to satisfy the patient but to redirect them toward the form of care that has any plausible chance of producing lasting benefit.

7. Discussion, Limitations, Conclusions and Future Perspectives

7.1. Discussion

The synthesis of the preceding chapters describes a clinical population that diverges from the standard aesthetic-medicine patient along three principal axes — physiology, pharmacology and psychopathology — and in which each axis interacts non-trivially with the agents and procedures that practitioners are expected to deliver. None of these axes has, to our knowledge, been adequately addressed in a single coordinated way within either the aesthetic or the sports-medicine literature, and the discussion below is therefore necessarily integrative rather than confirmatory.

On the physiological axis, the trained body presents elevated basal metabolic rate, exercise-induced oxidative stress, capillary angiogenesis, increased motor-unit turnover and chronic mechanical loading on selected muscle groups. The available evidence, although not yet supported by dedicated prospective imaging studies in athletes, suggests that these factors may shorten the effective duration of both crosslinked HA fillers — through accelerated oxidative depolymerisation and increased delivery of endogenous hyaluronidases to the depot — and of botulinum neurotoxin, with empirical confirmation of the latter in a controlled single-blind trial reporting faster electromyographic and clinical recovery in highly active subjects [11]. In the management of HA-related complications, hyaluronidase remains the cornerstone, with a robust mechanism of action — endo-β-N-acetyl-hexosaminidase cleavage of the β-1,4 glycosidic bonds of HA, with concentration- and time-dependent kinetics that vary with the filler product and the proximity of the enzyme to the depot [53]. The off-label use of hyaluronidase for dissolving HA fillers, addressing granulomatous reactions and managing skin necrosis arising from filler-induced vascular occlusion is considered the gold standard for HA-

related adverse events in aesthetic medicine [54]. A recent international survey of 264 aesthetic practitioners reported substantial variability in storage, preparation, skin-testing practice and emergency use, and emphasised the present absence of evidence-based guidelines on concentration, dosing and treatment intervals [55]. In athletes — and particularly in those with AAS-related polycythaemia or anticipated bleeding risk — the threshold for emergency hyaluronidase deployment and ancillary supportive measures may need to be lowered, and pre-procedure documentation correspondingly tightened.

Emerging filler technologies merit brief mention because they may, in time, modify some of the physiological vulnerabilities described in this work. Hybrid devices in which crosslinked HA is co-formulated with secondary regenerative components — for example, lactose-modified chitosan (Chitlac) — have been engineered to enhance elastic modulus, cohesivity and resistance to hyaluronidase and ROS-mediated degradation, while reducing the quantity of crosslinking agent required [56]. Such platforms may, in principle, prove more robust to the exercise-induced perturbations described in Section 4, though no athlete-focused evaluations have yet been reported.

On the pharmacological axis, the convergence of AAS, diuretics, growth-related peptides and contest-preparation nutrition with aesthetic procedures introduces complications that are largely absent in the general aesthetic-medicine literature. These complications span dermatologic (acne, keloid risk), hepatic, cardiovascular, haematological (polycythaemia, altered platelet behaviour), endocrine and electrolyte domains [10,27–33]. The clinical experience accumulated in adjacent special populations — for instance, in patients with autoimmune diseases, where aesthetic interventions require a tailored assessment of medication effects, immune status and tissue healing capacity [57] — provides a useful precedent: as in autoimmune care, the assessment of the athlete-patient may benefit from explicit, pre-procedural medication reconciliation, baseline laboratory testing where indicated, and individualised treatment planning that accounts for cycle phase, contest schedule and concurrent training load.

On the psychopathological axis, the convergence of BDD, MD, disordered eating, perfectionism and reward-system dynamics defines a clinical context in which technically

successful aesthetic procedures may produce only transient psychological relief, and may even be followed by symptom worsening or displacement to a new feature [37,38,44]. The data on satisfaction in BDD patients — with substantial proportions reporting symptom worsening or emergence of new appearance concerns after cosmetic procedures — argue for a baseline of caution, not for blanket exclusion. The latter is not consistent with the available evidence in the milder end of the spectrum; the former is.

7.2. Limitations of the Present Review

Several limitations of the present narrative review should be acknowledged. First, the format itself is descriptive rather than systematic; no pre-registered protocol or formal risk-of-bias appraisal was undertaken, and the literature search was not exhaustive in the manner of a Cochrane-style synthesis. Second, dedicated studies in athletes — particularly prospective, controlled investigations of filler longevity, neurotoxin durability and screening-tool performance in physique-oriented populations — remain very sparse, and many of the inferences offered here are drawn by analogy from adjacent populations (cosmetic surgery patients, weightlifters, dermatology cohorts) rather than from direct evidence. Third, the strength of association between AAS or diuretic use and specific aesthetic-procedure outcomes is largely inferential, since neither agent class can ethically be administered in a controlled aesthetic trial. Fourth, the heterogeneity of psychometric instruments used in the BDD literature, and the absence of athlete-specific validation for most of them, complicates the integration of prevalence and screening data across studies. Finally, the cultural specificity of body-image research — with substantial regional variability in BDD prevalence and in social-media exposure — restricts the universality of the conclusions offered here. The cautious linguistic hedging maintained throughout this work reflects these limitations and is intended to forestall the over-interpretation of evidence that is, in many places, suggestive rather than definitive.

7.3. Conclusions and Future Perspectives

7.3.1. Summary of the Most Important Interactions and Mechanisms

The most defensible conclusions to be drawn from this work are the following. (i) The pharmacokinetics of crosslinked HA fillers and BoNT-A may differ measurably in highly active competitive and physique athletes, with shortened effective duration plausibly attributable to elevated BMR, ROS flux, tissue perfusion and motor-unit turnover [11,15–18]. (ii) AAS, diuretics and growth-related peptides each affect tissue substrates relevant to aesthetic procedures — fibroblast biology, collagen turnover, haemostasis and fluid-electrolyte balance — and their use in physique-oriented populations modifies the risk profile of injectable and laser-based interventions in ways not addressed in registration trials [10,27–34]. (iii) BDD, MD and disordered eating appear over-represented in physique-oriented sport and in image-centric aesthetic populations, and the recognition of these conditions remains, even where regulatory mandate exists, suboptimal in routine practice [35–37,44,45]. (iv) Aesthetic interventions in the presence of unaddressed appearance-focused psychopathology are associated with elevated risk of dissatisfaction, symptom worsening and the so-called "Fix-it" trajectory of repeated treatment-seeking [38,39,43].

7.3.2. The Case for Standardised Psychometric Screening Prior to Injections in Athletes

A central practical implication of this review is the case for the systematic integration of validated psychometric screening into pre-procedural assessment of athletes, particularly those in physique-oriented disciplines. Instruments such as the BDD-YBOCS, BDDQ, BDDQ-DV, COPS and DCQ have established psychometric properties in general aesthetic populations [13,46,47] and, where regulatory mandates exist (as in Australia from 2023), have demonstrated implementation feasibility — albeit with substantial variability in practitioner uptake and confidence [45]. Recognising BDD is an important first step toward providing appropriate treatment, given that the condition typically follows a chronic course if untreated and that evidence-based interventions — chiefly CBT and selective serotonin reuptake inhibitors — have established efficacy [49,58]. A consolidated literature on psychotherapeutic interventions for BDD further confirms that CBT, whether delivered face-to-face or through internet-based

protocols (BDD-NET), is currently the most effective psychological treatment, and is most effective when combined with pharmacotherapy [59]. From a pragmatic standpoint, a brief BDDQ-DV at intake, supplemented by a structured athlete-specific red-flag interview and a clear referral pathway, offers the most realistic path forward for routine aesthetic practice. Special attention is warranted for athletes presenting in the immediate pre- or post-competition window, in those declaring or suspected of AAS or diuretic use, and in those with prior multiple aesthetic procedures and persistent dissatisfaction.

7.3.3. Evidence Gaps and a Research Agenda

The most pressing evidence gaps fall into four broad categories. **First**, prospective, imaging-based studies — using magnetic resonance imaging or high-frequency ultrasound — are needed to quantify the effective half-life ($t_{1/2}$) of crosslinked HA fillers in athletes of differing disciplines, training intensities and pharmacological backgrounds, and to compare these with sedentary controls. Such studies would resolve the present indirect inferences regarding accelerated filler degradation under sustained physiological stress, and would inform retreatment intervals tailored to this population. Parallel investigation is warranted for BoNT-A durability across different formulations, doses and target muscle groups, with electromyographic and patient-reported endpoints; the controlled single-blind data currently available [11] provide a template for further work. **Second**, dedicated pharmacological-interaction studies are required to characterise the effects of AAS, diuretics and rhGH/IGF-1 on filler behaviour, wound healing after invasive procedures, and the response of biostimulator-based platforms. Such studies will face ethical and recruitment challenges but may be feasible through observational cohorts of bodybuilders and physique competitors already engaged with aesthetic-medicine practice. **Third**, athlete-specific psychometric tools should be developed and validated; existing BDD instruments do not capture the sport-specific cognitive distortions described in Section 7, and integrated tools that combine BDD screening with MD-specific items (drive for muscularity, exercise dependence), disordered-eating items and AAS-screening questions would be of substantial clinical value. **Fourth**, long-term outcome studies — including post-retirement trajectories in former physique athletes — are needed to characterise the natural history of body-image disturbance in this population and the role of aesthetic interventions across the career arc.

The integration of these strands would, in the medium term, support the development of dedicated practice guidelines for aesthetic medicine in competitive and physique athletes, jointly issued by aesthetic-medicine, dermatological, psychiatric and sports-medicine societies. Such guidelines should articulate, at a minimum: (i) standard pre-procedural psychometric and medical screening, including substance-use enquiry; (ii) procedure-specific recommendations on dosing, retreatment intervals and adjunctive measures; (iii) protocols for managing acute complications in patients with elevated haematocrit or impaired haemostasis; (iv) clear absolute and relative contraindications; and (v) structured referral pathways to mental-health, eating-disorder and sports-medicine services. Until such guidance is developed, the careful, hedged judgement of the individual practitioner remains the principal safeguard.

In conclusion, the encounter between aesthetic medicine and competitive sport is no longer a marginal clinical event. The scalpel, the toxin and the pressure of performance converge, in many present-day clinics, on the same patient. The most useful response of the field is neither uncritical accommodation nor reflexive refusal, but the construction — through dedicated research, validated screening and disciplined practice — of a framework in which the benefits of aesthetic intervention can be delivered safely and ethically to a population whose physiology, pharmacology and psychology demand more than the standard protocol can offer.

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Author's contribution

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