Objective Facial Assessment With Artificial Intelligence: Introducing the Facial Aesthetic Index and Facial Youthfulness Index

Sonja Sattler MD,[a] Konstantin Frank MD,[b] Martina Kerscher MD PhD,[c] Sebastian Cotofana MD PhD,[d] Tatjana Pavicic MD,[e] Berthold Rzany MD PhD,[f] Peter Peng MD PhD,[g] Rainer Pooth MD PhD[h]

[a]Rosenparkklinik, Darmstadt, Germany
[b]Department of Hand, Plastic, and Aesthetic Surgery, Ludwig Maximilian University, Munich, Germany
[c]Division of Cosmetic Science, Department of Biochemistry and Molecular Biology, University of Hamburg, Hamburg, Germany
[d]Centre for Cutaneous Research, Blizard Institute, Queen Mary University of London, London, UK
[e]Private Practice for Dermatology & Aesthetics, Munich, Germany
[f]Medizin am Hauptbahnhof, Wien, Austria
[g]Department of Dermatology, Tri-Service General Hospital, National Defense Medical Center, Taipei, Taiwan
[h]Clinical Research & Development, ICA Aesthetic Navigation GmbH, Frankfurt, Germany

INTRODUCTION

Facial appearance has a substantial impact on psychosocial wellbeing, which may be considered an essential aspect of overall health. Cosmetic rejuvenation using a multimodal approach has been demonstrated to restore a sense of wellness for many patients, with improvements in mental health and self-confidence. Optimal care and treatment outcomes in many fields of medicine rely on objective evaluation metrics rooted in science, and clinicians are increasingly turning to digital health tools to aid in diagnosis and patient management. In aesthetic medicine, assessment is largely subjective and carries a high risk of bias, and dermatology-specific uses account for only a small fraction of available digital tools. A new application using artificial intelligence (AI) has been developed to standardize facial landmarks and characteristics for consistent, unbiased assessment in aesthetic medicine. A detailed analysis of large data sets across gender, age, and ethnicity groups validated by digital images and live assessments contributed to the development of the Facial Aesthetic Index (FAI) and Facial Youthfulness Index (FYI), AI-based algorithms that can identify and prioritize potential interventions for individualized treatment recommendations and provide users with a visible history of treatments and results. As both a diagnostic aid and consultation assistant, the FAI and FYI reflect a holistic impression of facial attractiveness using mathematically selected predictors and have the potential to set a new standard of care in aesthetic rejuvenation.

Demand for Objective Measurements in Aesthetic Medicine

According to the World Health Organization (WHO), health is not merely the absence of disease or infirmity but is defined as a state of complete physical, mental, and social well-being.[1] Facial attractiveness has a demonstrated effect on perceived biological health, mental health, and socioeconomic dimensions.[2,3] The abrupt shift to video conferencing during the pandemic has led to increased self-scrutiny and subsequent increase in demand for both surgical and non-surgical aesthetic procedures.[4] Research has demonstrated that a multimodal approach to full facial rejuvenation not only improves self-perception of age but also may significantly improve psychological well-being and self-confidence.[5] Optimal patient care and satisfaction relies on an objective understanding of aesthetics and beauty, but therein lies the difficulty: there is a lack of objective pre- and post-assessment tools for comprehensive treatment in the largely subjective field of aesthetic medicine.[6]

Many medical specialties rely on objective diagnostic criteria and outcome assessment based on scientific evidence and measurable treatment response. In aesthetic medicine, there is a lack of standardized, impartial evaluation metrics for assessment and treatment. There are validated scales[7,8] that assess the appearance of certain features, such as jowls, nasolabial folds, lateral canthal lines, or infraorbital hollows, but they still require a subjective assignment of severity or grading and fail to provide a complete picture of the aging face. There is no universally accepted definition of beauty and attractiveness.[9] Ratios and equations can be used to assess symmetry and proportions for a mathematical appreciation of beauty, but the perception of attractiveness is multidimensional and easily influenced by other factors, such as an individual's self-esteem, apparel, and confidence.[10-12]

Clinicians carry inherent biases informed by cultural background, geographic location, familiarity, individual visual environment, social media, peers, and patient population which have an effect on the ability to appreciate "normal" in a patient population and set exact parameters of beauty and attractiveness.[9] This may lead to vastly different aesthetic ideals across providers, subjective perceptions about beauty,

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treatment priorities, and outcomes, and a high risk of inherent bias in the determination of attractiveness and related facial landmarks before and after aesthetic procedures. Without objective metrics, facial rejuvenation relies on an instinctive and deeply personal assessment of beauty married with an in-depth knowledge of anatomy and the aging process. The lack of standardized facial measurements and clear definitions of aesthetic outcomes and beauty are still major obstacles preventing real change in the consultation dynamics to help better serve patients' expectations and subsequently improve satisfaction.[6]
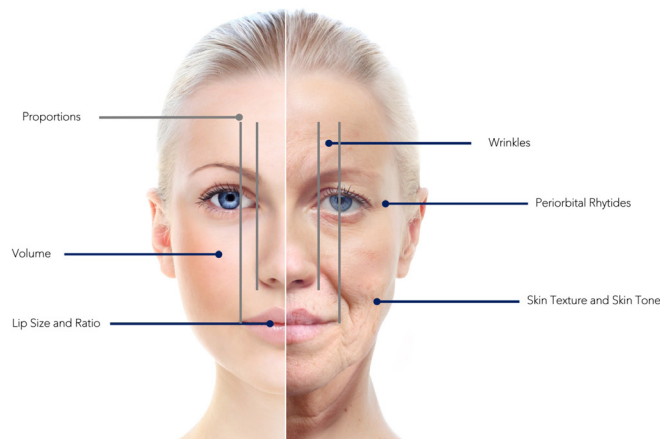
In other fields of medicine, clinicians are increasingly turning to digital health tools to aid in diagnosis and patient management. Innovation in digital health tools brings new approaches to the management of health conditions and holds great promise for improving human health.[13] Now an established part of the digital health landscape, the number of health-related mobile applications topped 350,000 in 2021, and there are rising efforts to fit digital health into clinical practice, as evidenced by the increasing inclusion of digital health tools in clinical trials and treatment guidelines. When broken down by therapeutic area, mental health, diabetes, and cardiovascular disease–related apps dominate, while dermatology accounts for only a small fraction of available disease-specific apps.[13] This may be surprising but also temporary; the rapid rise of teledermatology in recent years will likely lead to further development of patient-directed technology and artificial intelligence (AI) as an adjunct to care.[14]

Harnessing Artificial Intelligence in Facial Aesthetics

Artificial intelligence is the development of technology that simulates human cognitive functions.[15] In healthcare, the most promising application of AI involves machine learning, which consists of computer-based algorithms that use historical data to extract knowledge and interpret meaning—in other words, to learn.[16] The dominant AI technology for analyzing high-dimensional complex data, such as images, is deep learning, a subset of machine learning.[17] Deep learning harnesses mountains of data using a sophisticated artificial neural network, a collection of algorithms designed to process raw data (such as images) and produce an output (eg, diagnosis) with the least amount of error and without being told to do so. Arranged in multiple layers, these neurons, represented by algorithms, learn to recognize patterns and intricate structures in large data sets and adapt their connections in response, much like the human brain.[18,19]

In dermatology and dermatologic surgery, where visual analysis is the cornerstone of diagnosis, AI has the potential to improve patient care, and there is an upward trend in its use as a diagnostic aid for automatic detection of skin lesions, such as melanoma and non-melanocytic skin cancers, psoriasis, acne, dermatitis, and onychomycosis.[18,20] Its ability to perform

FIGURE 1. Individualized analysis provided by the FAI.

comprehensive analysis with large amounts of nonlinear data makes it a favorable aid for medical decision-making[20]; as such, it has been used successfully in various aspects for the ongoing dermatologic management of certain autoimmune disease[21] and in surgical settings, such as biopsy[22,23] and laser hair removal[24] and restoration.[25] Of particular interest for facial rejuvenation is the discovery that AI can accurately estimate a patient's true age before plastic surgery and predict age reduction postoperatively.[16,26]

Standardized Assessment: The Facial Aesthetic Index and Facial Youthfulness Index

A new digital health tool aims to provide a computer-based analysis of images for an objective evaluation of facial parameters while reducing the risk of subjective bias in aesthetic patients. The Facial Aesthetic Index (FAI; Caarisma®, ICA Aesthetic Navigation GmbH, Frankfurt, Germany) is an AI-based algorithm based on the detailed analysis and subsequent validation of over 200 original and derived facial variables in more than 15 facial regions to identify and summarize common landmarks of clinical facial features. Using a series of 4 photographs representing 4 different facial expressions, the FAI analyzes and compares a patient's unique characteristics

FIGURE 2. The FAI analyzes individual characteristics of a patient's face to assign a rating of attractiveness on a scale of 1 to 7 at baseline and generate the FYI. These algorithms can then forecast which facial features have the greatest potential for improvement and track treatment outcomes along the aesthetic journey of a patient.

The Aesthetic Evolution objectively demonstrated.

FAI

BEFORE — AFTER

Approx. interval of **+1,5 years**

such as skin texture and tone, proportions, symmetry, volume, and lip size and ratio, as well as the presence and severity of wrinkles (Figure 1) with the average of all recordings in large datasets across gender, age, and ethnicity groups and provides a 7-point FAI rating score that reflects a holistic impression of overall attractiveness using mathematically selected predictors. The facial analysis also generates a Facial Youthfulness Index (FYI), a validated measurement of the user's face in terms of apparent youthfulness that is displayed alongside the FAI. The algorithms can forecast which facial features have the greatest potential for improvement and prioritize key drivers that reflect primary treatment options offering the most benefit for each patient. Facial improvements over time can be observed visually and mathematically, offering visible confirmation of treatment outcomes (Figure 2). The tracking of long-term treatment outcomes with visuals and data may motivate patients to remain compliant with treatment recommendations and provides practitioners with complete documentation and improved quality assurance. In addition, this technology may serve as powerful education and communication tool that may strengthen trust between patients and physicians.

CONCLUSIONS

The WHO Constitution states that enjoyment of the highest attainable standard of health—complete physical, mental, and social well-being—is a fundamental right of every individual.[1] With its unbiased assessment of individual improvement potential and mathematically validated treatment recommendations, the FAI has the potential to contribute to an improvement in overall health and set new standards of care in facial rejuvenation. Aesthetic medicine is long overdue impartial evaluation metrics for assessment and ongoing treatment to provide optimal care and management. Tracking facial improvements over time using data, with demonstrated improvements in the FAI and FYI scores, as well as in visible appearance, represents an important leap in assessment capabilities. The FAI should be incorporated as a reliable measurement tool in clinical research and a standard pre- and post-assessment tool and enhanced consultation assistant in aesthetic clinics to detect primary treatment areas, identify how each would contribute to optimizing individual scores, track treatment history, and demonstrate improvement over time.

DISCLOSURES

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AUTHOR CORRESPONDENCE

Konstantin Frank MD
E-mail:................…........................ konstantinfrank@me.com