IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 24, Issue 7 Ser.1 (July 2025), PP 39-59
www.iosrjournals.org

Digital analysis of facial epidermal and dermal quality enhanced by Artificial Intelligence: methodologies and applications in clinical routine.

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Abstract: *The advancement of digital technologies has revolutionized the assessment of skin health and aesthetics, especially through the application of artificial intelligence (AI) in facial analysis devices. This article presents a critical and applied review of the digital methodologies used to measure facial epidermal and dermal quality, with an emphasis on AI-based systems. The seventeen parameters evaluated are discussed — such as texture, spots, pores, wrinkles, hydration, elasticity, among others — as well as the algorithms that allow the automated interpretation of high-resolution images. The incorporation of these tools into the clinical routine promotes greater diagnostic accuracy, evolutionary monitoring of treatment, and therapeutic personalization, in addition to being a conversion tool in the patient's decision to agree with the indications of the proposed skin treatments, since the device delivers a projection of the skin if the proposed aesthetic procedures are performed. Finally, a practical integration model is proposed for aesthetics and dermatology professionals, aiming to optimize results and strengthen the relationship with the patient through objective and comparative data.*

***Key Word**: **Key words**: Dermatology, Artificial intelligence, digital skin analysis, facial assessment, aesthetic technologies, skin diagnosis, AI in aesthetics.*

Date of Submission: 20-06-2025 Date of Acceptance: 03-07-2025

I. Introduction

Accurate assessment of facial skin is a crucial step in clinical aesthetic and dermatological practice, being essential for making assertive diagnoses, planning therapy and monitoring the progress of treatments. Because facial skin is constantly exposed to extrinsic factors — such as ultraviolet radiation, pollution and climate — and intrinsic factors — such as aging, lifestyle habits and genetic predisposition —, it has dynamic and complex characteristics that require careful analysis of parameters such as texture, hydration, blemishes, wrinkles, pores, sagging and elasticity (Kang et al., 2020; Piérard, 2021).

Historically, this assessment was performed using subjective methods, which included filling out clinical forms based on targeted anamnesis — addressing lifestyle habits, care routine, diet, presence of skin diseases and use of medications —, followed by visual inspection, manual palpation and, occasionally, the use of auxiliary resources such as magnifying lenses and Wood's lamp (Ortonne et al., 2009). Despite being widely used, these methods are subject to significant interobserver variability, in addition to directly depending on the experience and accuracy of the evaluating professional (Matsuki et al., 2022).

In recent years, the incorporation of artificial intelligence (AI) in aesthetics has significantly transformed the processes of facial evaluation and diagnosis. AI-based systems, such as Vision DNA AI, use deep learning algorithms and high-resolution image analysis to quantify skin parameters in an objective, precise, and reproducible manner, minimizing subjectivity and increasing clinical accuracy (Li et al., 2021; Lee et al., 2020). This technological innovation has established itself as a valuable tool in clinical practice, providing quantitative data that assist in the personalization of treatments and in the monitoring of therapeutic efficacy.

With the exponential advances in technology, especially in the last two decades, digital systems capable of performing high-precision facial analyses have emerged. These systems use high-resolution cameras and software that allow detailed capture of the skin surface, enabling objective quantification of parameters such as spots, texture, pores, wrinkles, sagging, oiliness, and hydration (Kim et al., 2021; Lee et al., 2020).

More recently, the integration of artificial intelligence (AI) and machine learning into these devices has revolutionized dermatological and aesthetic analysis, offering greater precision, sensitivity, and specificity in the detection of skin changes (Lansang & Kwong, 2020). AI allows not only automated interpretation of images, but also early identification of aging patterns, aesthetic dysfunctions, and dermatological conditions, in addition to providing continuous monitoring of therapeutic response through comparative analyses and evolutionary data (Cheng et al., 2021).

These technological innovations are becoming indispensable tools for professionals in aesthetics, dermatology and aesthetic medicine, as they increase diagnostic accuracy, reduce the subjectivity of manual assessment and favor the construction of highly personalized therapeutic protocols, based on objective data (Li et al., 2021).

In view of this scenario, the present study aims to analyze and validate the use of artificial intelligence applied to facial assessment in clinical practice, focusing on the experience obtained through the use of the Vision DNA AI system. In addition, it seeks to critically review current methodologies for digital facial skin analysis supported by AI, discuss their clinical applications and highlight the benefits of this resource in improving clinical reasoning, in the construction of individualized protocols and in obtaining better therapeutic results.

STRUCTURE AND PHYSIOLOGY OF FACIAL SKIN

The skin is the largest organ in the human body and plays an essential role in protecting against external agents, regulating temperature, maintaining hydroelectrolytic balance and providing sensory perception. In the facial region, the skin has distinct anatomical and physiological characteristics, being thinner, more vascularized and with a greater number of cutaneous appendages, which makes it particularly susceptible to both intrinsic and extrinsic factors that impact its health and appearance (Proksch et al., 2008; Farage et al., 2013).

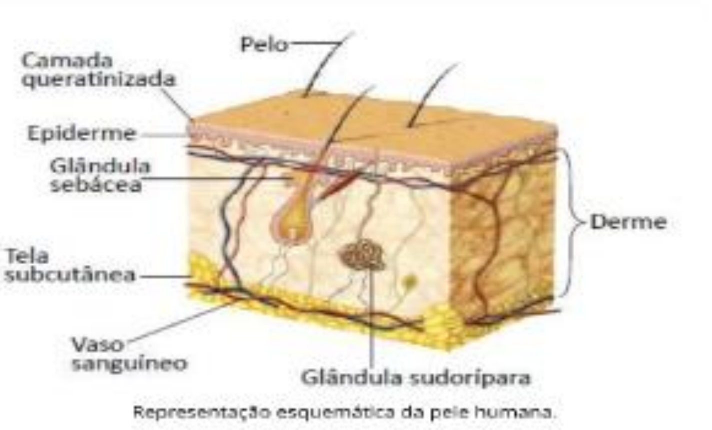
Skin Layers and Their Visual Markers

The skin is composed of three main layers: epidermis, dermis and hypodermis, each with specific functions and visible characteristics that can be captured through spectral analysis.

Epidermis: the most superficial layer, composed predominantly of keratinocytes. It is responsible for the skin barrier, protection, regulation of water loss and pigmentation. Changes in the epidermis are generally seen as spots, changes in texture, opacity and dryness (Elias, 2007).

Dermis: located below the epidermis, it is rich in collagen fibers, elastin and extracellular matrix, providing support, elasticity and resistance to the skin. Visible changes in the dermis include sagging, formation of wrinkles, deep grooves and loss of volume (Sherratt, 2009).

Hypodermis: deepest layer, composed of subcutaneous adipose tissue, responsible for mechanical protection and energy reserve. In facial aging, there is redistribution and reabsorption of this compartment, leading to loss of contours and support (Rohrich & Pessa, 2007).



SCHEMATIC REPRESENTATION OF HUMAN SKIN

Visual markers related to skin changes include:

Texture: associated with the integrity of the epidermis and the organization of the stratum corneum. Irregularities indicate dehydration, accumulation of dead cells or extrinsic damage (Kim et al., 2021).

Oiliness: reflects the activity of the sebaceous glands, visible as shine, dilated pores and predisposition to acne (Picardo et al., 2017).

Pores: result of the dilation of follicular ostia, generally accentuated by increased sebum production and loss of dermal elasticity (Flament et al., 2015).

Spots: localized hyperpigmentation, resulting from melanocytic dysfunctions or sun damage, evident in the epidermis or at the dermoepidermal junction (Ortonne, 2009).

Wrinkles: fine lines or grooves, generally associated with the degradation of collagen and elastin fibers in the dermis (Sherratt, 2009).

Sagging: loss of tone and firmness due to decreased density of collagen and elastin fibers, in addition to the reabsorption of subcutaneous fat (Wang et al., 2020).

Extrinsic and Intrinsic Factors that Influence the Skin

The physiology of facial skin is affected by a constant interaction between intrinsic and extrinsic factors.

Intrinsic Factors: related to chronological aging, genetic predisposition, cellular metabolism, and hormonal changes. These factors directly impact cell renewal, collagen synthesis, hydration, and the skin's antioxidant capacity (Quan et al., 2009).

Extrinsic Factors: associated with the exposome, including ultraviolet (UV) radiation, pollution, smoke, visible light, infrared, stress, poor diet, smoking and sleep deprivation. These factors accelerate low-grade chronic inflammation processes (inflamaging), increased reactive oxygen species (ROS) and degradation of the extracellular matrix, resulting in photoaging, spots, opacity and sagging (Krutmann et al., 2017; Giacomoni et al., 2009).

Conventional Skin Assessment: Limitations and Challenges in Clinical Practice

Clinical assessment of the skin is a crucial step in the development of aesthetic and dermatological therapeutic procedures. Traditionally, this analysis is performed based on manual and subjective methods, which include visual inspection, palpation, conventional photographs, clinical scales (such as Baumann, 2005) and directed anamnesis with data collection on lifestyle, pathological history and care routine.

Despite its historical and formative value, this traditional model presents important limitations that directly impact diagnostic accuracy, protocol standardization and clinical efficiency.

Main limitations of conventional assessment:

Examiner subjectivity: the interpretation of skin signs is highly dependent on the individual clinical experience and technical training of the professional, and may vary significantly between different professionals (interprofessional variability) and even within the same team.

Lack of standardization in records: the absence of objective measurement systems makes it difficult to monitor the evolution of treatments, leading to clinical decisions based on visual perception and descriptive memory, which compromises reproducibility and therapeutic continuity.

Risk of diagnostic error: small changes in the skin (such as incipient hyperpigmentation, subclinical inflammation or irregular porosity) may go unnoticed or be interpreted imprecisely, leading to inadequate or ineffective therapeutic proposals.

Compromised clinical time: the manual process requires prolonged consultation time, overloading the professional's routine, reducing productivity and making it difficult to adopt more complex or personalized protocols.

The limitations described reinforce the need for objective, standardized and automated technological tools, such as spectral analysis and artificial intelligence systems. These technologies act as a complement to clinical reasoning, offering precise data, comparative images and detailed analysis of parameters invisible to the naked eye, increasing diagnostic safety and therapeutic personalization.

APPLICATION IN SPECTRAL ANALYSIS

The use of capture systems using 8 spectral images, such as the Vision DNA AI device, represents a significant advance in facial skin analysis. This method uses a high-tech cabin equipped with ultra-high-definition sensors (more than 36 million pixels), which allows obtaining very high-quality images, favoring an accurate analysis of the characteristics of the epidermis and dermis, in addition to minimizing subjective errors in clinical evaluation (Lee et al., 2020; Kim et al., 2021).

Each image is captured under different light spectra, which penetrate the skin at varying depths, allowing the identification and quantification of both superficial and deep changes. This approach allows the analysis of diverse physiological and pathological markers, such as epidermal and dermal spots, texture, oiliness, pores, wrinkles, sagging, erythema and sebaceous disorders (Cheng et al., 2021).

Types of Spectral Lighting and Their Applications

White Light (Standard)

White light, also called standard lighting, is the closest to the conditions observed with the naked eye. This light source offers a faithful reproduction of the real appearance of the skin, using the full spectrum of visible light, which ranges from approximately 400 to 700 nm (nanometers) (Jacques, 2013).

This lighting is essential for a global analysis, as it simulates natural light conditions, allowing the professional to view the skin in a way similar to human perception. It is the initial basis for all spectral evaluation, being essential both for subjective analysis and for calibrating the objective parameters of artificial intelligence algorithms.

Assessment of surface texture: Allows for the observation of uniformity, roughness, fine lines and changes in the stratum corneum.

Analysis of visible spots: Detects apparent hyperpigmentation, such as melasma, solar melanosis, freckles and post-inflammatory hyperpigmentation.

Observation of pores: Highlights dilated pores, especially in areas of greater sebaceous activity (T zone).

Tone uniformity: Assesses noticeable chromatic disorders, such as dyschromia, erythema or hypopigmentation.

Clinical documentation: White light images serve as a basis for pre- and post-treatment comparison, in addition to assisting in visual communication with the patient.

Integration with AI: White light allows for the initial analysis of artificial intelligence algorithms, which correlate visible skin changes with data from other spectral lamps.

Biomedical optics studies demonstrate that white light interacts primarily with the superficial layer of the skin, being reflected, refracted or absorbed according to the composition and integrity of the epidermis and superficial dermis (Jacques, 2013). In addition, dermatological analysis systems such as VISIA, OBSERV 520 and Vision DNA 12D itself use white light as the gold standard to represent the visible state of the skin, complementing the information from other spectral lights (Lee et al., 2020; Kim et al., 2021).

White light is particularly effective in identifying directly perceptible aesthetic changes, being crucial for planning immediate interventions, such as peels, lightening treatments, oil control, spot therapy and dermal stimulation.

The twelve images obtained through the capture of white spectral light allowed detailed analysis of different skin changes. The records provided relevant diagnostic data, including the presence of acne, hyperpigmentation, wrinkles, and enlarged pores (Figures 1 to 12).

Positive Polarized Light

Positive polarized light, also known as parallel polarized light, plays a fundamental role in analyzing the skin surface. Its main function is to reduce or eliminate specular reflections (surface shine) that normally occur when light interacts with the stratum corneum, allowing precise observation of the structural characteristics of the epidermis (Jacques, 2013).

By aligning light waves in a single plane, positive polarized light highlights surface details, making aspects such as:

Skin texture: highlights irregularities in the organization of the stratum corneum, flaking and microporosities.

Superficial spots: improves the visualization of localized hyperpigmentation in the epidermis, such as solar melanosis and lentigines.

Dilated pores: allows precise measurement of the size and quantity of follicular ostia.

Fine lines and micro-wrinkles: especially those associated with dehydration or initial loss of elasticity of the epidermis.

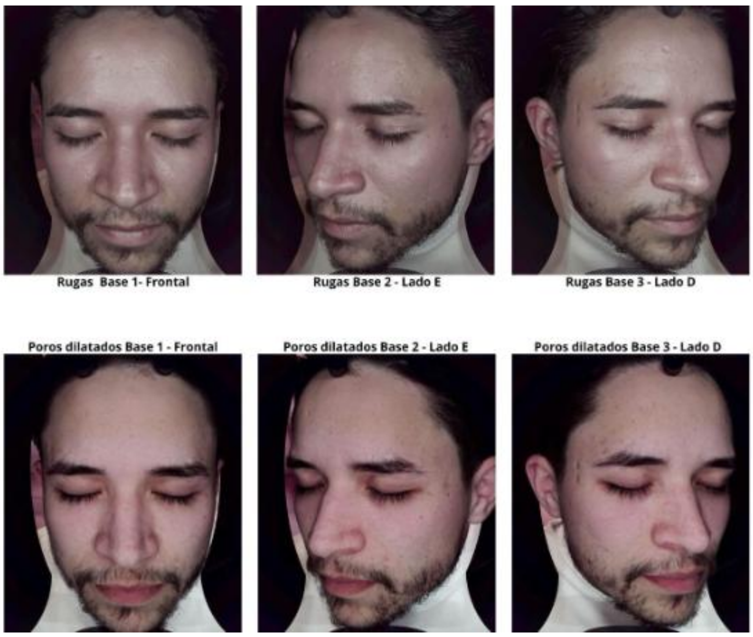
Superficial atrophic scars: such as acne scars, which are more easily visualized without interference from brightness.

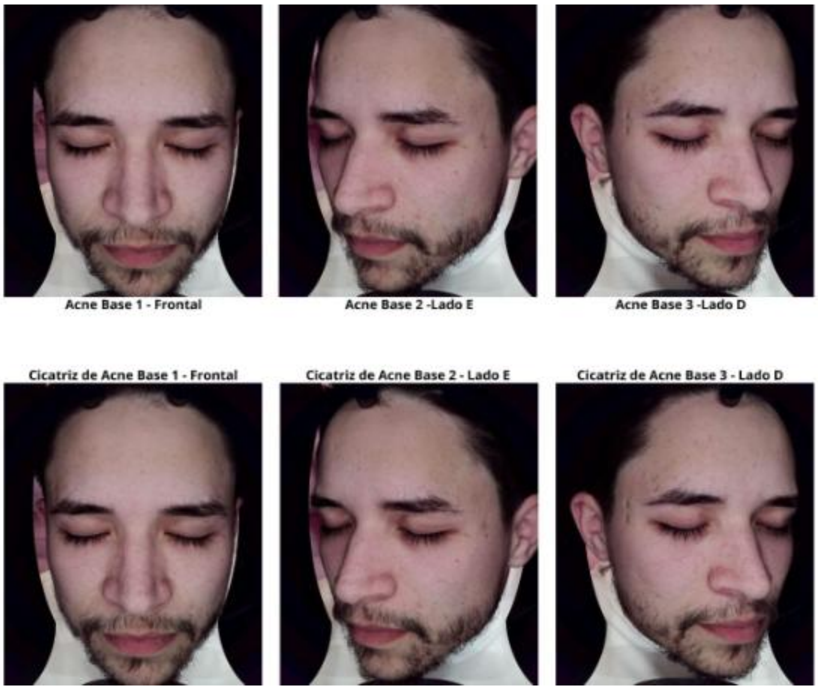
This lighting is extremely effective in evaluating disorders that affect the integrity of the epidermal barrier, in addition to being essential in the objective clinical documentation of the evolution of topical treatments, peels and regenerative therapies focused on the skin surface.

Studies of biophotonics and tissue optics demonstrate that parallel polarized light allows a better evaluation of the superficial reflection of the skin, facilitating the detection of changes in the epidermis. According to Jacques (2013) and Lee et al. (2020), parallel polarized light passes through the stratum corneum with minimal dispersion, highlighting superficial details while minimizing the brightness that would mask this information.

This technique is already applied in advanced dermatological systems, such as VISIA, OBSERV and, more recently, in Vision DNA 12D, enhancing dermatological and aesthetic diagnoses with high precision.

The twelve images obtained through the capture of positive polarized light allowed detailed analysis of different skin changes. The records provided relevant diagnostic data, including the presence of wrinkles, dilated pores, acne and acne scars (Figures 13 to 24).





Negative Polarized Light (Crossed Light)

Negative Polarized Light, also called Crossed Light, uses a polarizing filter oriented at a 90° angle in relation to the plane of light emission. This arrangement eliminates superficially reflected light and favors the capture of light that has been scattered within the tissues, highlighting information from deeper layers of the skin, especially the papillary and reticular dermis (Jacques, 2013).

Vascularization analysis: Highlights superficial and deep blood vessels, allowing the identification of telangiectasias, rosacea and hyperemia.

Detection of erythema and subclinical inflammation: Allows the visualization of inflammatory processes that are often not visible to the naked eye, providing important data on sensitization or chronic low-grade inflammation (inflammaging).

Assessment of dermal quality: Helps identify degradation of the extracellular matrix, fibrosis, edema and disorders in collagen density.

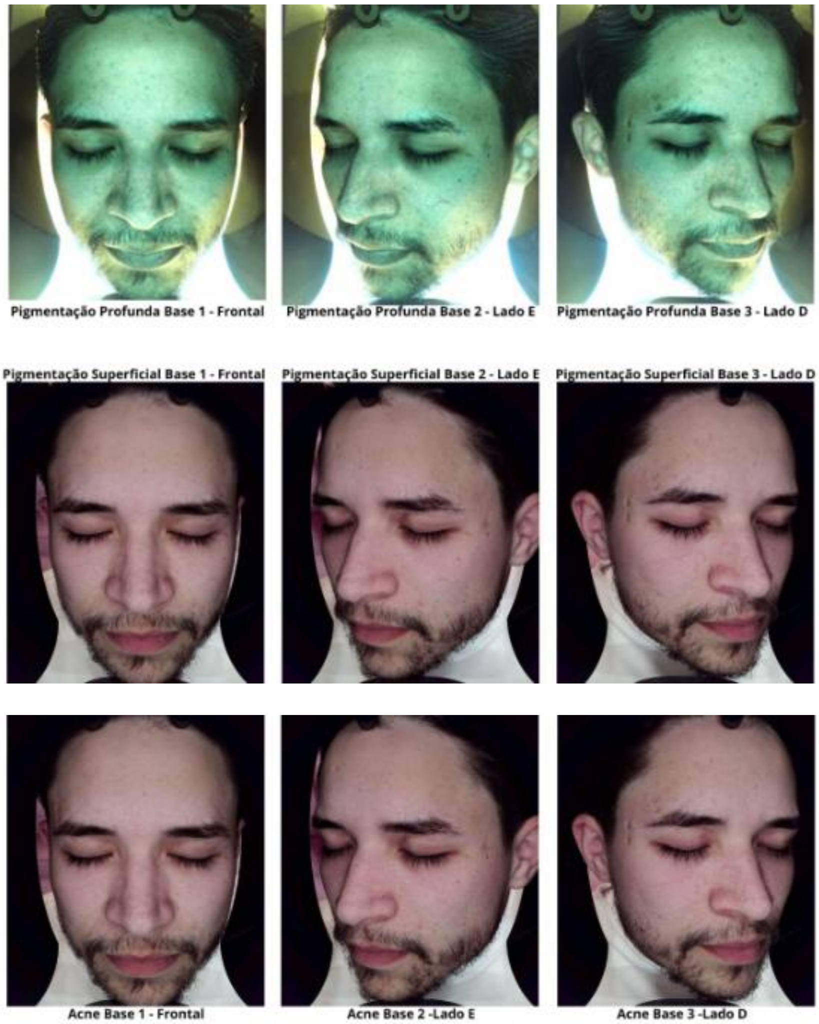
Sensitivity diagnosis support: Essential for detecting inflammatory patterns in sensitive or sensitized skin, which are often clinically underdiagnosed.

Pre- and post-treatment analysis: Allows for monitoring inflammation reduction, improved dermal circulation, and responses to regenerative or soothing treatments.

Crossed light (negative polarized) penetrates the skin layers and, by blocking the light reflected directly from the surface, allows for the capture of internally scattered light, which provides structural information about the dermis (Jacques, 2013). According to Kruglikov & Scherer (2020), this type of lighting is highly efficient for observing dermal inflammation patterns, in addition to providing data on vascularization and disorders associated with skin aging.

The use of cross-polarized light is also reported in advanced imaging systems, such as VISIA, OBSERV, and now in Vision DNA 12D, and is an indispensable tool for constructing a more complete aesthetic diagnosis, especially when associated with artificial intelligence, which quantifies the intensity of the captured signals.

The nine images obtained through the capture of negative polarized light allowed detailed analysis of different skin alterations. The records provided relevant diagnostic data, including the presence of hyperpigmentation, superficial pigments and acne (Figures 25 to 34).



Ultraviolet (UV) Light

Ultraviolet light is an advanced tool in spectral facial analysis, capable of revealing skin changes not visible to the naked eye. Vision DNA 12D uses this technology to deepen the diagnostic observation of the epidermis and superficial dermis, expanding the early detection of skin disorders.

UV light, especially at wavelengths between 320–400 nm (UV-A), interacts with melanin and other epidermal structures, emitting fluorescence that reveals pigmentary disorders, changes in barrier function and areas of accumulated actinic damage (Ortonne, 2009; Jacques, 2013).

Detection of invisible hyperpigmentation: UV light makes visible the melanin deposited in the basal layers of the epidermis, identifying early pigmentary lesions, such as incipient melasma, lentigines and dyschromias.

Analysis of chronic sun damage: Reveals actinic damage, solar elastosis and areas of excessive sun exposure, even before evident clinical manifestations.

Changes in the skin barrier: Highlights areas with dehydration, excess oiliness or compromised epidermal barrier function.

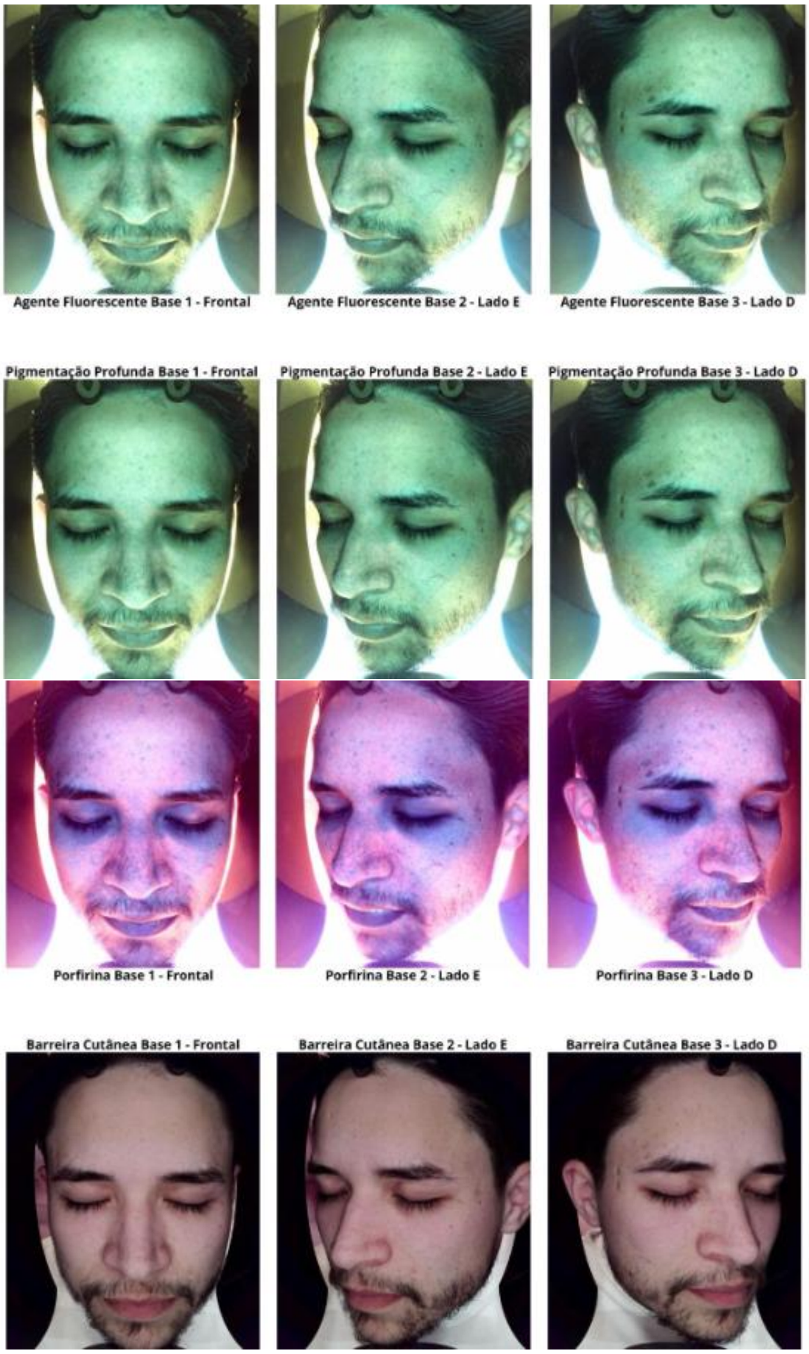
Identification of inflammatory areas: Can highlight areas of chronic inflammation or fungal infections, such as pityriasis versicolor, by means of specific fluorescence.

Therapeutic monitoring: Useful in monitoring the effectiveness of lightening, depigmenting and photoprotective agents, assessing pigment reduction and control of accumulated radiation.

According to Ortonne (2009), UV radiation is capable of highlighting subclinical photoaging and changes in melanogenesis that precede the appearance of visible spots. Biophotonics studies show that UV light activates the fluorescence of compounds in the epidermis and superficial dermis, such as melanin, oxidized keratin and bacterial porphyrins, allowing lesions to be visualized in their early stages (Jacques, 2013; Wölfle et al., 2014).

The clinical use of this technology has become essential for prevention and early diagnosis, and is widely used in dermatology and, more recently, in advanced aesthetics with the aid of artificial intelligence, such as the Vision DNA 12D system, which interprets these spectral images with algorithms that cross-reference pigmentary, inflammatory and structural data with greater precision.

The twelve images obtained through ultraviolet (UV) light capture allowed in-depth analysis of changes not visible to the naked eye. The records provided relevant diagnostic data, such as the presence of hyperpigmentation, identification of fluorescent agents, assessment of the integrity of the skin barrier and detection of porphyrins (Figures 35 to 47).



Wood's Lamp

The Wood's Lamp, which emits ultraviolet radiation in the range of approximately 365 nm, is a classic instrument in dermatology, now integrated into modern facial analysis systems, such as Vision DNA 12D. Its main function is to generate fluorescence in the skin, highlighting structural and biochemical changes not visible in natural light.

Through the fluorescence of certain compounds present in the skin — such as porphyrins, melanin, oxidized lipids and keratin degradation products, the Wood's lamp allows a detailed assessment of the integrity of the skin barrier, in addition to the identification of pigmentary and microbiological disorders.

Analysis of the skin barrier function: Highlights areas of dehydration (which appear opaque) and excess oiliness (bluish glow), contributing to the diagnosis of dysfunctions in the epidermal barrier.

Detection of epidermal spots: Increases the contrast of superficial hyperpigmentation, such as melasma, freckles, solar lentigines and post-inflammatory dyschromias.

Identification of skin infections: Highlights fungal infections (such as pityriasis versicolor, with golden fluorescence) and bacterial infections (such as erythrasma, which shines in a coral tone).

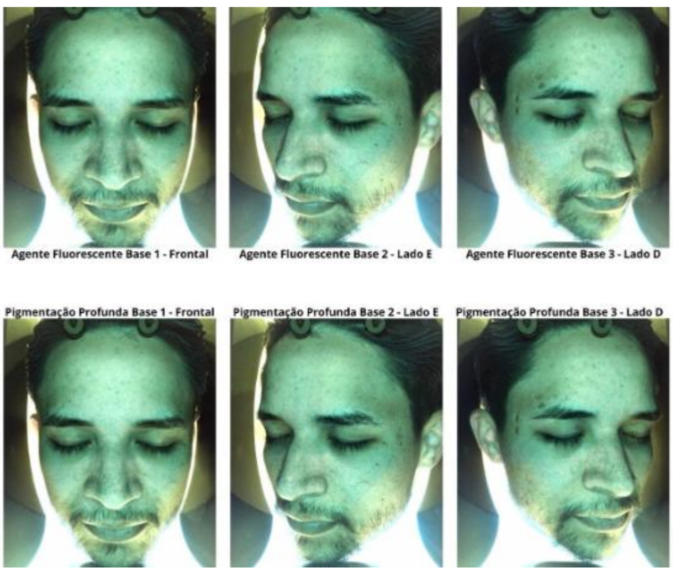
Assessment of oiliness: Regions of excessive oiliness reflect bluish or whitish fluorescence, facilitating the diagnosis of seborrheic skin.

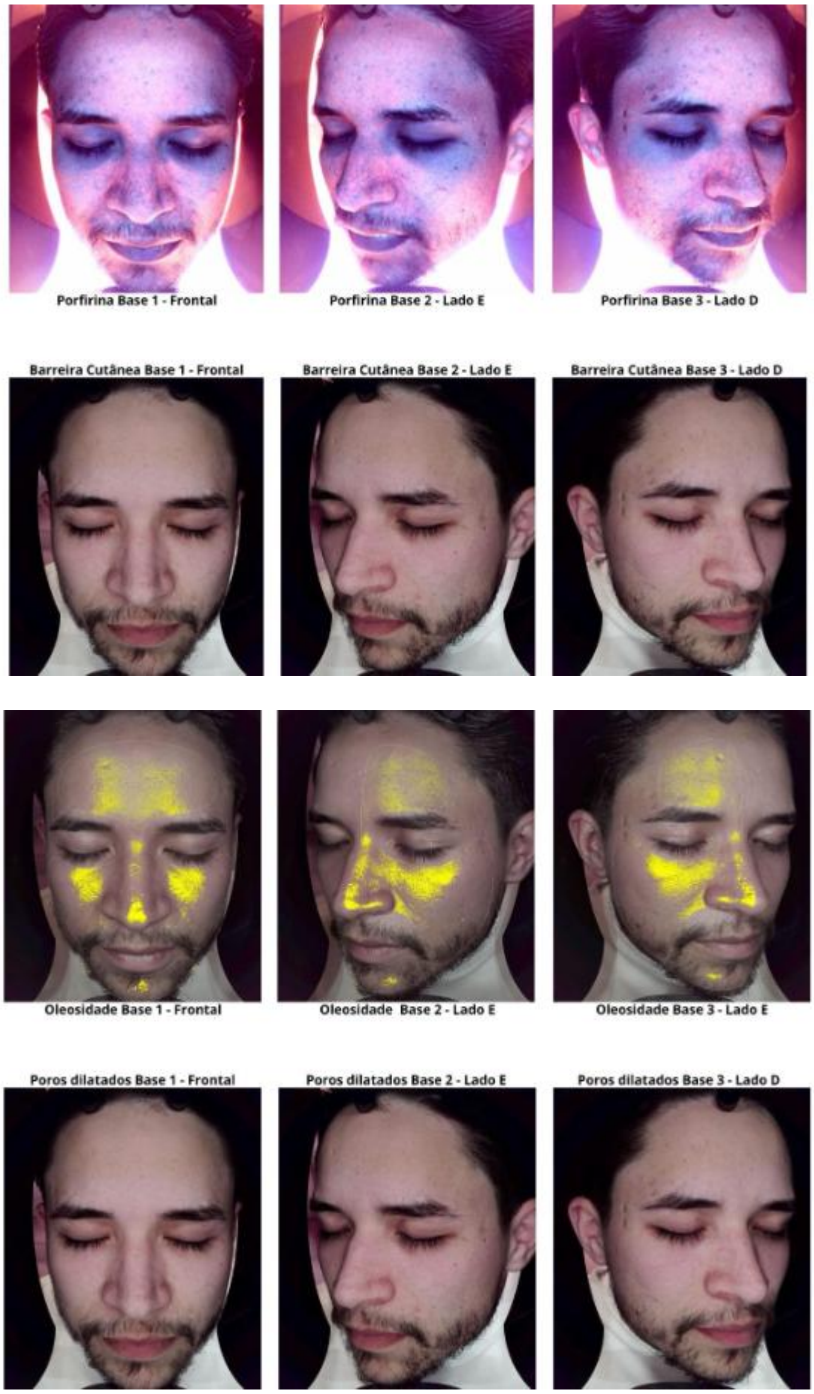
Visualization of subclinical disorders: Allows the identification of changes before they are clinically visible, such as microcracks, sensitized areas, microinflammations and impairment of the hydrolipidic film.

Emission in the UV-A range (365 nm) excites fluorophores present in the skin, causing fluorescence that varies according to the type of tissue, the presence of melanin, lipids or microorganisms (Cox & Cohen, 1995; Wölfle et al., 2014). The Wood's lamp is widely used in dermatological practice and is described as highly effective in detecting pigmentary disorders, barrier integrity and infections.

Currently, when combined with artificial intelligence systems such as Vision DNA 12D, this tool not only increases diagnostic accuracy but also quantifies changes, cross-referencing data with other spectral images to develop more accurate diagnoses and personalized therapeutic plans (Lee et al., 2020).

The eighteen images obtained through Wood's light capture allowed the analysis of skin characteristics that are not perceptible to the naked eye. The records provided relevant diagnostic data, including the presence of hyperpigmentation, identification of fluorescent agents, assessment of the integrity of the skin barrier, detection of porphyrins, visualization of dilated pores and accumulation of oil (Figures 48 to 66).





Brown Lamp

The Brown Lamp, which operates in the visible light spectrum with a predominance of yellow to brownish bands (approximately 580–620 nm), is a specific source used to enhance the visualization of pigments derived from melanin, both at a superficial (epidermis) and deep (dermis) level.

Unlike UV light, which detects subclinical changes through fluorescence, the brown lamp promotes selective reflection on melanin, highlighting areas with greater pigment density, making it a highly effective tool in the evaluation of complex pigmentary lesions, such as dermal melasma, solar melanosis and mixed hyperpigmentation.

Differentiation of stain depth: Highlights both superficial (epidermal) and deep stain pigmentation, allowing the assessment of the degree of dermal involvement.

Accurate analysis of melasma: The lamp intensifies the contours and density of stains, being crucial in defining whitening, laser or peeling protocols.

Identification of freckles, solar lentigines and post-inflammatory hyperpigmentation: Enhances the visibility of small and medium-sized pigmented lesions.

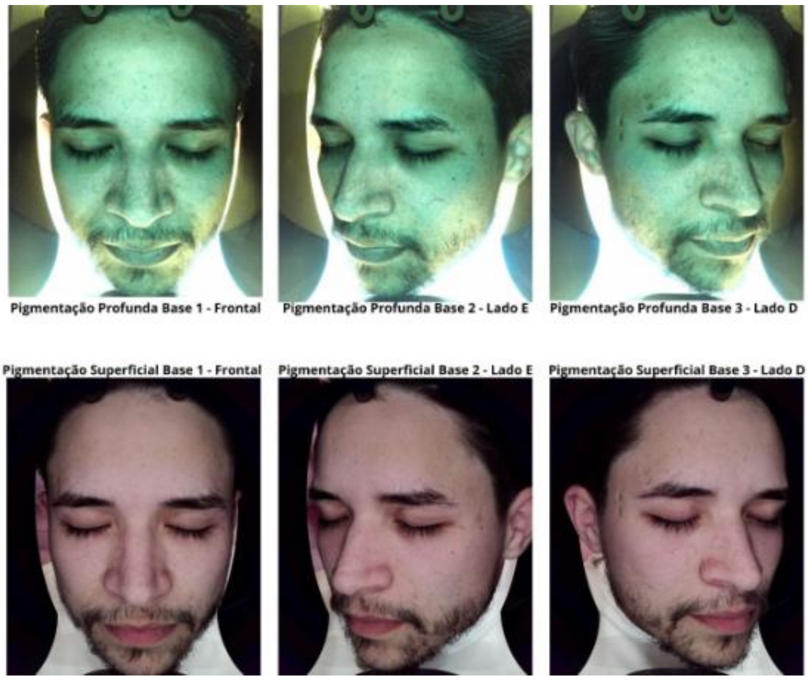
Monitoring of therapeutic efficacy: Allows you to monitor the progress of lightening treatments, assessing the reduction of pigment in an objective and precise manner.

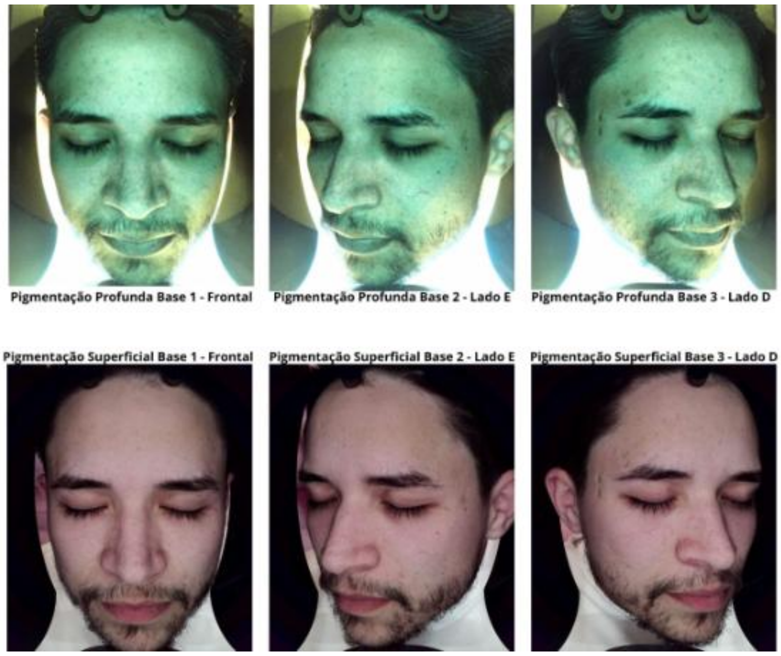
Assistance in differential diagnosis: Differentiates pigmented spots from other chromatic alterations, such as erythema, which do not stand out under this light.

Biomedical optics studies demonstrate that melanin has an absorption spectrum that is highly responsive to yellowish to reddish light bands (580–620 nm), which makes the brown lamp an accurate tool in identifying deep and mixed pigmentation (Anderson & Parrish, 1981; Jacques, 2013).

This technology is particularly relevant in clinical practice, as it allows the three-dimensional distribution of melanin to be assessed, contributing to more assertive therapeutic planning, especially in cases of refractory melasma and resistant hyperpigmentation. When combined with artificial intelligence, as in Vision DNA 12D, it provides quantitative data that refines the diagnosis and personalization of treatments.

The twelve images obtained through brown light capture enabled the analysis of skin pigmentation changes. The records provided relevant diagnostic data, including the presence of hyperpigmentation, superficial spots, melasma and brown pigmentation (Figures 67 to 78).





Red Light

The inclusion of the Red Lamp, which emits light in the near infrared spectrum (NIR — Near Infrared, between 700 and 900 nm), is extremely important in the composition of the 8 spectral lights, as this range has a greater capacity for tissue penetration, crossing the layers of the epidermis and reaching deep into the papillary and reticular dermis.

This optical characteristic allows an assessment that goes beyond superficial parameters, contributing to a more comprehensive analysis of the structural quality of the skin, essential in aesthetics, dermatology and aesthetic medicine protocols, such as:

Assessment of dermal density: Infrared light reveals optical attenuation patterns related to the quantity and organization of collagen and elastin, allowing the diagnosis of sagging, dermal aging and degradation of the extracellular matrix (Wang et al., 2020).

Analysis of collagen loss: Changes in the reflection and dispersion of NIR light are directly associated with the loss of collagen density, making it possible to visualize the reduction of skin support.

Diagnosis of tissue sagging: The lamp highlights the disorganization of collagen and elastic fibers, and is essential for indicating biostimulation treatments, microfocused ultrasound, radiofrequency and injectable biostimulants.

Mapping of the biological terrain: Allows for observing changes associated with the impairment of deep hydration, glycation, tissue aging and degradation of the dermal support barrier.

An essential complement to superficial analyses: While lamps such as UV, Wood, Brown and Polarized focus on epidermal dysfunctions (such as spots, oiliness, pores and texture), the Red Lamp expands the analysis to the dermal compartment, providing a three-dimensional view of the skin's health.

Without it, the assessment would be restricted to the most visible and superficial manifestations, leaving aside structural aspects that are crucial in indicating treatments for rejuvenation, biostimulation, firmness, elasticity and prevention of aging.

The nine images obtained using red light enabled the visualization of inflammatory, vascular and structural changes in the skin. The records provided relevant diagnostic data, including the presence of active acne, evidence of blood vessels, identification of skin lesions, and analysis of the quantity and organization of collagen and elastin fibers (Figures 79 to 87).

Purple Light (mixed)

The Purple Lamp, also called mixed light or combined spectrum, results from the combination of different bands of the light spectrum, generally involving wavelengths from the visible regions (white and blue light) and ultraviolet. This light mixture generates an amplified visualization of skin characteristics that, in isolation, would not be clearly perceived in a single light source.

Panoramic and integrated view of the skin allowing simultaneous observation of spots, pores, texture, oiliness and inflammation, based on optical interactions at different depths (epidermis and superficial dermis).

Improving diagnostic accuracy by combining spectra, the Purple Lamp allows cross-identification of patterns, facilitating the diagnosis of complex conditions such as mixed melasma, sensitive dermatitis with an inflammatory component and acne associated with porosity and oiliness.

Reduction of errors due to overlapping tissue lesions with the composite view prevents deep spots from being confused with superficial erythema, or irregular texture from being misinterpreted as hyperpigmentation, for example.

Support for sensitive skin and higher phototypes with the combination of spectra provides sufficient contrast even in phototypes IV to VI, in which white light or UV alone may be limited.

Ease of personalized protocols highlighting areas of sebum accumulation, superficial dysbiosis and irregular texture, aiding in the selection of products such as exfoliants, anti-inflammatories and barrier regulators.

Although the use of "mixed light" (violet or purple) in diagnosis is not widely standardized in isolated studies, its application is based on the principle of spectral overlap — widely studied in dermatoscopy and multispectral clinical photography.

The use of multiple light sources in spectral capture allows a three-dimensional analysis of the skin, considering its different layers. Studies show that the interaction of light with biological tissues varies according to wavelength: shorter wavelengths (UV) are absorbed in the superficial layers, while longer wavelengths (red and infrared) penetrate deeper, reaching the dermis (Jacques, 2013; Wang et al., 2020).

This methodology is especially relevant in aesthetic clinical practice, as it allows not only the precise identification of visible dysfunctions, but also the detection of subclinical changes, often imperceptible to conventional visual analysis. This translates into more personalized and effective protocols, in addition to rigorous evolutionary monitoring, based on objective and comparative data (Lansang & Kwong, 2020; Kim et al., 2021).

The three images obtained through purple light capture allowed in-depth analysis of marks related to skin aging. The records provided relevant diagnostic data, including the presence of wrinkles and rhytids in different degrees (Figures 88 to 90).

Rugas Base 1 - Frontal   Rugas Base 2 - Lado E   Rugas Base 3 - Lado D

Multidimensional Skin Diagnosis Based on 16 Functional Parameters: Integrating the Baumann Method with Vision DNA 12D

Accurate and individualized skin analysis is a growing requirement in aesthetic clinical practice. In this context, the use of Dr. Leslie Baumann's skin classification method (2005), widely validated in dermatology, offers a robust structure based on four functional axes: oiliness, sensitivity, pigmentation and aging. These axes, when combined, give rise to 16 distinct skin types, guiding effective and safe treatment protocols.

Vision DNA 12D technology, by using 8 multistructural spectral images, allows for the objective and standardized capture of clinical parameters that support the evaluation of these 16 biotypes, contributing with quantitative and comparative data that facilitate clinical reasoning and personalized therapy.

Parameters Evaluated and their Clinical Importance

Below, we describe the 16 analysis points performed by the system, correlating them with the four Baumann axes and their therapeutic implications:

Vision DNA 12D Analysis Table

Vision DNA 12D Parameter	Baumann Axis	Clinical and Therapeutic Importance
Oiliness	Oiliness	Determines indication for sebum regulators, peels, and deep cleansing (Baumann, 2006).
Enlarged pores	Oiliness / Sensitivity	Related to sebum production and skin texture; guides use of fractional laser, radiofrequency, or skinboosters (Luebberding et al., 2015).
Comedones (blackheads)	Oiliness / Sensitivity	Indicator of comedonal acne; guides the use of retinoids, extractions, or plasma jet.
Superficial spots	Pigmentation	Assessed with UV light, indicate epidermal hyperpigmentation (accumulated melanin); treatable with topical brighteners and peels (Ortonne, 2009).
Mixed and deep spots	Pigmentation	Suggest dermal melasma or mixed PIH; indication for technologies like Nd:YAG laser, LED, and intensive depigmenting agents.
Wrinkles	Aging	Reflect collagen/elastin loss; indicate use of microfocused ultrasound, biostimulators, or botulinum toxin (Fisher et al., 2002).
Porphyrins	Oiliness / Sensitivity	Detected under UV light, indicate presence of Cutibacterium acnes; aid in choosing antibacterials or blue light therapy.
Inflammatory acne	Sensitivity	Suggests the need for anti-inflammatory therapies and microbial control.
Thermal sensitivity barrier	Sensitivity	Assesses neurovascular inflammation and rosacea tendency; guides use of calming agents, antioxidants, and technologies with thermal control.
Pigment thermal sensitivity	Pigmentation / Sensitivity	Crucial for defining melasma type and personalized photoprotection (Passeron et al., 2019).
Collagen (dermal density)	Aging	Analyzed under red light; fundamental to indicate biostimulators, microfocused ultrasound, and radiofrequency.
Barrier fragility	Sensitivity	Indicates alterations in lipid barrier function and need for replenishment with ceramides, niacinamide, etc.
Moisture (hydration)	Oiliness / Sensitivity	Important to define the need for active hydration, topical/injectable hyaluronic acid.
Accumulated photoaging	Aging / Pigmentation	Indicates chronic UV exposure; important for antioxidants, brighteners, and dermal regeneration therapies.

Digital Skin Analysis Technologies: From Imaging to Artificial Intelligence in Treatment Personalization

Current Overview of Digital Skin Analysis Platforms

In recent years, advances in digital dermatology have led to the development of systems capable of performing facial assessments with a high degree of precision, using high-resolution image sensors, multiple light spectra, and analysis algorithms based on artificial intelligence (AI). Some of the most widely used equipment today are:

Visia® (Canfield Scientific)

Observ® (Sylton)

Vision DNA 12D® (DNA Med do Brasil)

The three images presented refer to the Vision 12D equipment used in the analyses, illustrating its structure from different angles. The front, right side, and left side views provide a complete view of the device, highlighting the optical configuration, magnification features, and functional design used in skin assessments (Figures 91 to 93).

Equipamento Vision 12D - Visão Frontal Equipamento Vision 12D - Visão Direita Equipamento Vision 12D - Visão Esquerda

Image Quality and Diagnostic Accuracy

Digital image quality is one of the determining factors in diagnostic accuracy. State-of-the-art equipment, such as the Vision DNA 12D, captures images with more than 36 million pixels, increasing the sharpness of details in the epidermis and dermis. Multichannel spectral analysis with eight different lamps allows the identification of parameters such as: spots, pores, wrinkles, sensitivity, collagen, oiliness, and others.

This multispectral approach is validated by studies that demonstrate that the combination of different light sources improves the ability to detect skin changes early, increasing the sensitivity and specificity of the diagnosis (Zhao et al., 2017; Barata et al., 2021).

Integration with software and artificial intelligence for therapeutic personalization

The contemporary differential of these platforms is the use of artificial intelligence (AI), which transforms digital analysis into a predictive and strategic tool. Integrated software interprets the captured data, cross-referencing it with clinical databases and machine learning algorithms to:

Classify the skin according to functional models (such as Leslie Baumann's);

Assign objective scores to each analyzed skin parameter;

Generate personalized reports with evidence-based treatment suggestions.

This functionality allows clinics to offer personalized treatments, directly connecting the visual diagnosis with specific aesthetic or dermatological protocols for each type of complaint: spots, acne, wrinkles, sensitivity, sagging or dehydration.

The use of AI in aesthetic dermatology has shown promising results in improving diagnostic accuracy and monitoring the evolution of patients, reducing clinical subjectivity (Jalalian et al., 2019; Esteva et al., 2017).

Integration of Artificial Intelligence in Digital Facial Assessment

The incorporation of artificial intelligence (AI) into digital facial analysis systems represents a disruptive advance in the field of clinical aesthetics. Unlike traditional manual assessments, which are limited by subjectivity and interprofessional variability, AI enables faster, more accurate, and standardized diagnoses. The application of machine learning and deep learning algorithms — advanced forms of computational learning that allow embedded systems to process large volumes of dermatological data and identify patterns of skin changes with accuracy comparable to that of trained specialists (Esteva et al., 2017; Zhou et al., 2020).

In clinical practice, this innovation is clearly observed in devices such as the Vision DNA 12D, which integrates AI directly into its proprietary software. This intelligence is neither open nor connected to the cloud: all processing occurs within the system itself, safely and quickly. In an average time of just 2 minutes and 12 seconds, the equipment captures 8 spectral images from 3 different facial angles: frontal, right side and left side — covering 180 degrees of facial anatomy. This multispectral scan allows real-time mapping of epidermal and dermal structures, based on specific lights (UV, visible, polarized and mixed), each highlighting different markers of skin health, such as pigmentation, texture, wrinkles, oiliness, thermal sensitivity, presence of porphyrins and collagen density (Barata et al., 2021; Tunnell et al., 2013).

One of the greatest advantages of the technology embedded in Vision DNA 12D is the ability to integrate this analysis with personalized prescription protocols. The data collected is automatically interpreted by the system, which generates a technical report containing the functional classification of the skin (based on the Leslie Baumann method), the points of dysfunction detected, and therapeutic suggestions compatible with the resources and treatments available in the clinic. In addition, the system offers an innovative feature: a projection of the future of the skin in five years, based on algorithmic beauty algorithms and the current behavior of the skin. This simulation is presented to the patient with two visual scenarios — one with appropriate treatment and the other without intervention — promoting greater therapeutic adherence and emotional engagement, in addition to providing visual support for clinical reasoning and aesthetic planning.

Therefore, the use of artificial intelligence applied to facial aesthetics represents not only a technological evolution, but a new diagnostic methodology with concrete clinical benefits: reduction of consultation time, standardization of analysis, early detection of dysfunctions, and therapeutic personalization based on real and objective data. This model, by combining data science with aesthetic practice, repositions the healthcare professional as a precision clinical analyst, increasing the predictability and safety of the treatments offered.

SKIN MICROSCOPY

In addition to automated spectral analysis, the Vision DNA 12D device incorporates a complementary step based on portable digital surface microscopy, specifically applied to measure the level of skin hydration. This assessment is performed by microscopic capture of the surface texture in four strategic regions of the face: forehead, right cheek, left cheek and chin. The captured images are analyzed by a pattern recognition algorithm that interprets the presence of grooves, shine, flaking and irregularity on the skin surface — clinical indicators of the presence or absence of water in the epidermis.

The results are classified on a scale from A to E, where:

A = excellent hydration (≥ 49%),

B = good hydration (30–48%),

C = moderate (15–29%),

D = low (5–14%),

E = critical hydration (< 5%).

This index is essential for interpreting the functional health of the skin, as hydration is directly related to the integrity of the skin barrier, the coherence of the stratum corneum, the ability to defend against external agents, and the support for electrotherapeutic, chemical, or injectable treatments (Verdier-Sévrain & Bonté, 2007; Voegeli et al., 2020).

Several studies show that dehydrated skin presents greater transepidermal water loss (TEWL), favoring sensitivity, inflammation, and irritability, in addition to impairing the physiological response to aesthetic procedures (Proksch et al., 2008). As a result, hydration analysis with microscopy becomes a decisive clinical criterion, even allowing the postponement or suspension of aggressive treatments (such as peels or lasers) until the skin is in better physiological conditions, protecting the patient from adverse effects and optimizing therapeutic results.

By providing objective data on the water content of the epidermis, this methodology helps professionals to recommend moisturizers with moisturizing, occlusive and emollient action according to the biotype and degree of deficiency identified, in addition to adjusting personalized protocols with greater clinical safety and scientific basis.

In addition to the hydration sensors, the same equipment is also equipped with a magnifying lens with magnification capacity of up to 400 times, allowing detailed and microscopic analysis of the skin, such as regions with inflammatory processes, nevi, areas of greater sensitivity, scars, hyperpigmentation, dilated pores, scalp, among others.

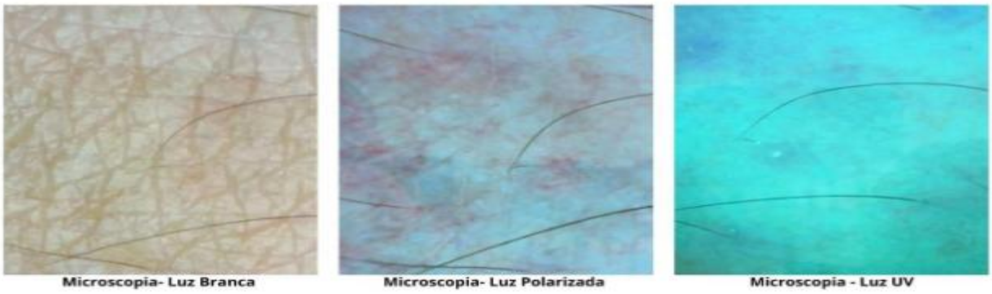
The system allows the recording of images in up to three distinct light spectra — white light, polarized light and ultraviolet light — which contributes to a more comprehensive dermatological evaluation. This multimodal approach facilitates the identification of changes and structures, promoting greater diagnostic accuracy and allowing objective monitoring of the patient's clinical evolution.

The two images presented refer to the microscopy equipment used in the morphological analyses, highlighting its structure, optical configuration and magnification resources employed during the examinations (Figures 94 and 95).

Microscopia Base 1

Microscopia Base 2

The three images obtained through optical microscopy with 400x magnification, using the Vision 12D system, allowed detailed morphological analysis of the skin structures at the cellular level. The equipment allowed for magnified observation of characteristics such as tissue organization, presence of structural alterations and integrity of the superficial layers of the skin (Figures 96 to 97).



II. METHODOLOGIES USED

The application of artificial intelligence in facial analysis requires a rigorous methodology, which begins with the standardized image collection stage. This process involves controlling multiple variables that directly affect diagnostic quality, such as ambient lighting, patient position, facial symmetry, camera angle, and neutrality of facial expression. Devices such as the Vision DNA 12D use a closed cabin with a fixed structure to ensure repeatability, minimizing external noise and promoting ideal spectral capture conditions, with highly defined images, greater than 36 megapixels.

The generated images are submitted to an embedded AI system that was previously trained with extensive dermatological databases and with characteristics of Brazilian skin miscegenation, with variations in miscegenation and use of geolocation through software connection and use of the internet to connect to the database size, composed of thousands of clinical and photographic records with different phototypes, age groups, genders, and skin conditions. The curation of this data is essential for machine learning algorithms to learn to recognize patterns with a solid statistical basis, enabling the extraction of morphological characteristics of the skin with high accuracy (Esteva et al., 2017; Barata et al., 2021). With the use of deep learning, the system is able to refine its diagnostic performance as it processes new clinical data, becoming increasingly accurate and contextualized.

During the analysis, the software automatically measures several skin parameters, including: wrinkle scale (depth and extension), density and diameter of dilated pores, presence of comedones, porphyrins, superficial pigmentation (such as post-inflammatory hyperpigmentation), deep spots (such as dermal melasma), redness, irregular texture and thermal skin sensitivity. Based on this data, the system classifies the skin according to functional axes, such as oiliness, sensitivity, pigmentation and aging, based on the Baumann classification model (2005).

In addition to diagnostic assessment, this methodology can be applied to formulate personalized clinical protocols. For example, in patients with associated hyperpigmentation and dehydration, AI can indicate the combination of superficial chemical peels, hydration with hyaluronic actives and light technologies (such as LED or IPL). In cases of deep wrinkles and sagging, the prescription can include microfocused ultrasound, collagen biostimulators and fractional photothermia, according to individualized findings. In case studies carried out in clinical practice with Vision DNA 12D, a significant improvement in treatment adherence was observed when patients visualized their skin data and future aesthetic projection — highlighting the educational and persuasive potential of AI in the clinical context.

Thus, the methodology based on artificial intelligence offers a robust diagnostic analysis model that is standardized, reproducible and capable of supporting clinical reasoning based on concrete data, strengthening the therapeutic link and optimizing aesthetic results.

Shape

CLINICAL AND AESTHETIC APPLICATIONS

The use of artificial intelligence (AI) in facial analysis equipment allows the precise identification of individual skin parameters, such as oiliness, sensitivity, pigmentation and aging. This automated reading allows the customization of protocols based on objective data and not just on subjective clinical observation. Frank et al. (2024) emphasize that AI-assisted systems increase diagnostic accuracy and promote greater individualization of aesthetic procedures.

In addition to monitoring treatment through images, it allows the quantification of subtle changes in the skin that could go unnoticed by the naked eye.

AI also stands out in the formulation of evidence-based therapeutic plans. According to Pérez et al. (2025), modern digital diagnostic systems cross-reference clinical data with clinical databases, which results in indications of active ingredients for topical use and procedures with a greater probability of clinical success, when associated with the visual presentation of the diagnosis, associated with the projection of future skin with and without treatment, promotes greater patient understanding and engagement with the therapeutic proposal. Matsuki et al. (2022) state that the AI-patient interface increases confidence in treatment, reduces doubts and improves adherence to the prescribed aesthetic plan.

The use of analyzers with AI allows the generation of technical reports that can be used in educational campaigns, respecting ethical principles of health communication. Being an ally in clinical marketing when associated with transparency, clear information and the presentation of real data, reinforcing the credibility of the professional.

LIMITATIONS AND CHALLENGES

Despite the technological advances promoted by artificial intelligence in facial analysis, there are important limitations that must be considered for ethical and effective application. Diagnostic accuracy is directly linked to the quality of the images captured, which requires a controlled environment, absence of makeup, standardized lighting, and exact positioning of the patient — conditions that, if neglected, compromise the accuracy of the data generated. In addition, the machine learning algorithms used in these systems are trained with databases that often do not take into account the ethnic and phototypical diversity of the Brazilian population, which can generate bias in the interpretation of parameters such as spots, sensitivity, and texture in black, brown, and mixed-race skin. Another critical point involves privacy and ethics in the use of facial biometric data: even if processing occurs locally, the collection of sensitive visual information requires clear consent, secure storage, and transparency regarding the use of data, especially in commercial contexts. Finally, the high cost of high-tech equipment and the infrastructure required to operate them still limit access by independent professionals or small clinics, creating a barrier to the democratization of this innovation and reinforcing inequalities in access to evidence-based aesthetics.

Dependence on image quality.

Biased algorithmic training (e.g., underrepresented phototypes).

Ethical and privacy issues regarding biometric data.

Cost of equipment and accessibility for small practices.

FINAL CONSIDERATIONS

The advancement of artificial intelligence (AI) applied to facial aesthetics represents a milestone in the transformation of clinical practice, especially when associated with high-resolution spectral imaging technologies, such as the Vision DNA 12D system. The ability to integrate objective, accurate, and comparative data on multiple skin parameters such as oiliness, pigmentation, sensitivity, aging, and barrier integrity promotes a new era in precision, evidence-based aesthetic diagnosis.

The automated analysis of 16 fundamental skin parameters, based on the functional classification proposed by Leslie Baumann, allows a comprehensive reading of the skin's biological profile. This favors the indication of more personalized, safe and effective treatments, with the potential to significantly improve clinical results and patient satisfaction.

However, the use of intelligent tools does not replace clinical reasoning. On the contrary, it requires that the aesthetics and health professional have technical mastery, critical vision and up-to-date training to correctly interpret the findings and integrate them into an ethical, personalized and scientifically based therapeutic approach.

Therefore, the need for specific training, standardization of protocols and ethical responsibility in the use of these technologies is highlighted. AI is a powerful ally, but its potential is only fully realized when used by trained professionals, committed to the scientific evolution of aesthetics and to valuing the health and well-being of patients.

In short, the incorporation of artificial intelligence into the facial aesthetics routine signals a promising and transformative path, capable of repositioning the aesthetic professional as the protagonist of a more accurate, technological and individual-centered clinical approach.

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