

An overview of photometric analysis to evaluate aesthetics in orthodontic patients

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Photometric analysis is a facial aesthetics evaluation method which is useful for diagnosis and treatment planning. This system is increasingly applied since there is growing attention to aesthetic improvement and occlusal correction as objectives of orthodontic treatment. Ten articles regarding aesthetic analysis on photos were identified through scientific archives and analysed. The diagnostic rationale, the scientific reliability and the methods used were identified to help clinicians in their practice. Photometric analysis represents an effective, reliable and cheap system for the analysis of craniofacial morphology of the face profile. This analysis can be achieved in subjective or objective ways; the latter modality provides greater reproducibility of the results as well as a good assessment of the harmony between the external craniofacial structures, including soft tissue contribution; it also provides repeatable and reliable measurements, thus enabling a rapid acquisition of the facial image, with long-term durability. Through facial profile photometric analysis it is possible to obtain proportionality, angular and linear measurements. These measures are useful as parameters for an optimal definition of the conditions of normality, harmony and profile balance.

Any orthodontic treatment causes several changes in the soft tissues, with a consequent significant aesthetic impact (1). To successfully meet expectations on facial aesthetics it is important to understand the impact of orthodontic treatment on it. Studies on craniofacial growth and facial aesthetics typically evaluate soft tissues using cephalometrics, with consequent limitations related to the difficulty in correctly reproducing the “Natural Head Position” and in assessing the real labial and incisal prominence and detailed reproduction of the soft tissues (2). In order to completely evaluate the aesthetics of the face, it is possible to use anthropometry, templates, photographs, videos, 3D reconstructions, lasers and optical surface scanning (3-23).

Photographs are easier to use than anthropometric analyses, allowing also to analyze larger areas and

more details than the templates, with lower costs compared to three-dimensional and laser analysis and avoiding patient exposure to radiation, contrary to what happens with telerradiographs from which cephalometries are extrapolated (24-37). Photometric analysis therefore represents an effective, reliable and cheap system for the analysis of the craniofacial morphology in face profile (38).

The aim of this work was to carry out an overview of the literature to analyze the state of the art regarding aesthetic analysis on photos to draw useful conclusions for clinical practice.

MATERIALS AND METHODS

An initial research of the abstracts was carried out through the scientific archives “PubMed” and

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“Cochrane Library” and the “full text articles” were downloaded in PDF. The following search terms were selected: “photometric analysis”, “photographic analysis”, “aesthetic analysis” or “soft tissue profile”. The research was limited to the international bibliography in English from 2000 to 2018. From the numerous articles found, only those of major scientific rigor were selected for a total of 10 articles. This allowed to deepen the knowledge present in the literature and to draw some conclusions regarding photographic analysis of facial soft tissue profile.

RESULTS

As observed by Li and Qian, orthodontic treatments produce changes in the soft tissues, with a consequent significant aesthetic impact (1). Many studies have used a subjective evaluation system for analyzing profile aesthetics and changes induced by orthodontic treatment; in particular, Sukhia et al. took into consideration the soft tissue changes resulting from orthodontic treatment by comparing the aesthetic preferences of orthodontists, patients and parents at the beginning and the end of the treatment (39). Similarly, but using a group of external evaluators that included students of art and dentistry alongside the parents of the patients, O'Neill et al. sought to determine the profilometric improvements produced by functional treatment in patients with class II division 1 malocclusion; however, no differences were found between the treated patients and the control group (40). Therefore, it is clear that a purely subjective assessment shows significant limits in terms of the possibility of quantification and reproducibility of the observations, as well as their statistical significance. Since these limits affect the diagnosis and the treatment planning, the use of photo-retouching programs has been proposed in order to visualize the potential aesthetic improvement obtainable thanks to different orthodontic treatments (41-44). However, these are still purely subjective evaluations, which do not allow a “quantification” of aesthetic improvements. Although the photographs are much closer to the real appearance of the face than the radiographs, it emerges that it is necessary to use techniques for the quantitative measurement of the facial structures in order to obtain an objective assessment of the characteristics of the patients' profiles.

Photometric analysis techniques have been proposed in order to obtain an objective and biologically and economically advantageous evaluation of the facial aesthetics. In fact, photographs provide a good assessment of the harmony between external craniofacial structures, including the contribution of soft tissues. Furthermore, they provide reliable measurements which, thanks to the almost zero invasiveness, can be repeated during the intermediate stages of treatment, in order to monitor its progression (45-48).

Through the facial profile photometric analysis, it is possible to obtain proportionality, angular and linear measurements, useful as parameters for an optimal definition of normality, harmony and balance profile conditions (49.) Various studies have attempted to identify the facial features that account for the pleasantness of a face: some classified facial profiles through subjective analysis of the photographs, others studied some structural features that can influence profile aesthetic (50-53).

Fortes et al. conducted a study in order to identify which linear, angular and proportional measures could be considered decisive in influencing the pleasantness of the profile. After a preliminary evaluation by specialists (plastic surgeons and orthodontists) and common people of 150 standardized photographs of the facial profile, classified as “pleasant”, “acceptable” or “unpleasant”, and the selection of the 15 best and 15 worst profiles of the sample, the photographs were scanned using AutoCAD software. Linear, angular and proportional measurements were performed on this scan: they showed a statistically significant difference between pleasant and unpleasant profiles (54).

Once again, Marchiori et al. tried to correlate the cephalometric measurements of the nasolabial angle, of the Holdaway H line and of the distance between the H line and the tip of the nose, in order to overcome a purely subjective assessment of the face profile and to obtain quantitative and statistically relevant data. These measurements were taken on the profile photographs of a sample of 50 subjects (25 males and 25 females, aged between 17 and 24), with the subjective evaluations of a group of common people and orthodontists. From what

emerged, there would be an important relationship between subjective and cephalometric evaluations, demonstrated by the best evaluation attributed to the subjects with a profile presenting little deviations from the normal cephalometric values (55). Similarly, Oh et al. performed a comparative analysis between profile photographs and cephalometries of the same subjects, concluding however that the association between objective data and subjective assessments of facial attractiveness, even though formulated by specialists in orthodontics, was less than expected and substantially poor (56).

In order to obtain more predictable and statistically significant results, a cephalometric analysis of the soft tissues can also be carried out using specific software on patient profile photographs, rather than on lateral teleradiographies. In fact, this is the most effective and efficient method, allowing a simultaneous analysis of various data, as well as greater accuracy and precision in the information collected and in the obtainable results. In particular, Dimaggio et al. elaborated an aesthetic analysis applied to the left profile photographs of a sample of I, II and III dentoskeletal class patients. The evaluation was conducted on upper anterior facial height (N-Sn), lower anterior facial height (Sn-Gn), total facial height (N-Gn), facial convexity (N-Sn-Gn), cutaneous analogue of the angle ANB (Sn -N-SI), nasal prominence (Sn-N-Pn), nasolabial angle (Pn-Sn-Ls), interlabial angle ((Sn-Ls) - (Li-SI)), cutaneous class (Projection of Sn and S1 on the Camper plane). The results showed that, given the highlighted correspondence between the cutaneous and the dentoskeletal class and the significant differences in the parameters considered between I, II and III class patients, this protocol represents a non-invasive, simple and low-cost method: it can provide quantitative and qualitative data, useful as a preliminary diagnostic tool for the evaluation of the facial soft tissues. In addition, this procedure can be repeated during treatment, thus providing useful information on the impact of therapy on the soft tissue appearance (57-59).

DISCUSSION

Although the photometric analysis of the patient's

profile has historically been considered purely practical, more functional to a general clinical setting rather than to an effective diagnostic purpose, it is an essential tool for diagnosis and orthodontic planning. Indeed, it represents an effective, reliable and economic tool, which provides some advantages compared to conventional cephalometry, including the possibility of correctly reproducing the "Natural Head Position", of evaluating the real lip and incisal prominence and of reproducing the soft tissues in detail. The use of objective tools also ensures predictable and statistically significant results, thus allowing the advantages of the two types of images, radiographic and photographic, to be combined.

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